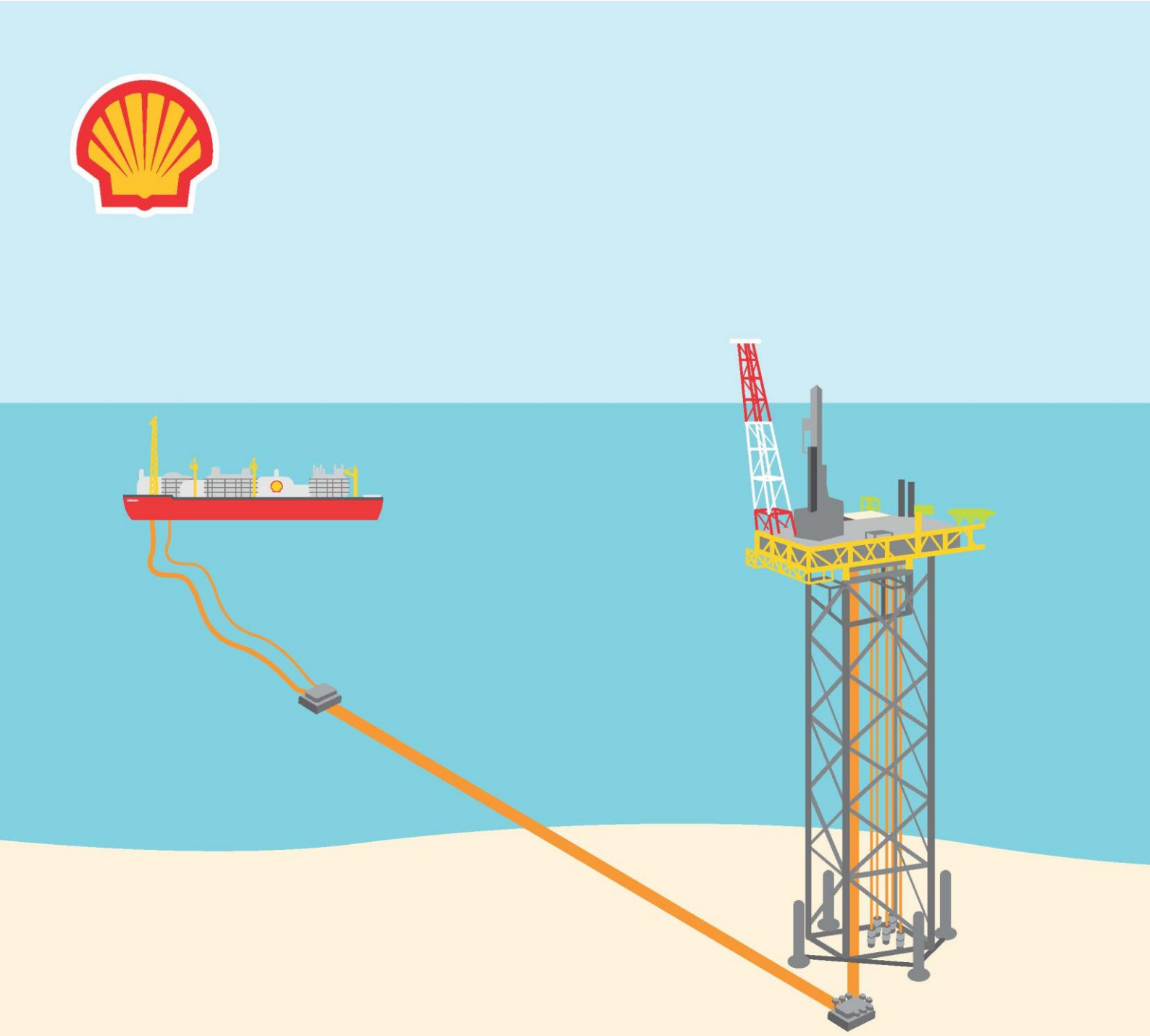

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Crux Installation and Cold Commissioning Environment Plan

Crux Installation and Cold Commissioning Environment Plan

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1 Environment Plan Summary Statement

The Crux Installation and Cold Commissioning Environment Plan (EP) summary has been prepared from material provided in this EP. The summary comprises the following, as required by section 35(7) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023* (Cth) (OPGGS(E) Regulations):

Summary material requirement	Relevant section of this EP
The location of the activity	6.2
A description of the receiving environment	7
A description of the activity	6
Details of the environmental impacts and risks of the activity	8.3
The control measures for the activity	8.3
The arrangements for ongoing monitoring of the titleholder's environmental performance	10.4.1
Response arrangements in the oil pollution emergency plan	9.14 and 10.8
Consultation already undertaken and plans for ongoing consultation	5
Details of the titleholder's nominated liaison person for the activity	10.6.4

2 Introduction

The Shell Australia Pty Ltd (Shell) - operated Crux Project is located in Commonwealth waters in the northern Browse Basin, 190 kilometres (km) offshore north-west Australia and 620 km north-east of Broome, in waters ~165 metres (m) deep (Figure 2-1).

The Crux Offshore Project Proposal (OPP) was accepted in August 2020 by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The Crux OPP describes the Crux Project, as depicted in Figure 2-2.

During the execution phase of the project, Shell proposes to develop a number of separate EPs which incorporate the various stages of the project.

This EP covers the installation of the Crux Pipeline, Substructure and Topside, including all tie-ins, cold commissioning, contingent and supporting activities which are described in detail within Section 6.

The petroleum activity covered by this EP will integrate into the Crux development wells and tie into the existing Prelude Floating Liquefied Natural Gas (FLNG) facility. The Crux Project may be operated locally under specific scenarios or remotely from the Prelude FLNG facility or the Integrated Operations Centre (IOC). The Crux start-up, hot commissioning and operational activities will be covered in future EP/s.

This EP is prepared in accordance with the OPGGS(E) Regulations and describes the following:

- Shell's Health, Security, Safety and Environment and Social Performance (HSSE & SP) Commitment and Policy and the environmental performance objectives that derive from the Policy.
- The consultation process undertaken with the Relevant Persons and the associated resolution of and/or responses to any objections or claims.
- The area of operations, the proposed activities, and its expected time frame.
- The environmental management framework for the activity including legislation and other requirements.
- The existing physical, natural, social, and economic environments of the region, including issues or sensitivities particular to the activity.
- The impacts and risks to the environment from both planned (normal) and unplanned (abnormal) operations.
- The Environmental Performance Outcomes (EPOs), Environmental Performance Standards (EPSs) and Measurement Criteria (MC) against which environmental performance is measured.
- The Implementation Strategy, including key roles and responsibilities that are employed to achieve the program's environmental performance goals[1].
- A system for documenting, monitoring, reporting, and reviewing the success of the Implementation Strategy to facilitate improvement of environmental performance and external reporting as required.

[1] The Shell Browse Regional OPEP (HSE_GEN_016765) (BROPEP), APPEA OSMP Framework and the Shell's Browse Regional Operational and Scientific Monitoring Bridging Implementation Plan (HSE_PRE_016370) (Browse Regional OSMP). Shell refers to these documents as information previously given under section 56(1) of the OPGGS(E) Regulations.

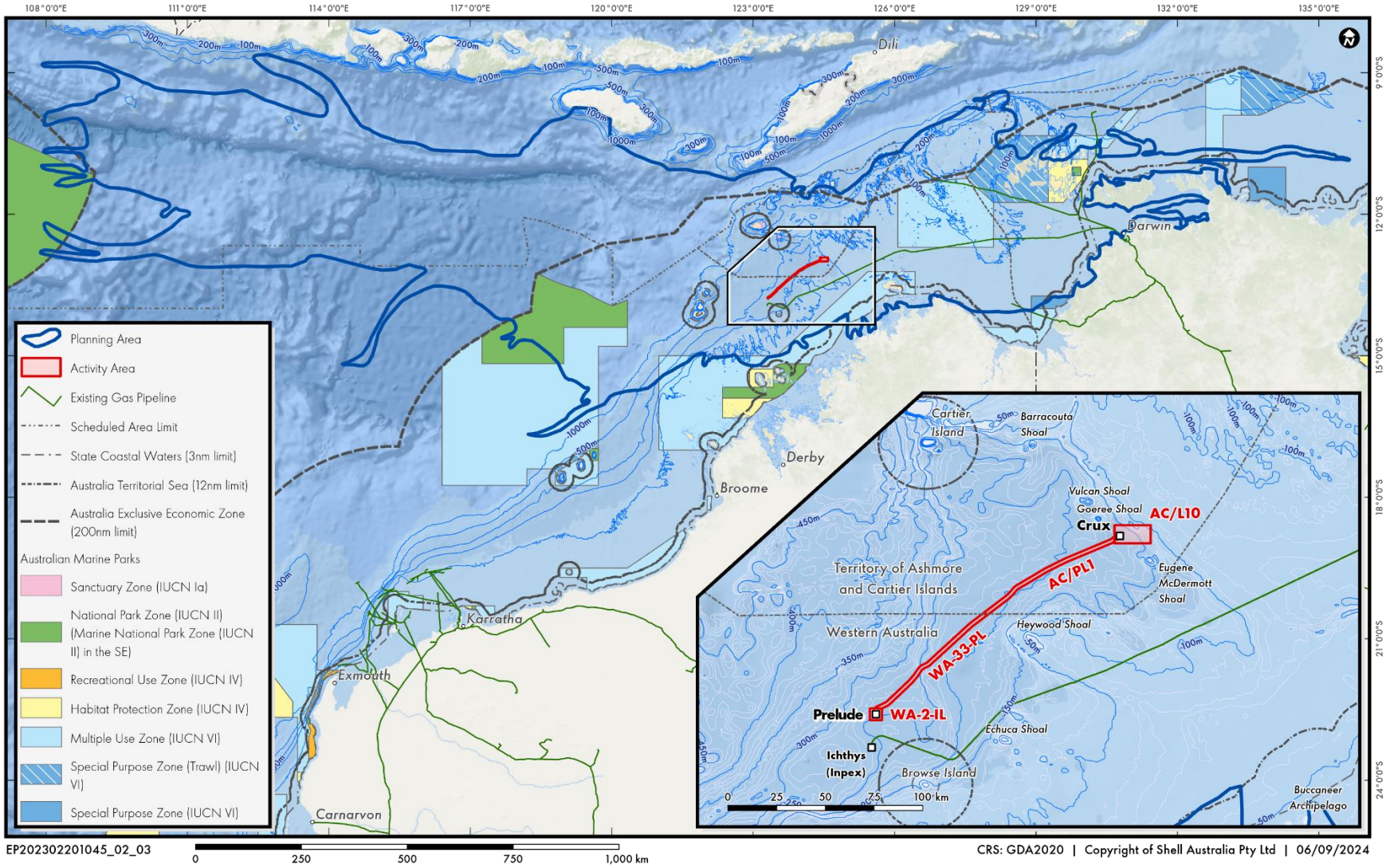

Figure 2-1: Location of the Activity Area

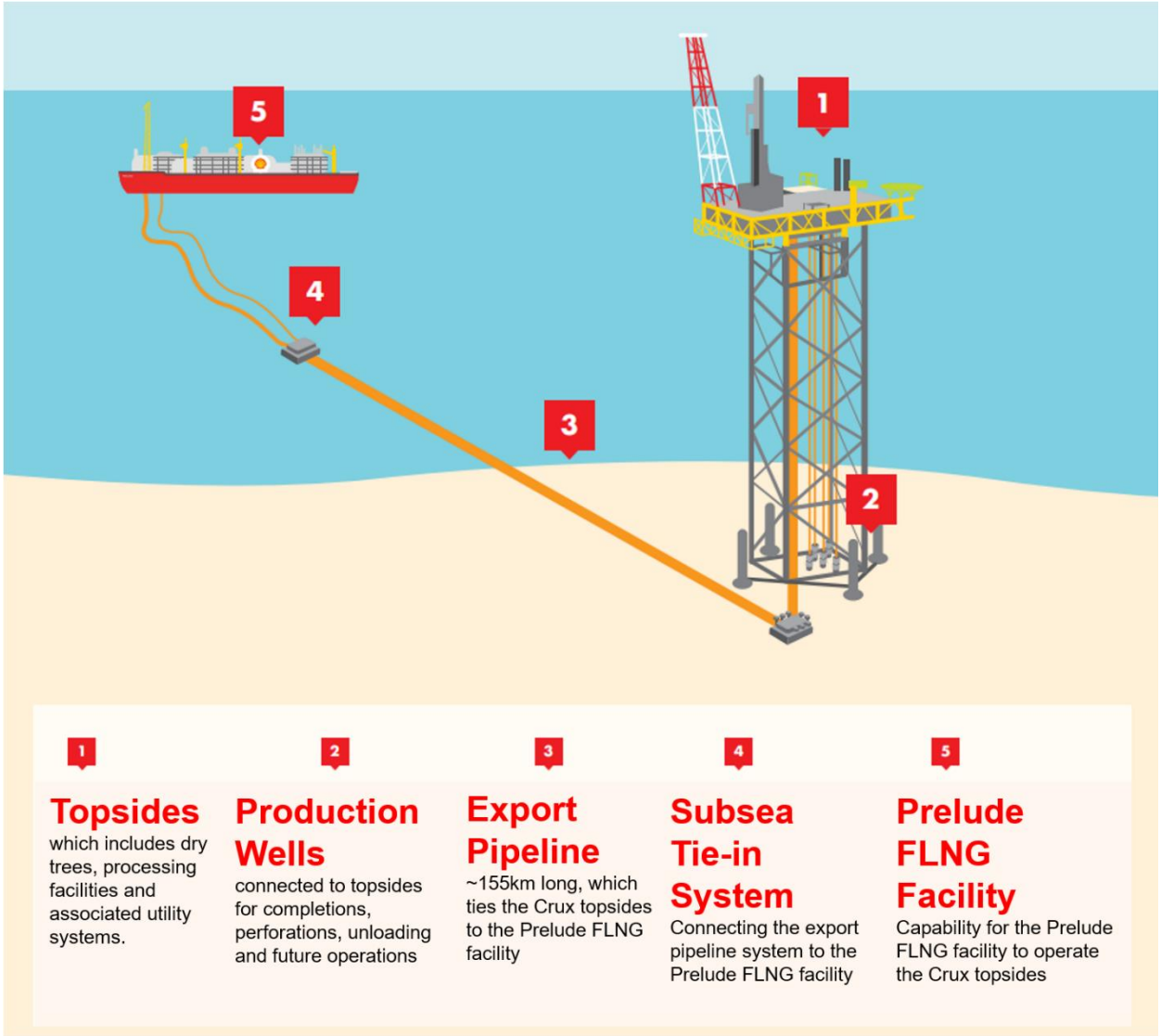

Figure 2-2: Crux Infrastructure Schematic

3 Requirements

This section is intended to fulfil the requirements of section 21(4) of the OPGGS(E) Regulations and meet NOPSEMA's expectations stated in the EP Content Requirements Guidance Note (NOPSEMA 2024a). Section 21(4) stipulates that an EP 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.

NOPSEMA does not expect that requirements that are not relevant to the environmental management of petroleum activities be included in the EP (NOPSEMA 2024a).

These subsections are intended to meet the requirements stated above:

- Commonwealth policy (Section 3.1)
- Commonwealth legislation (Section 3.2)
- Standards and guidelines (Section 3.3)
- International agreement and conventions (Section 3.4).

3.1 Commonwealth Policy

3.1.1 Australia's Oceans Policy

Australia's Oceans Policy 1998 (CoA 1998) provides a framework for integrating environmental, economic, social and cultural ocean uses. This policy details a comprehensive approach to exercising and protecting Australia's marine jurisdiction, and aims to:

- fulfil Australia's obligations under the United Nations Conventions on the Law of the Sea 1982;
- understand and safeguard the marine environment; and
- promote ecologically sustainable development (ESD) through integrated planning and management.

Under this policy, the federal, state and territory governments have established a system of Australian Marine Parks (AMPs) and state/territory reserves (such as state marine parks). These parks are managed using the principles of ESD (including multiple use), which balance conservation with economic activity.

The AMPs were established under the Commonwealth (Cth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and states and territories established their reserves under the National Representative System of Marine Protected Areas. Section 3.2.2.1.1 gives further information on AMPs management plans.

3.2 Commonwealth Legislation

Various Commonwealth legislation applies to the environmental management of the petroleum activities within the scope of this EP. In the remainder of this section, each major piece of legislation is summarised, particularly in relation to its relevance to the petroleum activities. Links to various sections in this EP are also provided—these sections relate to how these legislative requirements were considered in the development of this EP.

The activities considered in this EP will take place entirely in Commonwealth waters; therefore, legislation relating to the environmental management of the petroleum activities considered in this EP are primarily Commonwealth Acts and their subsidiary legislation and regulations. The key Acts are the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth) (OPGGS Act; Section 3.2.1) and the EPBC Act (Section 3.2.1.1.1), and their associated regulations.

The Australian Government (Commonwealth) encourages investment in, and development of, petroleum resources in Commonwealth waters. To develop offshore petroleum resources involves an independent regulator, NOPSEMA, and an administer and management of the oil, gas and GHG titles, National Offshore Petroleum Titles Administrator (NOPTA) in accordance with the OPGGS Act. Together, NOPSEMA and NOPTA identify and release prospective acreage, and grant, regulate, and surrender exploration and development titles. Additional Commonwealth legislation is considered in detail in Table 3-4.

State and territory legislation that may apply to the environmental management of such an emergency event is also detailed in Table 3-4.

3.2.1 Offshore Petroleum and Greenhouse Gas Storage Act 2006

The OPGGS Act provides the regulatory framework for petroleum exploration, production and greenhouse gas (GHG) activities in Commonwealth waters. The OPGGS Act is supported by a range of subsidiary legislation, including:

- *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009* (OPGGS (Safety) Regulations), which ensure that facilities are designed, constructed, installed, operated, modified and decommissioned in Commonwealth waters only in accordance with Safety Cases that have been accepted by NOPSEMA
- OPGGS(E) Regulations.

The OPGGS Act manages all offshore petroleum activities, including decommissioning, under sections 572 and 270. The proposed Crux infrastructure and facility to be installed under this EP, has been designed to meet operational legislative requirements, and reduce operational impacts and risks to As Low As Reasonably Practicable (ALARP) and acceptable levels. Appendix A describes the environment in design and selection process and outlines the outcomes, as of November 2023, for the proposed infrastructure. The design and selection process is applied to key design elements to mitigate risks, minimise operational environmental impacts, and to demonstrate ALARP and acceptable levels. The Crux operational impacts and risks will be assessed under the Crux Completions, Hot Commissioning, Start-up and Operations EP/s. Section 10.1.3 and 10.1.4 describes the infrastructure maintenance and decommissioning planning, including decommissioning design and selection process, ongoing asset management and maintenance, and decommissioning and removal strategy.

The OPGGS(E) Regulations (see Section 3.2.1.1) require the environmental impacts and risks of offshore petroleum and GHG storage activities be managed to a level that is acceptable and ALARP.

3.2.1.1 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023

The OPGGS(E) Regulations provide for the protection of the environment in Commonwealth waters by requiring that petroleum and GHG storage activities be managed in a way that:

- reduces the environmental impacts and risks of the activity to a level that is ALARP;
- reduces the environmental impacts and risks of the activity to an acceptable level (See Section 8.2); and
- is consistent with the principles of ESD, as defined in section 3A of the EPBC Act (see Section 8.1).

The methodology applied to assess environmental impacts and risks from the petroleum activities considered in this EP details how impacts and risks are managed to a level that is acceptable, ALARP and consistent with the principles of ESD. Sections 8, 9.1 and 9.2 describe this methodology, while Sections 9.3 to 9.15 detail aspect-specific demonstrations for each impact and risk assessment.

Section 22(3) of the OPGGS(E) Regulations requires EPs to consider Matters of National Environmental Significance (MNES) protected under the EPBC Act, including:

- world heritage values of a declared World Heritage property;
- national heritage values of a National Heritage place;
- the ecological character of a declared Ramsar wetland;
- the presence of a listed threatened species or listed threatened ecological community;
- the presence of a listed migratory species;
- any values and sensitivities that exist in, or in relation to, part or all of:
  - a Commonwealth marine area; or
  - Commonwealth land.

Section 7 describes the MNES that may credibly be impacted, or are at risk of being impacted, and these are considered in the assessment of environmental impacts and risks.

Section 34 of the OPGGS(E) Regulations states the criteria for acceptance of an EP for an activity. Table 3-1 summarises these criteria and links to the Sections in this EP that relate to each.

Table 3-1: Relationships between Section 34 of the OPGGS(E) Regulations Requirements and this EP

OPGGS(E) Regulation	Requirement	Relevant Section of EP
34(a)	The EP is appropriate for the nature and scale of the activity	Sections 6 and 10 detail the nature and scale of the petroleum activities considered within this EP. Section 7 describes the environmental receptors that may credibly be impacted, or are at risk of being impacted, by the planned activities and unplanned events. Sections 9.3 to 9.15 details the environmental impact and risk assessments based on the context provided by Section 5 and Section 7 (as well as Shell's internal context and the context provided by relevant persons).
34(b)	The EP demonstrates that the environmental impacts and risks of the activity will be reduced to ALARP	Sections 9.1 and 9.2 details the method Shell uses to demonstrate that environmental impacts and risks are managed to a level that is ALARP. Aspect-specific ALARP demonstrations are detailed in the impact and risk assessments in Sections 9.3 to 9.15.
34(c)	The EP demonstrates that the environmental impacts and risks of the activity will be of an acceptable level	Section 8 details the method Shell uses to demonstrate that environmental impacts and risks are managed to a level that is acceptable. Aspect-specific demonstrations of acceptability are detailed in the impact and risk assessments in Sections 9.3 to 9.15.
34(d)	The EP provides appropriate environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria (MCs)	EPOs, EPSs and MCs are detailed in Sections 9.3 to 9.15.
34(e)	The EP includes an appropriate implementation strategy and monitoring, recording and reporting arrangements	Section 10 describes the implementation strategy for the EP.
34(f)	The EP 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	Section 6 details the planned petroleum activities considered in this EP, none of which will occur within a World Heritage Area.
34(g)	The EP demonstrates that: (i) the titleholder has carried out the consultations required by section 25; and (ii) the measures (if any) that the titleholder has adopted, or proposes to adopt, because of the consultations are appropriate	Appendix C and Section 5 details the consultation undertaken in relation to the EP, including Shell's responses to any claims or objections made by relevant persons. Any management measures adopted in response to consultation outcomes are considered in the aspect-specific impact and risk assessments in Sections 9.3 to 9.15 and also within Sections 5, 7, 8 and 10.
34(h)	The EP complies with the Act, this instrument and any other regulations made under the Act.	Section 3.2.1 shows the relationship between the Act, regulations and components of the EP.

3.2.1.1.1 Assessment of Concordance with the Crux Development OPP

Under the OPGGS(E) Regulations, offshore petroleum projects are required to be assessed and approved via NOPSEMA acceptance of an OPP. The Crux OPP was accepted by NOPSEMA in August 2020. The Crux OPP outlines the scope of the development and its activities at the concept stage, including a comprehensive and thorough evaluation of likely environmental impacts and risks, as well as the establishment of a framework for the forward environmental management and performance in relation to project impacts and risks.

OPPs are developed at an early stage of project development, before the detailed planning of specific activities is fully complete. Consequently, refinement of the detailed descriptions of these activities, and their associated impacts and risks, are expected to be provided and adapted in EPs as the project/activity definitions mature (NOPSEMA Guidance Note: Offshore project proposal content requirements N-04790-GN1663 A473026).

Since the Crux OPP was an early stage, whole-of-project assessment prior to detailed technical definition (i.e. pre-FEED), the EPOs in the Crux OPP may not be inherited verbatim in every subsequent EP, however any EP EPOs will maintain the equivalent, or better, level of environmental performance for the activities that fall within the scope of that EP. Table 3-3 Similarly, the key management controls outlined in the Crux OPP are considered to be initial judgements on likely available key controls, but adjustments in these key controls may occur in subsequent EPs, subject to final design and operational processes established.

To confirm that the EPOs and key controls (control measures and associated Environmental Performance Standards) within this EP will ensure an equivalent or better level of environmental performance to that described in the Crux OPP for the aspects relevant to the activities within the scope of this EP, Table 3-2 presents a comparison of EPOs in the Crux OPP and this EP, and presents a comparison of key controls in the Crux OPP with the controls/EPS in this EP, along with an explanation of any changes and evaluation of resulting environmental performance.

The assessment of concordance with the Crux OPP shows that the EPOs and controls/EPS defined in this EP will ensure an equivalent, or better, level of environmental performance to that described in the Crux OPP for the activities/aspects that fall within the scope of this EP.

Table 3-2: Concordance of the Cold Commissioning and Installation EP Environmental Performance Outcomes (EPOs) with the Crux OPP EPOs

Aspect	Crux OPP Environmental Performance Outcome	EP achieves equivalent, or better, level of environmental performance?	EP Environmental Performance Outcome	Evaluation of change (where applicable)
Physical Presence and Vessel Movements (including seabed disturbance)	Direct impacts to benthic habitats from the Crux project will be limited to < 0.1% of the total Project Area.	Yes	Direct impacts to benthic habitats from the Crux infrastructure installation will be limited to <25 Ha of the total Project Area.	EP EPO ensures direct impacts to benthic habitats will be <0.1% of the total Project area.
	Direct seabed disturbance from the Crux project will be limited to < 315,980 m^2.	Yes		
	Impacts to the continental slope demersal fish communities KEF will be limited to <1% of the total area of the KEF.	Yes	Impacts from the export pipeline that intersects the Continental slope demersal fish communities KEF will be <0.05% of the total KEF area.	
	No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal and Vulcan Shoal will occur as a result of the Crux project.	Yes	No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal and Vulcan Shoal as a result of installation activities.	
	No collisions between project vessels and marine fauna resulting in mortality or injury of species listed as threatened or migratory under the EPBC Act will occur within the Crux project area.	Yes	No injury or mortality of listed threatened or migratory MNES species associated with vessel collisions within the Activity Area.	
	No adverse interactions between Shell's activities within the Crux project area and other marine users.	Yes	No adverse interactions between the activity and other marine users within the Activity Area.	
	Displacement of other marine users within the Crux project area restricted to: • temporary displacement from project activities (e.g. from pipelaying vessels and drilling activities), and • exclusion from gazetted Petroleum Safety Zones (e.g. 500 m exclusion around the Crux platform).	Yes	Displacement of other marine users is restricted to: • temporary displacement within the Activity Area • exclusion from gazetted PSZs.	
	Other marine users will be provided with information on the timing, nature and scale of aspects of the Crux project through Shell's consultation program.	Yes	N/A	Other marine users have been provided with information on the timing, nature and scale of activities under this EP through Shell's consultation program, as described in EP Section 5
		Yes	No planned impacts to cultural heritage features within the Activity Area as a result of the petroleum activities.	New EPO to address impacts and risks identified from EP relevant persons consultation.
		Yes	No significant impacts to cultural heritage values within the Activity Area as a result of the petroleum activities	New EPO to address impacts and risks identified from EP relevant persons consultation.
Light Emissions	No mortality or injury of threatened and migratory MNES species as a result of artificial light emissions from the Crux project.	Yes	No injury or mortality of listed threatened or migratory MNES species as a result of artificial light emissions from the activity.	
Underwater Noise	No mortality or injury of threatened and migratory MNES species as a result of underwater noise from the Crux project.	Yes	No injury or mortality to listed threatened or migratory MNES species as a result of noise emissions from the activity.	
Atmospheric Emissions	No significant decline in air quality at residential or sensitive populations as a result of atmospheric emissions from the Crux project.	Yes	No significant impacts to the airshed surrounding the Activity Area as a result of the Activity.	
	Atmospheric emissions associated with all drilling rigs, project vessels and the Crux platform to comply with MARPOL Annex VI requirements.	Yes	Atmospheric emissions associated with all drilling rigs, project vessels and Crux platform activities under this EP to comply with MARPOL Annex VI requirements.	

Aspect	Crux OPP Environmental Performance Outcome	EP achieves equivalent, or better, level of environmental performance?	EP Environmental Performance Outcome	Evaluation of change (where applicable)
	Atmospheric emissions associated with the project will be consistent with national and international mechanisms for the management of GHG emissions for the life of the project.	Yes	Shell will report Scope 1 GHG emissions annually to CER, where required under the NGER Act.	Addressed in EP EPS, not an EPO. This addresses this Crux OPP EPO adequately such that the statement of performance is equal to or better than what is outlined within the Crux OPP, suitable for this aspect in this EP.
Greenhouse Gas Emissions (Scope 3 emissions not included)	Emissions at the Crux facility will not exceed 0.5 Mt CO2-e in any single operating year.	N/A	N/A	Not relevant to the petroleum activities within scope of the EP - Relates to the operations phase
	Emissions at the Crux facility will not exceed an average of 0.4 Mtpa CO2-e over a 5-year period.	N/A		
	Emissions at the Crux facility will comply with the Australian government safeguard mechanism baseline.	N/A		
		Yes	GHG emissions associated with the Activity will be minimised	New EPO to address GHG emissions from vessels etc during scope of EP.
Invasive Marine Species	No IMS of concern established in the natural environment as a result of the Crux project.	Yes	No IMS of concern introduced in the Activity Area as a result of the petroleum activities.	Better level of performance since Crux OPP established.
	No introduction of IMS to the marine environment from ballast water exchange operations undertaken or biofouling by project vessels.	Yes	No IMS of concern introduced in the Activity Area as a result of the petroleum activities.	Better level of performance since Crux OPP established.
Waste Management	No mortality or injury of threatened and migratory MNES species as a result of unplanned waste discharge to sea during the Crux project	Yes	No injury or mortality of listed threatened or migratory MNES species as a result of minor releases to sea during the petroleum activities.	
			No incidents of spills or the release of equipment, materials or waste to the ocean from the activity.	Better level of performance since Crux OPP established.
Liquid Discharges	No measurable impacts to sediment quality or water quality in the region from liquid discharges during the Crux project.	Yes	No significant impacts to water and sediment quality from activity discharges. No significant impacts to water and sediment quality from liquid effluent discharges.	EPO adjusted to reflect reduced scale of impacts targeted.
			No measurable impacts to sediment quality or water quality in the region from liquid discharges during the Crux project.	
	PFW discharges from the Crux platform will meet relevant ANZECC & ARMCANZ guidelines 95% species protection levels for sediment and water quality and/or be within natural variation or background concentration beyond the predicted mixing zone(s) under normal operations.	N/A	N/A	Not relevant to the petroleum activities within scope of the EP - Relates to the operations phase
	Direct impacts to benthic habitats from the Crux project will be limited to < 0.1% of the total Project Area.	Yes	Direct impacts to benthic habitats from Activity discharges will be limited to < 0.05% of the total Project Area (as defined in the OPP).	Better level of performance since Crux OPP established for this activity.
	No mortality or injury of threatened and migratory MNES species as a result of liquid discharges during the Crux project.	Yes	No injury or mortality of listed threatened or migratory MNES species as a result of activity discharges. No injury or mortality of listed threatened or migratory MNES species resulting from liquid effluent discharges.	

Aspect	Crux OPP Environmental Performance Outcome	EP achieves equivalent, or better, level of environmental performance?	EP Environmental Performance Outcome	Evaluation of change (where applicable)
	Impacts from liquid discharges from the Crux project on the continental slope demersal fish communities KEF will be limited to <1% of the total area of the KEF.	Yes	Impacts from Activity discharges from the Crux project on the continental slope demersal fish communities KEF limited to <1% of the total area of the KEF.	
	No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal and Vulcan Shoal will occur as a result of liquid discharges from the Crux project.	Yes	No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal, Vulcan Shoal or other sensitive benthic community will occur as a result of Activity discharges.	
	No direct loss of coral communities on the outcropping reef feature will occur as a result of the discharge of drill fluids and cuttings for future tie-back wells within the Crux in-field development area.	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
Unplanned Spills	No emergency events associated with the unplanned release of Crux condensate or vessel fuel to the marine environment during the Crux project.	Yes	No emergency events associated with the release of vessel fuel to the marine environment from the Activity.	EPO updated to reflect scope of EP (i.e. no potential for condensate release)

The Crux OPP outlined key management controls that were considered likely to be required for the Crux development as a whole to ensure impacts and risks from the development (all phases) would be managed such that the defined EPOs were achieved, and all impacts/risks reduced to acceptable levels. The Crux OPP recognised that the key management controls described were initial judgements on likely available key controls, and that adjustments in these key controls may occur in subsequent EPs, subject to final design and operational processes established. A number of the key management controls described in the Crux OPP are relevant to Crux development phases and/or activities (e.g. flaring during Operations) that are not within the scope of this EP. Additionally, some have been addressed through project design/planning and are inherent in the Activity Description (e.g. concrete coated export pipeline) or have already been addressed during development of the EP (e.g. consultation, OPEP preparation). Furthermore, in accordance with the requirements of the Regulations, the EP describes proposed control measures along with the environmental performance standards (EPS) required for each control measure. Consequently, the environmental performance that the EP will achieve needs to be considered holistically rather than simply through direct comparison of specified management controls. Shell considers that implementation of this EP during the proposed activities will ensure an equivalent, or better, level of environmental performance to that described in the Crux OPP for the activities/aspects that fall within the scope of this EP.

Table 3-3: Concordance of the Cold Commissioning and Installation EP Controls/Environmental Performance Standards with the Crux OPP Key Management Controls

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
Physical Presence and Vessel Movements	All project vessels operating within the project area will adhere to the navigation safety requirements contained within the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), Chapter 5 of The International Convention for the Safety of Life at Sea 1974 (SOLAS Convention), International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), the *Navigation Act 2012* (Cth) and any subsequent Marine Orders, which specify standards for crew training and competency, navigation, communication, and safety measures.	Yes	Project vessels equipped and crewed in accordance with Australian maritime requirements.	Vessels will be equipped and crewed in accordance with the Navigation Act 2012 (Cth) (as applicable for vessel size, type and class), including implementing: Marine Order 21 (Safety and emergency procedures), including: • safety measures such as manning and watchkeeping. Marine Order 27 (Safety of navigation and radio equipment), including: • radio equipment and communications • navigation safety measures and equipment • danger, urgency and distress signals and messages. • Marine Order 30 (Prevention of Collisions), including: • lights and signals as applicable to vessel class per COLREGS requirements. Marine Order 71 (Masters and Deck Officers), including: • All master, mate and watchkeeper officer duties undertaken by crew certified as applicable to vessel class per International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW) requirements.	
	Maintenance of a minimum 1 km buffer from shoals within the in-field development area (Figure 5-3).	Yes	Separation distance to shoals identified to require protection in the OPP	Project vessels shall not operate within 1 km of named Shoals adjacent to the Activity Area.	
	Vessels will adhere to the requirements of the EPBC Regulations Part 8.1 – Interacting with cetaceans, (except in emergency conditions or when manoeuvring is not possible, such as in the case of pipelay activities), which include:	Yes	Project vessel interactions with threatened and migratory species to follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06).	Vessels comply with EPBC Regulations 2000 Part 8, Division 8.1 Interacting with Cetaceans, specifically: • Project vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf. • If the whale, dolphin, turtle or whale shark shows signs of being distressed, project vessels will immediately withdraw from the caution zone at a constant speed of ≤6 knots (except in emergency conditions or when manoeuvring is not possible, such as in the case of pipelay activities or floatover activities).	

[2] If there are any inconsistencies between the performance standards stated in this table, and those included in Section 9 of this EP, the latter take precedence.

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	• implement a caution zone of 150 m for dolphins and 300 m for whales • vessels will not knowingly approach closer than 100 m to a whale and 50 m for a dolphin (i.e. no approach zone) • make sure a vessel does not drift or approach within 50 m of a dolphin or 100 m of a whale • vessels will not knowingly travel > 6 knots within the caution zone of a whale or dolphin, and • there will not knowingly be no more than three vessels within 300 m of a whale (i.e. caution zone).				
	All areas of the seabed disturbed by installation activities will be surveyed prior to installation. (The Crux NNM platform location and export pipeline corridor have been surveyed as part of the baseline environmental studies for the Crux project and no sensitive seabed features were observed).	Yes	Areas of the seabed disturbed by installation activities will be surveyed prior to installation.	Infrastructure is installed on the seabed within the Activity Area and design footprint as confirmed by as laid surveys.	The EP control measure and associated EPS are considered equal to the management control outlined within the Crux OPP.
	Validate that the Crux platform, export pipeline and subsea integration system facilities are laid according to planned locations within allowable tolerances.	Yes	Position infrastructure on the seabed within the design footprint to reduce seabed disturbance.		
	An anchoring plan will identify suitable areas for anchors to be placed within the in-field development area and will confirm no anchoring on shoals or within the associated 1 km buffer.	Yes	Prohibit project vessels from anchoring in the Activity Area except in emergency situations	No anchoring associated with the activities.	EP control/EPS avoids anchoring impacts to seabed, including at shoals and is therefore better than the Crux OPP management control.
	If future tie-backs are proposed within 2 km of the shoals or on the outcropping reef feature within the Crux in-field development area, then additional studies will be undertaken to further characterise the benthic habitats within the proposed disturbance area. The studies will inform an assessment of the acceptability of the impacts, particularly with regard to disturbance of any hard seabed substrates that contain high biodiversity value.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Australian Hydrographic Service will be advised of project activities and installed infrastructure to facilitate issuing Notices to Mariners.	Yes	For specific vessel-based campaigns, give advance notice to the AHO before the vessel arrives on location to enable a 'Notice to Mariners' to be issued before petroleum activities occur within the Activity Area.	AHO is notified, at least four weeks prior, to enable a 'Notice to Mariners' to be issued before petroleum activities occur.	
			Installed infrastructure locations provided to AHO for inclusion on nautical charts	Australian Hydrographic Service notified of location of installed infrastructure to facilitate inclusion on nautical charts.	
		Yes	Vessel speed restrictions within the Activity Area during sensitive periods (whale shark migration period July to November).	Vessels shall not exceed 10 knots when operating within the Activity Area during the whale shark migration period (July to November).	New control/EPS to reduce risks to whale sharks (and other megafauna).
		Yes	Remove all temporary structures, equipment and property that are no longer in use.	All temporary structures, equipment and property will be designed to be retrievable and removed if no longer required. Should Crux activities beyond the scope of this EP require the temporary structures, equipment or property will be recorded in an asset register to facilitate future removal.	New control/EPS to reduce duration of seabed disturbance associated with construction activities/equipment.

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
		Yes	Underwater heritage chance find process.	Shell's underwater heritage chance find process will be implemented should a chance find be encountered to reduce impacts to potential heritage and cultural features and values to ALARP. This process will include stop work triggers and notification processes.	New control/EPS to cover cultural heritage protection.
Decommissioning	Development and implementation of a project decommissioning plan which considers environmental impacts and risks.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP, however suitable details of decommissioning considerations for this stage of this project are outlined within section 10.1.4.
	Prior to the end of operating life, a comparative assessment of potential decommissioning options will be undertaken to inform the development of a Decommissioning EP that will be submitted to NOPSEMA. The comparative assessment will consider the merits of each option in the context of health, safety and environmental protection, technological feasibility, local capacity, regulatory compliance, public participation and economic stewardship within a broader ALARP framework to inform selection of the preferred decommissioning strategy.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP, however suitable details of decommissioning considerations for this stage of this project are outlined within section 10.1.4.
	The Decommissioning EP will present the outcomes of the comparative assessment and include an ALARP and acceptability assessment of the preferred option. The acceptability assessment will consider ESD, industry standard at the time and stakeholder expectations. The Decommissioning EP will be implemented for the duration of the decommissioning activities.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP, however suitable details of decommissioning considerations for this stage of this project are outlined within section 10.1.4.
Light Emissions	External lighting on offshore facilities/infrastructure will be minimised through design to that required for navigation, safety of deck operations and security considerations, except in the case of an emergency.		External lighting on the platform topsides minimised through design to that required for navigation, safety of deck operations and security considerations.	Lighting limited to that required for safe work/navigation and security requirements. Light spill to the ocean is avoided where practical.	New control/EPS to cover lighting better than Crux OPP.
	Flaring during operations is optimised to enable the safe and economically efficient operation of the facility.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
		Yes	The pipelay vessel will have an enclosed pipe welding deck	The pipelay vessel shall have an enclosed pipe welding deck to shield light emissions.	New control/EPS to cover lighting.
		Yes	Project vessel lighting will be used as required for safe work conditions and navigational purposes.	Vessel navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, Marine Orders 21: Safety of Navigation and Emergency Procedures, *Navigation Act 2012* (Cth) and Chapter 5 of the SOLAS Convention. Work lighting will be the minimum required to maintain safe working conditions for all areas where the crew are operating on project vessel deck.	New control/EPS to cover lighting.
Underwater Noise	Any VSP activities conducted at the development well will comply with 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEWHA 2008c) (or the contemporary	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP - No VSP within scope of the EP

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	requirements at the time of the activity), specifically: • pre-start-up visual observations. Visual observations for the presence of whales by a suitably trained crew member will be carried out at least 30 minutes before the commencement of VSP. • start-up and normal operating procedures, including a process for delayed start-up, should whales be sighted. Visual observations by trained crew should be maintained continuously. • night time and low visibility procedures.				
	Pile driving activities conducted for the Crux platform foundations will comply with 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines, specifically: • pre-start-up visual observations. Visual observations for the presence of whales by a trained marine mammal observer will be carried out at least 30 minutes before the commencement of pile driving. • start-up and normal operating procedures, including a process for delayed start-up, should whales be sighted. Visual observations by a trained marine mammal observer should be maintained continuously. • shut-down procedures. Piling will be stopped should whales come within 500 m of the pile driving barge. • night time and low visibility procedures. • in addition to the 'Standard Management Procedures' identified above, Shell will commit to at least one trained marine mammal observer being present on the pile driving barge for the duration of pile driving activities for the Crux platform foundations.	Yes	Implement pile driving procedure adapted from the 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (EPBC Act Policy Statement 2.1) (DEWHA 2008b). Extend the implementation of the pile driving procedure adapted from the 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (EPBC Act Policy Statement 2.1) (DEWHA 2008b) to include whale sharks.	Pile driving activities implemented in accordance with the pile driving procedure, adopted from the EPBC Act Policy Statement 2.1 to minimise the risk of impairment or disturbance from underwater noise to whales, whale sharks and the dusky sea snake. The Procedure will include: A suitable number of competent marine mammal observers (MMOs) on a suitable observer platform (e.g. vessel) before any pile driving will occur, such that at least one dedicated MMO will be on watch during the pile driving operations, supported by trained crew during breaks, with a minimum of two MMOs offshore. Pre–start-up visual observation: • During daylight hours, visual observations (using binoculars and the naked eye from a high vantage point) for the presence of whales/whale sharks/dusky sea snake will be undertaken by one dedicated MMOs for at least 30 minutes before commencing piling activities. Soft-start procedure (also known as ramp-up): • The hammer piling will be initiated at the lowest striking force, with a gradual ramp-up over 30 minutes until the full striking power (if required) is reached. Operations procedure: • During daylight hours, a dedicated MMO, supported by a trained crew member to cover breaks, will undertake visual observations continuously during the piling activity,. • Any break in piling >10 minutes will reinitiate the soft-start requirement. Stop work procedure: • If a whale/whale shark/dusky sea snake is sighted within the 3 km observation zone an additional trained crew member should also be brought to the bridge to continuously monitor the whale/whale shark/dusky sea snake while it is in sight. • If a whale/whale shark/dusky sea snake is sighted within or is about to enter the protection zone (1 km), the acoustic source should be powered down to the lowest possible setting. • If a whale/whale shark/dusky sea snake is sighted or is about to enter the shut-down zone (500 m or 700m for	Scope of OPP control expanded to cover whale sharks and the dusky sea snake which is better than what was outlined in the Crux OPP.

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				the dusky sea snake), the acoustic source (piling) should be shut down completely. • An exception to shut-down and low power requirements within the shut-down and protection zones listed above, are allowable whilst completing the final 3m of each pile. • Powering up the acoustic source with soft-start procedures should only occur after the whale/whale shark/dusky sea snake has been observed to move outside the protection zone, or when 30 minutes have lapsed since the last sighting.	
			Night-time Piling Procedure	Where three or more whale shark shutdowns occur on a single day shift no night-time piling operation will occur the following night.	Scope of Crux OPP control expanded to cover whale sharks and methodology specified to capitalise on BAT.
				Shell BES SME will carry out a field trial using the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular prior to offshore piling operations commencing to confirm marine whale detection effectiveness is suitable at night and considerations of observer fatigue management. Outcomes and learnings from this field test will be used in informing the application of EPS3.5 and EPS3.6.	
				Subject to the outcomes of EPS3.4 which may find field trial confirms the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular is effective in whale detection at night, observer fatigue management and other relevant considerations confirm the application of this EPS is suitable. A minimum of two MMOs, one on day and one on night, will be used throughout the piling operations, with at least 7 hours of active observation per shift whilst continuously piling, supported by trained crew members for MMO breaks to manage observer fatigue and breaks effectively. Training of crew members will be done by an MMO.	
				Subject to the outcomes of EPS3.4 which may find limitations and constraints do not support the more extended application of thermal camera technology outlined in EPS3.5 during the piling campaign this EPS will be adopted. Night observation using the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular will be implemented through the use of trained crew members on nights where three or more whale shutdowns occurred the day prior. Training of crew members will be done by an MMO.	

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			Low visibility procedure during pile driving	Piling will cease where there is low visibility, less than 1000m, and there were three or more whale, whale shark or dusky sea snake shutdowns in the previous 24 hours.	
		Yes	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Project vessels shall not operate within 1 km of named Shoals adjacent to the Activity Area.	
	Maintenance of a minimum 1 km buffer from shoals within the in-field development area (Figure 5-3).	Yes	Separation distance to shoals identified to require protection in the OPP	Project vessels shall not operate within 1 km of named Shoals adjacent to the Activity Area	
		Yes	Project vessel interactions with threatened and migratory species to follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06).	Vessels comply with EPBC Regulations 2000 Part 8, Division 8.1 Interacting with Cetaceans. Including: • Subject to the outcomes of EPS3.4 which may find limitations and constraints do not support the more extended application of thermal camera technology outlined in EPS3.5 during the piling campaign this EPS will be adopted. • Night observation using the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular will be implemented through the use of trained crew members on nights where three or more whale shutdowns occurred the day prior. Training of crew members will be done by an MMO.	New control/EPS to address underwater noise risks from vessel(s).
Atmospheric Emissions	All drilling rigs, vessels and Crux platform (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012* (Cth), the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and subsequent Marine Orders. which requires vessels to have a valid International Air Pollution Prevention Certificate (for vessels > 400 tonnage) and use of low sulphur fuel, when possible.	Yes	Vessel engines to use low-sulfur content fuel (≤0.5% m/m S) or an IMO approved alternative measure to reduce sulfur oxide emissions.	Use only low-sulfur fuel (≤0.5 m/m S) or an IMO approved alternative measure (e.g. EGCS fitted) to reduce sulfur oxide emissions.	Control/EPS subdivided.
			Project vessels (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsequent Marine Orders	Specified project vessels are required to have this valid documentation, as required by vessel class, size and type: • EIAPP certificate • IAPP certificate • IEE certificate • SEEMP.	
				Waste from incineration managed in accordance with MARPOL Annex VI.	
				ODS managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air, as required by vessel class, size and type.	
	Flaring during operations is optimised to enable the safe and economically efficient operation of the facility.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Selection of gas turbine generators during design process considers energy efficient (i.e. low emission) equipment, in alignment with the selected concept.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	TEG off gas will not be vented but sent to the flare for combustion if the flare is ignited.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	During operations of the Crux facility, regular reviews of GHG opportunities will be reviewed and adopted where appropriate	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
		Yes	Maintenance management system	Vessel maintenance program is implemented for project vessels equipment that provides a status on the maintenance of equipment.	New EPS to ensure continued combustion efficiency through regular maintenance
Greenhouse Gas Emissions (Scope 3 emissions not included)	All drilling rigs, vessels and Crux platform (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012* (Cth) , the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and subsequent Marine Orders. which requires vessels to have a valid International Air Pollution Prevention Certificate (for vessels > 400 tonnage) and use of low sulphur fuel, when possible.	Yes	Project vessels (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsequent Marine Orders	Specified project vessels are required to have this valid documentation, as required by vessel class, size and type: • EIAPP certificate • IAPP certificate • IEE certificate • SEEMP. Waste from incineration managed in accordance with MARPOL Annex VI.	Control/EPS subdivided
	Flaring during operations is optimised to enable the safe and economically efficient operation of the facility.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Selection of gas turbine generators during design process considers energy efficient (i.e. low emission) equipment, in alignment with the selected concept.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP (but see relevant EP EPS below). In addition, detailed consideration of the GTG design optimization is in Appendix A.
	TEG off gas will not be vented but sent to the flare for combustion if the flare is ignited.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	During operations of the Crux facility, regular reviews of GHG opportunities will be reviewed and adopted where appropriate. This will be implemented through a GHG Energy Management Plan (GHGEMP), that will be kept up to date through an annual abatement workshop.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
		Yes	Maintenance management system	Vessel maintenance program is implemented for project vessels equipment that provides a status on the maintenance of equipment.	New control/EPS to ensure continued combustion efficiency through regular maintenance
		Yes	Vessel route planning	Vessel route planning will be carried out as per marine assurance requirements.	New control/EPS capturing controls that will reduce GHG emissions from key activities (i.e. vessel movements) that fall within scope of this EP.
		Yes	Vessel specific biofouling management and/or risk assessment.	Project vessels (as appropriate for size, type and class) entering Australian territorial seas [12 nm limit] from international locations, prior to entering the Activity Area, will apply the Australian Biofouling Management Requirements (DAFF 2023), including:	

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
				• an effective biofouling management plan and record book; or • vessel cleaned of all biofouling within 30 days prior to arriving in Australian waters; or • implementation of an alternative biofouling management method.	
				Projects vessels (as appropriate for size, type and class) entering the Activity Area directly from international locations will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector; and • undertake IMS risk reduction measures as guided by an industry recognised IMS inspector if a vessel is not considered low risk; and • only vessels classified as low risk will be permitted entry into the Activity Area.	
				Locally sourced project vessels (as appropriate for size, type and class) entering the Activity Area from Australian domestic locations, will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector or using the industry recognised risk assessment tool Vessel–Check; and • undertake IMS risk reduction measures if a vessel is not considered low risk (either guided by an IMS inspector or through implementation of the measures which address risks identified by Vessel-Check); and • only vessels classified as low risk will be permitted entry into the Activity Area.	
		Yes	Report GHG emissions to the Clean Energy Regulator (CER), where required by the NGER Act.	Shell will report Scope 1 GHG emissions annually to CER, where required under the NGER Act.	New control/EPS reflecting contemporary requirements for GHG reporting.
		Yes	Greenhouse Gas and Energy Management Plan (GHGEMP) for the Crux Project execute phase	The GHGEMP for execute phase shall be developed and implemented. Scope shall include; • summarise the design GHG abatement options and measures considered, including those implemented and not implemented to support future operations. • list key management measures to continue to reduce GHG emissions throughout execute phase to ALARP,	New control/EPS providing commitment regarding implementation and timing of Crux OPP management control (see above).

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				including input on options considered and adopted/rejected by contractors. • summarise GHG targets for key remaining execute phase. • Describe key roles and responsibilities of resourcing and implementation of the GHGEMP. • Review emissions performance through quarterly performance monitoring and reporting (PMR) process. The GHGEMP will be developed before the end of Q1 2025.	
Invasive Marine Species	Ballast water exchange operations will comply with the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004 (as appropriate to vessel class), Australian Ballast Water Management Requirements (DAWR 2017) , *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (Cth) and *Biosecurity Act 2015* (Cth), including: • all ballast water exchanges conducted > 12 nm from land • vessel Ballast Water Management Plan stipulating that ballast water exchange records will be maintained, and • completion of DAWR Ballast Water Management Summary sheet for any ballast water discharge in Australian waters).	Yes	Vessel specific ballast management.	Ballast water discharges are aligned with the Australian Ballast Water Management Requirements (DAWE 2020), the *Biosecurity Act 2015* (Cth) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (as appropriate for size, type and class).	
	Biofouling management for vessels in accordance to the IMO Guidelines for the Control and Management of Ships Biofouling to Minimise the Transfer of Invasive Aquatic Species.	Yes	Vessel specific biofouling management and/or risk assessment.	Project vessels (as appropriate for size, type and class) entering Australian territorial seas [12 nm limit] from international locations, prior to entering the Activity Area, will apply the Australian Biofouling Management Requirements (DAFF 2023), including: • an effective biofouling management plan and record book; or • vessel cleaned of all biofouling within 30 days prior to arriving in Australian waters; or • implementation of an alternative biofouling management method.	
	The International Convention on the Control of Harmful Anti-fouling Systems on Ships will be complied with, including vessels (of appropriate class) having a valid International Anti-fouling Systems Certificate.	Yes	Anti–foul coating/system	Vessels (as appropriate for size, type and class) will have an antifoul coating applied in accordance with the International Convention on the Control of Harmful Antifouling Systems on Ships and the Protection of the Sea (Harmful Anti–fouling Systems) Act 2006 (Cth), including Marine Order 98 (Marine Pollution – Anti-fouling Systems) including (as appropriate for size, type and class): • a valid International Anti-fouling System Certificate or • anti–fouling declaration.	
	Compliance with the *Biosecurity Act 2015* (Cth), *Fish Resources Management Act 1994* (WA) and *Aquatic Resources Management Act 2016* (WA), *Fisheries Act 1998* (NT) and associated regulations.	Yes	The management and disposal of any quarantine risk material will be in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	Any quarantine risk material is managed and disposed of in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth)	Control/EPS subdivided
		Yes	Vessel specific biofouling management and/or risk assessment.	Project vessels (as appropriate for size, type and class) entering Australian territorial seas [12 nm limit] from international locations, prior to entering the Activity Area, will	

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				apply the Australian Biofouling Management Requirements (DAFF 2023), including: • an effective biofouling management plan and record book; or • vessel cleaned of all biofouling within 30 days prior to arriving in Australian waters; or • implementation of an alternative biofouling management method.	
				Projects vessels (as appropriate for size, type and class) entering the Activity Area directly from international locations will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector; and • undertake IMS risk reduction measures as guided by an industry recognised IMS inspector if a vessel is not considered low risk; and • only vessels classified as low risk will be permitted entry into the Activity Area.	
				Locally sourced project vessels (as appropriate for size, type and class) entering the Activity Area from Australian domestic locations, will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector or using the industry recognised risk assessment tool Vessel–Check; and • undertake IMS risk reduction measures if a vessel is not considered low risk (either guided by an IMS inspector or through implementation of the measures which address risks identified by Vessel-Check); and • only vessels classified as low risk will be permitted entry into the Activity Area.	
	Alignment with the National biofouling management guidance for the petroleum production and exploration industry and the WA DPIRD Biofouling Biosecurity Policy.	Yes	Vessel specific biofouling management and/or risk assessment.	Projects vessels (as appropriate for size, type and class) entering the Activity Area directly from international locations will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector; and • undertake IMS risk reduction measures as guided by an industry recognised IMS inspector if a vessel is not considered low risk; and • only vessels classified as low risk will be permitted entry into the Activity Area.	Control/EPS subdivided

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				Locally sourced project vessels (as appropriate for size, type and class) entering the Activity Area from Australian domestic locations, will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector or using the industry recognised risk assessment tool Vessel–Check; and • undertake IMS risk reduction measures if a vessel is not considered low risk (either guided by an IMS inspector or through implementation of the measures which address risks identified by Vessel-Check); and • only vessels classified as low risk will be permitted entry into the Activity Area.	
	Maintenance of a minimum 1 km buffer from shoals within the in-field development area (Figure 5-3).	Yes	Separation distance to shoals identified to require protection in the OPP	Project vessels shall not operate within 1 km of named Shoals adjacent to the Activity Area	
	The Crux platform and jacket will not be wet towed to the Crux in-field development area.	Yes	Transportation restrictions for Crux platform and jacket	The Crux platform and jacket will not be wet towed from international locations to the Activity Area.	
		Yes	Only use locally sourced supply and support vessels (specifically those described in Section 6.8.8) where practicable.	Vessel procurement outcomes demonstrate locally sourced supply and support vessels are selected which meet technical and commercial requirements where practicable	
Waste Management	All discharge of waste from vessels will comply with relevant MARPOL 73/78, *Navigation Act 2012* (Cth) and *Protection of the Sea (Prevention of Pollution) Act 1983* (Cth) and subsequent Marine Order requirements (as appropriate for vessel classification).	Yes	Macerate food waste to ≤25 mm particle size before discharge to sea.	Food macerator is maintained in accordance with the maintenance management system to reduce food waste to ≤25 mm	Control/EPS subdivided
			Project vessels will maintain a Garbage Management Plan (or equivalent) (as required by vessel class, size and type).	Project vessels (to which MARPOL Annex V / Marine Order 95 applies) have a current Garbage Management Plan (or equivalent).	
				Project vessels to comply with Marine Orders 94 and 95 (marine pollution prevention – packaged harmful substances/garbage), specifically: • no planned disposal of domestic waste, solid wastes or maintenance wastes overboard from vessels (other than planned discharges permitted by this EP) • food wastes discharges macerated to < 25 mm particle size.	
			For project vessels, treat oily bilge water with an oil-water separator before discharge, in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil).	For project vessels, bilge and slops effluent will be discharged via an oil-water separator compliant with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil) requirements (≤15 ppm).	
			Project vessels routine discharges of treated sewage and grey water will comply with *Navigation Act 2012* (Cth), *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Order 96 (International Sewage Pollution Prevention [ISPP] certificates) as relevant to vessel class, size and type.	Assurance will be undertaken for project vessels to check for a valid and in date ISPP Certificate (or equivalent voluntary statement of compliance audits where relevant) (as required by vessel class, size and type) in accordance with Marine Order 96.	

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	Waste management procedures will be implemented for the Crux project that: • provide for waste segregation and storage • safe handling and transport of waste • appropriate waste classification and disposal, recycling and landfill.	Yes	Implement waste management procedures on the substructure (e.g. drilling rig) and topsides.	Waste management procedures are in place and implemented which supports good practice and prevents accidental discharge by focusing on: • waste segregation and storage • safe handling and transport of waste • appropriate waste disposal classification (e.g. re-use, recycling, landfill). • The disposal of non-hazardous and hazardous wastes will be tracked to confirm they are disposed of at an appropriately licensed waste facility.	
	The disposal of non-hazardous and hazardous wastes will be tracked to confirm they are disposed of at an appropriately licensed waste facility.	Yes			
	The management and disposal of any quarantine risk material will be in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	Yes	The management and disposal of any quarantine risk material will be in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	Any quarantine risk material is managed and disposed of in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth)	
		Yes	Designated waste storage areas available on project vessels.	Designated waste storage facilities on vessels are available to enable waste to be secured and stored.	New control/EPS to address the risk posed by waste entering the marine environment.
		Yes	Designated waste storage areas available on the topsides platform.	Designated waste storage facilities on the topsides platform are available to enable waste to be secured and stored.	New control/EPS to address the risk posed by waste entering the marine environment.
		Yes	Implement procedures for lifting operations.	Crane and lifting procedures include controls, as appropriate, to reduce the risk of dropped objects entering the marine environment: • lifting equipment certification and inspection • preventive maintenance on cranes • lifting crew competencies • heavy-lift procedures • weather considerations.	New control/EPS to address the risk posed by waste entering the marine environment.
		Yes	Dropped objects recovered where safe and practicable to do so.	Dropped objects to ocean are recovered where safe and practicable to do so.	New control/EPS to address the risk posed by waste entering the marine environment.
Liquid Discharges	All planned discharges from vessels will comply with relevant requirements of MARPOL 73/78, the *Navigation Act 2012* (Cth), *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and any subsequent Marine Orders requirements (as appropriate for vessel classification).	Yes	Project vessels routine discharges of treated sewage and grey water will comply with *Navigation Act 2012* (Cth), *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Order 96 (International Sewage Pollution Prevention [ISPP] certificates) as relevant to vessel class, size and type.	Assurance will be undertaken for project vessels to check for a valid and in date ISPP Certificate (or equivalent voluntary statement of compliance audits where relevant) (as required by vessel class, size and type) in accordance with Marine Order 96.	Control/EPS subdivided
			For project vessels, treat oily bilge water with an oil-water separator before discharge, in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil).	For project vessels, bilge and slops effluent will be discharged via an oil-water separator compliant with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil) requirements (≤15 ppm).	
			Project vessels to comply with Marine Order 91 (IOPP certificates).	Project vessels will have a valid and in date IOPP certificate (as required by vessel class and type) in accordance with Marine Order 91.	

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			Project vessels will maintain a Garbage Management Plan (or equivalent) (as required by vessel class, size and type).	Project vessels (to which MARPOL Annex V / Marine Order 95 applies) have a current Garbage Management Plan (or equivalent).	
				Project vessels to comply with Marine Orders 94 and 95 (marine pollution prevention – packaged harmful substances/garbage), specifically: • no planned disposal of domestic waste, solid wastes or maintenance wastes overboard from vessels (other than planned discharges permitted by this EP) • food wastes discharges macerated to < 25 mm particle size.	
			Food macerator is maintained in accordance with the maintenance management system to reduce food waste to ≤25 mm	Macerate food waste to ≤25 mm particle size before discharge to sea.	
			EGCS discharges are managed in accordance with standard maritime practice.	Project vessels (if relevant) to maintain an EGCS Record Book in accordance with EGCS Guidelines (IMO 2021) to ensure discharges meet water quality guidelines.	
	The Crux platform deck drainage shall be managed to reduce impacts on the environment.	Yes	For the topsides, treat potentially oil contaminated water collected in the open drains system with an oil-water separator before discharge.	Topsides deck drainage will be discharged via an oil-water separator (V-26501) once commissioned, except by design, where drain boxes discharge clean water directly overboard in the event of heavy rains or further wash water which is considered clean.	
				Within 2 months of topsides arrival onsite, during cold commissioning, the topsides deck drainage oil-water separator (V-26501) will be verified that it achieves its design basis of ≤30 mg/l free oil in water.	
	Oily bilge water from machinery space drainage is treated to a maximum concentration of 15 ppm oil-in water prior to discharge from vessels, as specified in MARPOL 73/78 (Annex I).	Yes	For project vessels, treat oily bilge water with an oil-water separator before discharge, in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil).	For project vessels, bilge and slops effluent will be discharged via an oil-water separator compliant with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil) requirements (≤15 ppm).	
	Offshore discharge of sewage from vessels will be in accordance with Marine Order 96.	Yes	Project vessels routine discharges of treated sewage and grey water will comply with *Navigation Act 2012* (Cth), *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Order 96 (International Sewage Pollution Prevention [ISPP] certificates) as relevant to vessel class, size and type.	Assurance will be undertaken for project vessels to check for a valid and in date ISPP Certificate (or equivalent voluntary statement of compliance audits where relevant) (as required by vessel class, size and type) in accordance with Marine Order 96.	
	Food wastes will be macerated to < 25 mm particle size whilst operational prior to discharge to sea, in accordance with Marine Order 95.	Yes	Macerate food waste to ≤25 mm particle size before discharge to sea.	Food macerator is maintained in accordance with the maintenance management system to reduce food waste to ≤25 mm	
			Project vessels will maintain a Garbage Management Plan (or equivalent) (as required by vessel class, size and type).	Project vessels to comply with Marine Orders 94 and 95 (marine pollution prevention – packaged harmful substances/garbage), specifically: • no planned disposal of domestic waste, solid wastes or maintenance wastes overboard from vessels (other than planned discharges permitted by this EP) • food wastes discharges macerated to < 25 mm particle size.	

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	Containment around liquid hydrocarbon storage tanks will be installed on the Crux platform to reduce the potential for minor accidental releases of chemicals/hydrocarbons to the environment.	Yes	For the topsides, treat potentially oil contaminated water collected in the open drains system with an oil-water separator before discharge.	Topsides deck drainage will be discharged via an oil-water separator (V-26501) once commissioned, except by design, where drain boxes discharge clean water directly overboard in the event of heavy rains or further wash water which is considered clean. As soon as practicable during cold commissioning, the topsides deck drainage oil-water separator (V-26501) will be verified that it achieves its design basis of ≤30 mg/l free oil in water.	
	For chemicals planned to be used in production and process (including in the subsea facilities and well) and for hydrotesting, and which will be discharged to the marine environment, will be selected in accordance with the Chemical Management Process for chemical selection and assessment of effects on the environment.	Yes	Shell Australia Chemical Change Process.	Chemicals that are planned for discharge to sea are substitution warning free and are rated Gold, Silver, D, or E through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oslo and Paris Convention for the Protection of the Marine Environment of the North-east Atlantic [OSPAR] Commission), or have a complete ALARP assessment.	
	An evaluation will be undertaken prior to hydrotesting of the Crux export pipeline to inform the selection of the discharge location of the pipeline hydrotest water (i.e. Crux versus Prelude end of the pipeline). The evaluation will include a comparison of environmental impacts between the two discharge locations, to determine which location has the lowest environmental impact. The evaluation will also consider safety and technical factors as part of the decision making process.	Yes	N/A	N/A	Evaluation of export pipeline hydrotest discharge, including comparison of environmental, safety and technical factors for different location options, was conducted during FEED and was used to select the discharge location identified in the Activity description, as outlined in Section 6.10.1 of the EP
	An environmental monitoring program and adaptive management framework will be developed for PFW. The monitoring program will include: • continuous monitoring, whilst available, of PFW discharge volume (online flow meter) and dispersed oil-in-water (online oil-in-water analyser) • chemical characterisation of PFW – WET testing will be completed when a suitably representative PFW sample of normal operations can be taken, and then on a risk-based approach thereafter • additional monitoring as a result of trigger actions, and • periodic environment monitoring within the in-field development area.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	The oil-in-water concentration of PFW will be continuously monitored by an online analyser, while available, which will be fitted with an alarm that activates if the oil-in-water concentration is > 30 mg/L. Calibration of the online analyser will be undertaken regularly during the initial early operations phase.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	When using SBM, the solids control equipment will reduce the residual base fluid on cuttings content prior to discharge overboard. Residual base fluid on cuttings will be less than 10% w/w averaged over all well sections using SBM. If drilling for future tie-backs is proposed within 2 km of the shoals within the Crux in-field development area then additional modelling will be undertaken. The concept select	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	for any future tie-backs will use the results of the modelling to inform selection, to achieve acceptable impacts. Should new regionally relevant information become available that provides scientific evidence that 2 km is not a suitably conservative buffer to protect drill cuttings and fluid impacts on coral communities at the shoals as related to tie-backs, Shell will apply an adaptive management approach informed by further validation modelling.				
		Yes	Omission of drilling muds such as water- and synthetic-based muds.	The drilling method will use untreated sea water only (e.g. no chemical additives)	New control/EPS described in EP.
		Yes	No disposal of dry grout to the marine environment.	No disposal of dry grout to the marine environment.	New control/EPS described in EP.
		Yes	No simultaneous discharge of the Crux dewatering fluids and Prelude FLNG produced water (outside the scope of this EP) to avoid cumulative impacts.	No simultaneous discharge of the dewatering fluids and Prelude FLNG produced water to avoid cumulative impacts	New control/EPS described in EP.
		Yes	Stock polyfluoroalkyl substances (PFAS)-free fire extinguishers on the topsides.	Topsides will stock PFAS-free fire extinguishers.	New control/EPS described in EP.
		Yes	Implement export pipeline FCGT and dewatering operations in accordance with the contractor's cold commissioning philosophy.	Implement pipeline FCGT and dewatering, which will include dosing metering controls, such as: • chemical injection skid software to automatically adjust the pump to ensure that dosing rates do not exceed 500 mg/L mixture of biocide, oxygen scavenger, corrosion inhibitor and fluorescein dye • log metering protocols • samples and testing • end of activity onshore validation testing confirms discharges did not exceed 500 mg/L mixture of biocide, oxygen scavenger, corrosion inhibitor and fluorescein dye.	New control/EPS described in EP.
		Yes	Fail-safe tensioner (locks on and contingency tensioners) is in place on the pipelay vessel	The pipelay vessel will have a fail-safe tensioner in place and operational to provide additional loss of position safeguard.	New control/EPS described in EP.
		Yes	Criticality mode software system is in place on the pipelay vessel	The pipelay vessel will have a criticality mode software system in place and operational to provide additional loss of position safeguard.	New control/EPS described in EP.
		Yes	Export pipeline FCGT discharge undertaken via horizontal manifold ports	Export pipeline FCGT discharge occurs via horizontally oriented 4" port on the manifold	New control/EPS described in EP.
		Yes	Undertake in-field pre-operations baseline water quality, sediment quality and benthic habitat study	Pre-operations baseline water quality, sediment quality, and benthic habitat study will be undertaken in accordance with Section 10.4.2 and will be executed within the duration period described in this EP.	New control/EPS described in EP.

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
Unplanned Spills	Vessel specific controls will align with MARPOL 73/78, the *Navigation Act 2012* (Cth), the *Protection of the Sea (Prevention of Pollution from Ships Act 1983* (Cth) and subsequent Marine Orders (as appropriate for vessel classification), which includes managing spills aboard, emergency drills and waste management requirements.	Yes	Project vessels to comply with Marine Order 91 (International Oil Pollution Prevention [IOPP] certificates).	Project vessels will have a valid and in date IOPP certificate (as required by vessel class and type) in accordance with Marine Order 91.	
			Shipboard Oil Pollution Emergency Plan (SOPEP) or equivalent (appropriate to class).	SOPEP (or equivalent) shall be in place for all project vessels as required by class in accordance with as per AMSA Marine Order 91. This control measure enables the efficient and prompt response to unplanned hydrocarbon releases, thereby reducing potential impacts to the marine environment.	
			Spill kits available in high-risk areas	Spill kits are located near high-risk areas.	
			Project vessels equipped and crewed in accordance with Australian maritime requirements.	The project vessels within the Activity Area will adhere to the navigation safety requirements contained within the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), SOLAS Convention, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), the *Navigation Act 2012* (Cth) and any subsequent Marine Orders, which specify standards for crew training and competency, navigation, communication, and safety measures.	
	All vessels involved in the project will have a valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) which is maintained including: Spill Kit – Pollution Control Equipment container/ box is located at a strategic location, containing adequate equipment/material (minimum as per the Shipboard Oil Pollution Emergency Plan) to control spills of pollutants on board.	Yes	Shipboard Oil Pollution Emergency Plan (SOPEP) or equivalent (appropriate to class).	SOPEP (or equivalent) shall be in place for all project vessels as required by class in accordance with as per AMSA Marine Order 91. This control measure enables the efficient and prompt response to unplanned hydrocarbon releases, thereby reducing potential impacts to the marine environment.	
			Spill kits available in high-risk areas	Spill kits are located near high-risk areas.	
	All project vessels operating within the project area will adhere to the navigation safety requirements contained within the COLREGS, Chapter 5 of the SOLAS Convention, STCW Convention, the *Navigation Act 2012* (Cth) and any subsequent Marine Orders, which specify standards for crew training and competency, navigation, communication, and safety measures.	Yes	Project vessels equipped and crewed in accordance with Australian maritime requirements.	The project vessels within the Activity Area will adhere to the navigation safety requirements contained within the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), SOLAS Convention, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), the *Navigation Act 2012* (Cth) and any subsequent Marine Orders, which specify standards for crew training and competency, navigation, communication, and safety measures.	Equivalent to Crux OPP
	Offshore Vessel Inspection Database or equivalent reviewed prior to mobilisation of project vessels.	Yes	Implement a vessel planned maintenance system.	Documented maintenance program is in place for equipment including DP systems, engines and machinery on vessels that provides a status on the maintenance of equipment.	Also specifically addressed in EP Section 10.4.3 – Marine Vessel Assurance
	Australian Hydrographic Service notified of location of installed infrastructure to facilitate inclusion on nautical charts.	Yes	Installed infrastructure locations provided to AHO for inclusion on nautical charts	Australian Hydrographic Service notified of location of installed infrastructure to facilitate inclusion on nautical charts.	
		Yes	For specific vessel-based campaigns, give advance notice to the AHO before the vessel arrives on location to enable a 'Notice to	AHO is notified, at least four weeks prior, to enable a 'Notice to Mariners' to be issued before petroleum activities occur.	

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	Australian Hydrographic Service advised of project activities and installed infrastructure to facilitate issuing Notices to Mariners.		Mariners' to be issued before petroleum activities occur within the Activity Area.		
			Installed infrastructure locations provided to AHO for inclusion on nautical charts	Australian Hydrographic Service notified of location of installed infrastructure to facilitate inclusion on nautical charts.	
	Accepted WOMP in place for all wells, in accordance with the OPGGS Act requirements. The WOMP will outline the barriers in place throughout the construction and operation of the well to prevent a loss of well control. For development drilling, the WOMP will include: • maintaining overbalance in the well through the use of weighted drilling fluids, • installation of a BOP during drilling operations of the bottom hole sections, and • regular testing of BOP.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Accepted EPs and OPEPs in place for all petroleum activities appropriate to the nature and scale of the credible hydrocarbon spill risks.	Yes	Accepted OPEP.	N/A	Addressed by EP and BROPEP submissions
	The OPEP shall consider: • relief well planning and preparedness • interim source control (e.g. capping stacks for subsea well blowouts) • oiled wildlife response, and • operational and scientific monitoring.	Yes	Accepted OPEP.	N/A	Refer to the NOPSEMA–accepted BROPEP (HSE_GEN_016765)
	The OPEP include an Operational and Scientific Monitoring Program will be initiated and implemented as appropriate to the nature and scale of the spill and the existing environment, as informed by a net environmental benefit assessment.	Yes	Accepted OPEP and OSMP.	N/A	Refer to the NOPSEMA–accepted Browse Regional OSMP (HSE_PRE_016370)
	Stakeholder consultation throughout the Crux project, including consultation consistent with the requirements of the OPGGS (E) Regulations for all subsequent petroleum activities and associated EPs.	Yes	N/A	N/A	Addressed through consultation process, as described in Section 5 of EP.
	Where vessel dynamic positioning systems are required, they shall be in working order whilst within the Crux platform petroleum safety zone at all times.	Yes	Implement a vessel planned maintenance system.	Documented maintenance program is in place for equipment including DP systems, engines and machinery on vessels that provides a status on the maintenance of equipment.	
	Development and implementation of a maintenance management system for the Crux platform, export pipeline and subsea infrastructure.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Development of simultaneous operations (SIMOPS) plans where interactions with other activities (e.g. Prelude operations, backfill installations) may credibly occur.	Yes	Manual of Permitted Operations (MOPO) to manage simultaneous operations (SIMOPs)	Shell will manage vessel SIMOPs by developing and implementing the MOPO and field management plan, which will describe how marine SIMOPs are assessed and subsequently managed in the field via the Crux Field Coordinator	
	Concrete coating of the majority of the export pipeline reduces the risk of a dropped object damaging the pipeline.	Yes	N/A	N/A	Addressed in EP activity description

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	The Crux platform will have controls/systems in place that will assist with the early detection of spills/leaks from the NNM platform, including: • fire and gas system, • satellite monitoring of the Crux platform location, and • continuous process control monitoring system (assist in detection of significant leaks).	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Assess feasible design and monitoring controls that will assist with the early detection of spills/leaks from the Crux platform. Controls that are considered compatible with the NNM philosophy will be implemented, unless it can be demonstrated that the 'cost' is grossly disproportionate to the benefit gained. Selection of key material will take corrosion into account.	N/A	N/A	N/A	
	Pigging of the Crux gas export pipeline will be undertaken as required throughout operations to detect defects, assess integrity and enable risk based management of the pipeline.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Fuel type will be considered in the construction vessel contracting process where alternatives to marine diesel are being considered.	Yes	None adopted. Three control measures consider and rejected within Table 9-83 included: Use renewable energy (e.g. solar, wind, wave) instead of IFO and marine diesel for project vessel propulsion. Use alternate fuels instead of IFO and marine diesel for project vessel propulsion. Use of hybrid power options for vessel propulsion to reduce IFO and marine diesel fuel storage requirements.	N/A	Contracting for Crux Project installation activities occurred shortly after FID in 2022. Vessel fuel type was considered during this contracting process, however technical, commercial and safety considerations were key in the contracting decisions. This is considered to have the same standard to that outlined in the Crux OPP. Additional rejected controls and ALARP descriptions considering the use of alternate fuels and fuel arrangements for marine diesel are included in Table 9-83: Use renewable energy (e.g. solar, wind, wave) instead of IFO and marine diesel for project vessel propulsion. Use alternate fuels instead of IFO and marine diesel for project vessel propulsion. Use of hybrid power options for vessel propulsion to reduce IFO and marine diesel fuel storage requirements.
		Yes	Implement chemical management procedures on the project vessels, substructure (e.g. drilling rig) and topsides platform.	Contractor Chemical management procedures will be implemented as far as practicable and include controls to reduce the risk of accidental chemical release to the marine environment:	New control/EPS described in EP.

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
				• safe handling and storage aligned with EPS11.3 • spill response and emergency procedures • disposal considerations.	
		Yes	Designated chemical and hydrocarbon storage areas available on project vessels.	Chemicals will be stored in bunds which will be able to contain at least 110% of the volume of the largest container stored	New control/EPS described in EP.
		Yes	Use radar/ Automatic Identification System (AIS)/ Automatic Radar Plotting Aid (ARPA) and associated alarms on project vessels and AIS activated on topsides once installed	Project vessels are equipped with suitable and operational navigation and collision avoidance equipment, specifically: • ARPA • AIS • associated alarms • radar, and/or • equivalent system.	New control/EPS described in EP.
				Topsides equipped with AIS which is activated once installed.	New control/EPS described in EP.
		Yes	Confirm the Crux drilling template (or equivalent) PSZ is in place.	Compliance with PSZ as per Part 6.6 of the OPGGS Act.	New control/EPS described in EP.
		Yes	Implement bunkering procedures for hydrocarbons and chemicals.	Contractor bunkering procedure will be implemented to minimise the risk of bunkering spills to the ocean, which includes (where appropriate to vessel arrangements): • transfer hoses will have dry-break couplings, inspected and certified bunkering hoses, and this equipment will be maintained • drains plugged • approved bunker for specified volumes • designated receiving tanks and agreed pumping rates • direct communication between all involved • supervision at both ends • availability of spill kits on each vessel • vessel bunkering (via hose) to commence during daylight hours.	New control/EPS described in EP.
				A permit to work, job hazard analysis or equivalent process is implemented for bunkering.	New control/EPS described in EP.
		Yes	The management and disposal of any quarantine risk material will be in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	Any quarantine risk material is managed and disposed of in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	New control/EPS described in EP.
Health Impacts	An ongoing stakeholder engagement program will be undertaken as the project progresses through future phases of development planning and implementation.	Yes	N/A	N/A	Addressed through consultation process, as described in Section 5 of EP.
	Emergency Planning will include early discussions with local health authorities on local community arrangements to provide appropriate support in the scenario of medical response.	Yes	N/A	N/A	Addressed through consultation process for development of the BROPEP.

Aspect	Crux OPP Key Management Control	EP achieves equivalent, or better, level of environmental performance?	EP Control Measure	EP Environmental Performance Standard[2]	Evaluation of change (where applicable)
	The Crux platform is designed to operate under a NNM concept, which will deliver benefits of minimal workforce requirements and commensurate minimal disturbance to onshore communities	Yes		N/A	Not relevant to the petroleum activities within scope of the EP
	Scheduling of flights in accordance with the Broome International Airport Fly Neighbourly Policy. Shell will aim to replicate Prelude planned flight considerations (flight plans/times), which are designed to minimise local disturbance: • No flights on Sundays • Reduced number of flights on Saturday, and • Flying route to avoid Roebuck Bay and local Aboriginal community (Mallingbar).	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP
	Shell is considering local content and progressing an AIP plan as part of the development of the Crux project.	N/A	N/A	N/A	Not relevant to the petroleum activities within scope of the EP

3.2.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act and supporting regulations provide for the protection of the environment and the conservation of biodiversity in Australia. Amendments to the OPGGS Act and OPGGS(E) Regulations in February 2014, undertaken as part of streamlining environmental approvals for petroleum activities in Commonwealth waters, require that impacts and risks to matters protected under Part 3 of the EPBC Act (i.e. MNES) be considered in the EP. Following these streamlining arrangements, NOPSEMA became the sole environmental regulator for petroleum activities in Commonwealth waters (i.e. NOPSEMA regulates activities under the OPGGS Act and EPBC Act).

The matters protected under Part 3 of the EPBC Act that are required by the OPGGS(E) Regulations are outlined in Section 3.2.1.1. As part of the streamlining arrangements, matters protected under Part 3 of the EPBC Act must be considered by NOPSEMA when assessing an EP.

3.2.2.1 EPBC Management Publications

3.2.2.1.1 Australian Marine Park Management Plans

The EPBC Act provides for the declaration of AMPs based on the International Union for Conservation of Nature (IUCN) principles and guidelines for categorising protected areas. Australia has established a network of AMPs throughout Commonwealth waters, which are managed under a series of regional management plans. These plans detail the management objectives of the AMPs, the environmental values within each AMP, and the activities that are permissible within AMP zones. AMPs are part of the Commonwealth Marine Area (Section 7.3.4.1), which is an MNES.

The planned petroleum activities considered within this EP will not credibly impact any AMPs; however, an emergency event may potentially impact several AMPs. Section 7.3.4.2 describes these AMPs, which are managed under the Australian Marine Parks – North Marine Parks Network Management Plan 2018 (DNP 2018a) and Australian Marine Parks – North-west Marine Parks Network Management Plan 2018 (DNP 2018b).

The requirements of relevant AMP management plans were considered as part of Shell's setting acceptable levels of environmental impacts and risks.

3.2.2.1.2 Recovery Plans and Conservation Advice

Species and communities listed as threatened under the EPBC Act are MNES and receive protection under Commonwealth law. The Threatened Species Scientific Committee (TSSC) may publish conservation advice for a threatened species, which provides information on threats and conservation management. The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) has developed recovery plans relating to threatened species. Recovery plans provide a framework to prevent further decline and facilitate the recovery of threatened species. Recovery plans may contain actions that warrant consideration when assessing environmental impacts and risks. Recovery plans may also identify habitat critical for the survival of a species; such habitat is protected under the EPBC Act.

Shell identified a number of threatened species that may credibly be impacted, or are at risk of being impacted, by the petroleum activities considered in this EP. Section 7.3.3.6 details these species and relevant information from their recovery plans and conservation advice.

3.2.2.1.3 Other

Other EPBC Act publications, such as guidance and policy statements, are described in Section 3.3.1.

3.3 Standards and Guidelines

3.3.1 Industry, Australian and International Standards and Guidelines

In Australia, the petroleum exploration and production industry operate within an industry code of environmental practice developed by the Australian Petroleum Production and Exploration Association (APPEA), now Australian Energy Producers (APPEA 2008). This code provides guidelines for activities and has evolved from the collective knowledge and experience of the oil and gas industry both nationally and internationally. The code provides the Australian petroleum industry with guidance on management measures

to protect the environment during exploration, production and decommissioning phases. Shell is a signatory to the APPEA guidelines and will align with their intent in the implementation of this EP.

In compliance with this policy, Shell has a petroleum title and pipeline licences granted for the Crux Project, Crux OPP accepted by NOPSEMA, and has developed or is developing a suite of Crux EPs to enable the development of the Crux Project which took a final investment decision in May 2022.

The following Australian guidelines are also applicable to the Activity (as defined in Section 6.1):

- NOPSEMA Guidance Note GN1344 – Environment plan content requirements – January 2024
- NOPSEMA Guideline GL2086 – Consultation in the course of preparing an environment plan – May 2024
- NOPSEMA Guideline GL1887 – Consultation with Commonwealth agencies with responsibilities in the marine area – January 2024
- NOPSEMA Information paper IP1765 – Acoustic impact evaluation and management – January 2024
- NOPSEMA Guidance Note GN1343 – Petroleum activity January 2024
- NOPSEMA Guidance Note GN1785 – Petroleum activities and Australia marine parks January 2024
- NOPSEMA Guidance Note GN1488 – Oil Pollution Risk Management – July 2021
- NOPSEMA Information paper IP1349 – Operational and Scientific Monitoring Programs – January2024 NOPSEMA Information paper IP2002 – Planning for proactive decommissioning – January 2024
- NOPSEMA Policy PL1903 – Section 572: Maintenance and removal of property – November 2022 (NOPSEMA 2022d)
- Australian Ballast Water Management Requirements (Department of Agriculture, Water and the Environment [DAWE] 2020)
- National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009 (Marine Pest Sectoral Committee 2009)
- Australian biofouling management requirements version 2 (Commonwealth Department of Agriculture, Fisheries and Forestry [DAFF] 2023)
- Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA 2015)
- Matters of National Environmental Significance (MNES) – Significant Impact Guidelines 1.1 (DoE 2013)
- EPBC Act Policy Statement 'Indirect consequences' of an action (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2013)
- National Plan for Maritime Environmental Emergencies – 2020 edition (AMSA 2020)
- Marine Oil Pollution: Response and Consultation Arrangements (Department of Transport 2020).

The following international guidelines are also applicable to the project:

- Environmental Management in Oil and Gas Production (United Nations Environment Program and Oil Industry International Exploration and Production Forum 1997).

3.4 International Agreements and Conventions

Australia is signatory to several international agreements and conventions that are relevant to the environmental management of the petroleum activities considered in this EP. These agreements and conventions are typically implemented by Commonwealth legislation, much of which is detailed in Section 3.1. Table 3-5 lists the relevant international agreements and conventions, along with a justification of their relevance to the petroleum activities considered in this EP.

Table 3-4: Summary of Relevant Legislation

Legislation	Summary	Relevance to this EP
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth)	Protects areas and objects that are of particular significance to Aboriginal and/or Torres Strait Islander People	The EP will take into consideration any heritage values (see Section 7.4).
Aboriginal Heritage Act 1972 (WA)	This Act provides for the recognition, protection, conservation and preservation of Aboriginal cultural heritage in Western Australia.	The EP will take into consideration any heritage values (see Section 7.4).
Aboriginal Sacred Sites Act 1989 (NT)	This Act is the legislation that responds to requests to protect sites, maintains registers of sites and includes the requests and requirements for consultation with Aboriginal custodians to determine the constraints on any works or proposed impacts to sites.	The EP will take into consideration any heritage values (see Section 7.4).
Australian Heritage Council Act 2003 (Cth)	Identifies areas of heritage value, including those listed on the World Heritage List, National Heritage List and the Commonwealth Heritage List (all of which are MNES under the EPBC Act).	The EP will take into consideration any heritage values (Section 7.3.4.4).
Australian Maritime Safety Authority Act 1990 (Cth)	Establishes the Australian Maritime Safety Authority (AMSA) and provides for its functions, including to combat pollution in the marine environment. AMSA is also responsible for administering Marine Orders in Commonwealth waters. The Act also aims to promote maritime safety, protect the marine environment from pollution and environmental damage from ships, provide for a national search and rescue service and promote the efficient provision of service by AMSA. AMSA is the control agency for vessel-based non-petroleum activity spills in Commonwealth waters.	Vessel emergencies, including oil spills in Commonwealth waters.
Biodiversity Conservation Act 2016 (WA) Biodiversity Conservation Regulations 2018 (WA)	Requires WA conservation management agencies to take a lead role in oiled wildlife response in WA. The WA Department of Biodiversity, Conservation and Attractions (DBCA) has the responsibility and statutory authority to conserve, protect and manage wildlife, including threatened species	Oiled wildlife response will comply with this Act.
Biosecurity Act 2015 (Cth) Australian Biofouling Management Requirements (Version 2 2023)	Provides for managing the risk of pests and diseases entering Australian territory. The Act includes requirements for pre-arrival reporting, ballast water management plans and certificates.	The Activity will comply with biosecurity requirements, specifically in relation to project vessel biofouling and ballast water requirements (Section 9.8).
Climate Change Act 2022 (Cth)	This Act commenced in September 2022 and sets out Australia's net-zero commitments and codifies Australia's net 2030 and 2050 GHG emissions reductions targets under the Paris Agreement.	The oil and gas sector is not subject to direct obligations under this Act; however, this Act legislates Australia's emissions net-zero targets by 2050. Refer to the Shell climate target (Shell 2024).

Legislation	Summary	Relevance to this EP
Emergency Management Act 2005 (WA)	Provides for processes for hazard management. Requires the WA Department of Transport (WA DoT) (Hazard Management Agency) to be the control agency for spills within or entering WA state waters. It is the legislative basis for the WA State Emergency Management Plan for Marine Oil Pollution.	Emergencies, including oil spills that enter WA waters will comply with this Act.
Environment Protection (Sea Dumping) Act 1981 (Cth)	Intended to prevent pollution of the sea by prohibiting the discharge of potentially harmful materials to the sea.	Chemical inventories on a vessel may potentially breach this convention if unpermitted via this EP and if deliberately discharged to the sea.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Cth) Environment Protection and Biodiversity Conservation Regulations 2000 (Cth)	While the OPGGS(E) Regulations under the OPGGS Act (see below) regulate day to day petroleum activities and apply to any activity that may have an impact on the environment, the EPBC Act regulates the assessment and approval of proposed actions that are likely to have a significant impact on a matter of National Environmental Significance (MNES). Refer to Section 3.2.1.1.1 for a detailed description of the requirements.	The Crux Project is approved under the EPBC Act. Refer to Section 7 Description of the environment as well as Section 8.3 – consideration of impacts and risks for MNES. Consideration has also been afforded to [Policy Statement for 527E]. Appendix H explains Shell's approach to indirect GHG emissions.
Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Cth)	Regulates the export, import and transport of hazardous waste to ensure that hazardous waste is managed appropriately so that human health and the environment are protected from the harmful effects of the waste.	The Project will comply with the export, import and transport requirements for hazardous waste.
Heritage Act 2011 (NT)	This Act covers the management and protection of Aboriginal and Macassan heritage places and defines requirements to conserve that heritage through regulating work on heritage places, providing for heritage agreements that enable conversation and forming the Heritage Council.	The EP will take into consideration any heritage values (see Section 7.4).
Marine Safety (Domestic Commercial Vessel) National Law Act 2012 (Cth) Marine Safety (Domestic Commercial Vessel) National Law Regulation 2013 (Cth)	This Act is a single regulatory framework for the certification, construction, equipment, design and operation of domestic commercial vessels inside Australia's EEZ. The Act names AMSA as the National Marine Safety Regulator and confers functions on AMSA in relation to marine safety, including that AMSA may make and maintain Marine Orders. The Regulations under the Act set out the definition of a vessel and details and requirements of the accredited marine surveyor scheme.	Shell, when contracting vessel contractors, will assure the vessel contractors compliance with applicable maritime law and regulations.
National Environment Protection (National Pollutant Inventory) Measure 1998 (established under the	Provides the framework for developing and establishing the National Pollutant Inventory (NPI), which provides publicly available information on the types and amounts of listed toxic substances being emitted into the Australian environment. These substances	The Activity will comply with the NPI National Environment Protection Measure (NEPM) by reporting relevant NPI substances (if required).

Legislation	Summary	Relevance to this EP
National Environment Protection Council Act 1994) (Cth)	were identified as important due to their possible effect on human health and the environment.	
National Environment Protection Council Act 1994 (Cth)	Establishes the National Environment Protection Council, whose primary functions are to: • define national environment protection measures (NEPMs) to ensure Australians have equivalent protection from air, water, soil and noise pollution • assess and report the implementation and effectiveness of NEPMs.	The Activity will comply with the requirements of the relevant NEPMs.
National Greenhouse and Energy Reporting Act 2007 (Cth) National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (Cth)	Provides a single, national framework for reporting and distributing information related to GHG emissions, GHG projects, energy production and energy consumption. Reporting obligations are imposed upon corporations that meet emissions/energy thresholds. The Act includes National Greenhouse and Energy Reporting (NGER) requirements and the Safeguard Mechanism requirements.	Shell reports as a corporate group under the Act; this includes reports related to emissions from activities under its operational control. If operational control is determined to sit with Shell's contractors, it is each contractor's responsibility to adhere to the Act.
Native Title Act 1993 (Cth)	The Native Title Act recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs, and creates processes through which native title can be recognised and protected. Under s 280(2) of the OPGGS Act, petroleum activities must be carried out in a manner that does not interfere with the enjoyment of native title rights and interests under the Native Title Act to a greater extent than necessary.	There are no requirements arising under the Native Title Act that apply to the environmental management of the Activity. The Activity will not interfere with the enjoyment of native title rights and interests under the Native Title Act 1993 (Cth) to a greater extent than necessary. Refer to Section 7.4.1.2.2. Refer also to Section 5 in relation to consultation.
Navigation Act 2012 (Cth) Navigation Regulations 2023 (Cth)Marine Order 21 (Safety and emergency arrangements) 2016 (Cth) Marine Order 27 (Safety of navigation and radio equipment) 2023 (Cth) Marine Order 30 (Prevention of collisions) 2016 (Cth) Marine Order 71 (Masters and deck officers) 2014 (Cth)	Relates to maritime safety and the prevention of pollution of the marine environment in Australian waters. It gives effect to several international conventions relating to maritime issues to which Australia is a signatory. The Act's subsidiary legislation is contained in Regulations and Marine Orders.	The Activity, including project vessels, will adhere to the Act and subsidiary legislation enabled by the Act, such as Marine Orders relating to the international conventions listed in Table 3-5.
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth)	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements	Requirements under the OPGGS Act and associated Regulations are addressed throughout this EP.

Legislation	Summary	Relevance to this EP
Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (Cth)	specified in the OPGGS Act and associated Regulations. Refer to Section 3.2.1 for a detailed description of the requirements.	
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 (Cth)	Aims to protect the environment by reducing emissions of ozone depleting substances (ODSs) and synthetic greenhouse gases (SGGs). It controls the manufacture, import and export of ODSs and SGGs and products containing these gases.	The Activity will adhere to restrictions on importing and using ODSs/SGGs by implementing appropriate measures that control procuring of products which contain these gases.
Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (Cth) Marine Order 98 (Marine pollution prevention — anti-fouling systems) 2023 (Cth)	Aims to protect the marine environment from the effects of harmful antifouling systems. Under the Act, the negligent application of a harmful antifouling compound to a ship by a person or persons is an offence. The Act also requires that all Australian ships (that meet specific criteria) must hold 'antifouling certificates'.	Project vessels associated with offshore petroleum activities are required to adhere to this Act.
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth) Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994 Marine Order 91 (Marine pollution prevention — oil) 2014 Marine Order 93 (Marine pollution prevention — noxious liquid substances) 2014 Marine Order 94 (Marine pollution prevention — packaged harmful substances) 2014 Marine Order 95 (Marine pollution prevention — garbage) 2018 Marine Order 96 (Marine pollution prevention — sewage) 2018 Marine Order 97 (Marine pollution prevention — air pollution) 2023 Marine Order 98 (Harmful Anti-Fouling Systems) 2023	Regulates discharges from ships to protect the sea from pollution. These discharges include oil or oily mixtures, noxious liquid substances, packaged harmful substances, sewage and garbage. The Act imposes a duty to report certain incidents involving prohibited discharges and to maintain record books and management plans. The Act and its subsidiary Marine Orders enact the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL).	Project vessels are subject to this Act and will adhere to the requirements for discharges and waste management outlined in the relevant MARPOL and Marine Orders (as appropriate to vessel class).
Underwater Cultural Heritage Act 2018	Aims to protect Australia's underwater cultural heritage (UCH). The Act came into effect on 1 July 2019, replacing the *Historic Shipwrecks Act 1976*. The Act protects Australia's shipwrecks and broadens protection to sunken aircraft and other types of UCH.	Planned petroleum activities will not interfere with any known UCH site (see Section 7.4.3).

Table 3-5: Summary of Relevant International Agreements and Conventions

Agreement / Convention	Summary	Relevance to this EP
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 (JAMBA)	This agreement aims to conserve migratory bird species that travel between Japan and Australia. This includes many species of shorebirds that use the East Asian–Australasian Flyway (EAAF). It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under JAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several birds listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this EP. Refer to Section 7.3.3.4.
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 (CAMBA)	This agreement aims to conserve migratory bird species that travel between China and Australia. This includes many species of shorebirds that use the EAAF. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under CAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several bird species that use the EAAF were identified as potentially being impacted by the petroleum activities considered in this EP. Refer to Section 7.3.3.4.
Agreement between the Government of Australia and the Government of the Republic for Korea for the Protection of Migratory Birds and their Environment 2007 (ROKAMBA)	This agreement aims to conserve migratory bird species that travel between the Republic of Korea and Australia. This includes many species of shorebirds that use the EAAF. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under ROKAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several birds listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this EP. Refer to Section 7.3.3.4.
Convention on the Conservation of Migratory Species of Wild Animals 1979 (the Bonn Convention)	This convention aims to conserve migratory fauna species throughout their ranges, particularly where their range crosses international jurisdictional boundaries. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under the Bonn Convention to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several species listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this EP. Refer to Section 7.3.3.
International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	This convention prohibits the use of harmful organotins in antifouling paints applied on ships. Additionally, this Convention establishes a mechanism to prevent the potential future use of other harmful substances in antifouling systems. The *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (Cth) and subsidiary Marine Order give effect to the Convention.	Project vessels are required to comply with this Convention. Refer to Section 9.8

Agreement / Convention	Summary	Relevance to this EP
International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004	This Convention was adopted by the International Maritime Organization (IMO) and entered into force globally in 2017. It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for managing and controlling ships' ballast water and sediments. Thus, ballast water management systems must be approved in accordance with this Convention. From 8 September 2017, all vessels that use ballast water are required to meet the Regulation D2 discharge standard of this Convention at their next renewal survey.	Project vessels must manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. This Convention is relevant in preventing the introduction of invasive marine species (IMS). Refer to Section 9.8.
International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL)	This convention is an agreement to minimise the pollution of the marine environment by ships caused by operational or accidental causes. The convention provides a standardised approach to the environmental management of international and domestic shipping. The convention is implemented in Commonwealth law by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and a series of Marine Orders made under this Act.	Project vessels are required to comply with MARPOL.
International Convention for the Safety of Life at Sea 1974 (SOLAS) and its Protocol of 1988	This convention provides internationally agreed minimum standards for the construction, equipment and operation of vessels. It is implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	Project vessels are required to comply with SOLAS.
International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW)	This convention provides a standardised approach to the qualifications and competencies of masters, officers and watch personnel. It is implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	Project vessels and crew are required to comply with STCW.
Convention on Wetlands of International Importance 1975 (Ramsar)	This convention aims to conserve and promote the sustainable human use of wetlands. Many wetlands provide important habitat for migratory bird species, and Ramsar wetlands are important for conserving many species of migratory shorebirds and waders. Ramsar wetlands are protected under the EPBC Act and are MNES.	The Ashmore Reef Ramsar wetland was identified as potentially being impacted if an unplanned release of large volumes of hydrocarbons was to occur (e.g. vessel collision). Refer to Section 7.3.4.3.
International Regulations for Preventing Collisions at Sea 1972 (COLREGS)	These regulations provide internationally agreed rules on vessel navigation, which are intended to reduce the likelihood of vessel collisions. COLREGS are implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	Project vessels are required to comply with COLREGS.

Agreement / Convention	Summary	Relevance to this EP
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention)	This convention is an agreement to control pollution of the sea by intentional disposal at sea of potentially harmful materials. It is implemented under Commonwealth law by the *Environment Protection (Sea Dumping) Act 1981*.	Project vessels may potentially breach this convention if unpermitted via this EP and if deliberately discharged to the sea.
Memorandum of Understanding between the Government of Australia and the Government of the Republic of Indonesia Regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Exclusive Fishing Zone and Continental Shelf 1974	This memorandum of understanding (MOU) recognises the long history of traditional Indonesian fishermen exploiting biological resources within Timor Sea waters within Australia's exclusive economic zone (EEZ). The MOU provides for an area (commonly referred to as the MOU box) within which traditional Indonesian fishing is permitted. The area includes several offshore reefs, including Ashmore Reef, Cartier Island, Scott Reef and Seringapatam Reef.	The Activity Area[3] is situated within the MOU box. Refer to Section 7.4.4.
Minamata Convention on Mercury	This convention aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. The convention came into force in Australia on 7 March 2022 and is implemented through various legislative instruments, including the OPGGS Act and the OPGGS(E) Regulations. The National Implementation Plan: Minamata Convention on Mercury (October 2024) (DCCEEW 2024p) informs how the obligations of the convention are being implemented in Australia, and states "*The Regulations [OPGGS(E)] require that environment plans describe legislative and other requirements that apply, and demonstrate how they will be met. NOPSEMA requires offshore oil and gas projects to be compliant with the Minamata Convention and to apply best available techniques and best environmental practices to control mercury releases and manage mercury waste in an environmentally sound manner*." Compliance is achieved through the requirement in the OPGGS(E) Regulations that environmental impacts and risks of an activity be reduced to ALARP and an acceptable level.	The Crux project aligns with relevant environmental conventions, including those related to mercury management (noting that unlike traditional drilling operations, the drilling activity will not use drilling fluid/mud or produced formation fluids, see Section 6.9.7.3). The Crux project will control mercury releases and manage mercury waste to ensure that environmental impacts and risks of the activity are reduced to ALARP and an acceptable level. Additionally, the project must comply with national reporting requirements, ensuring transparency and accountability in its mercury management practices. Design aspects and considerations are outlined in Appendix A. BAT and BEP are equivalent to an ALARP assessment, therefore to term ALARP in the context of assessment on mercury removal and reduction will use that term moving forward.
Paris Agreement on Climate Change (2015)	The Paris Agreement is an instrument made under the United Nations Framework Convention on Climate Change, with the central aim of strengthening the global response to the threat of climate change by keeping the global temperature rise this century well below 2° C above pre-industrial levels and to pursue efforts to limit	Refer to Section 9.12 which refers to the Shell climate target (Shell 2024).

[3] defined as the petroleum titles AC/L10 and WA-3-IL; and pipeline licences WA-33-PL and AC/PL1.

Agreement / Convention	Summary	Relevance to this EP
	the temperature increase even further to 1.5° C in order to prevent dangerous human caused interference with the climate system. It deals with GHG emissions mitigation, adaptation, and finance. The agreement's language was negotiated by representatives of 196 state parties, including Australia, and adopted by consensus on 12 December 2015, before entering in to force in late 2016. Australia has since ratified the Paris Agreement. The Paris Agreement requires each party to: volunteer its own Nationally Determined Contributions (NDCs), to report against them annually, and improve them if it is determined that the collective commitment to NDCs is considered ineffective or insufficient to keep global temperature increases to less than 2° C below pre-industrial levels. This allows for variation in emissions reduction performance according to the development status of the country determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming. No mechanism forces a country to set a specific emissions target by a specific date, but each target should go beyond previously set targets. Under the Paris Agreement, Australia has set an NDC of a 43% reduction in greenhouse gas emissions by 2030 (based on 2005 levels). The Intergovernmental Panel on Climate Change released a report in October 2018 on the 1.5° C target, which concluded that global emissions need to reach net zero around mid-century to give a reasonable chance of limiting warming to 1.5° C.	
The East Asian–Australasian Flyway Partnership 2006	The EAAF Partnership was adopted in the list of the World Summit on Sustainable Development as a Type II initiative, which is informal and voluntary, and was launched on 6 November 2006. This partnership aims to protect migratory waterbirds, their habitat and the livelihoods of people who depend upon them.	Several migratory bird species that use the EAAF were identified as potentially being impacted by the petroleum activities considered in this EP. Refer to Section 7.3.3.4.

4 Shell Environmental Management Framework

4.1 Shell Performance Framework

Shell Australia Pty Limited (Shell), as a subsidiary of Shell plc, is a member of the Shell group of companies (in this EP, references to Shell's global activities use the term 'Shell Group'; Australian activities use 'Shell'). The Shell Performance Framework is the overarching framework adopted by Shell Group to deliver on its strategy. The Shell Performance Framework applies to all Shell Group companies and provides a consistent approach for how each company in Shell Group operates.

The Shell Performance Framework provides a common language for how Shell Group talks about its activities. It encourages a focus on business outcomes, a holistic approach to business challenges and the use of a plan-do-check-adjust loop (Improvement Cycle) to ensure Shell Group continues to learn and improve.

The Health, Safety, Security and Environment & Social Performance (HSSE & SP) Commitment and Policy (Section 4.2) and the Safety, Environment & Asset Management (SEAM) Standards (Section 4.3) are fundamental elements of the Shell Performance Framework.

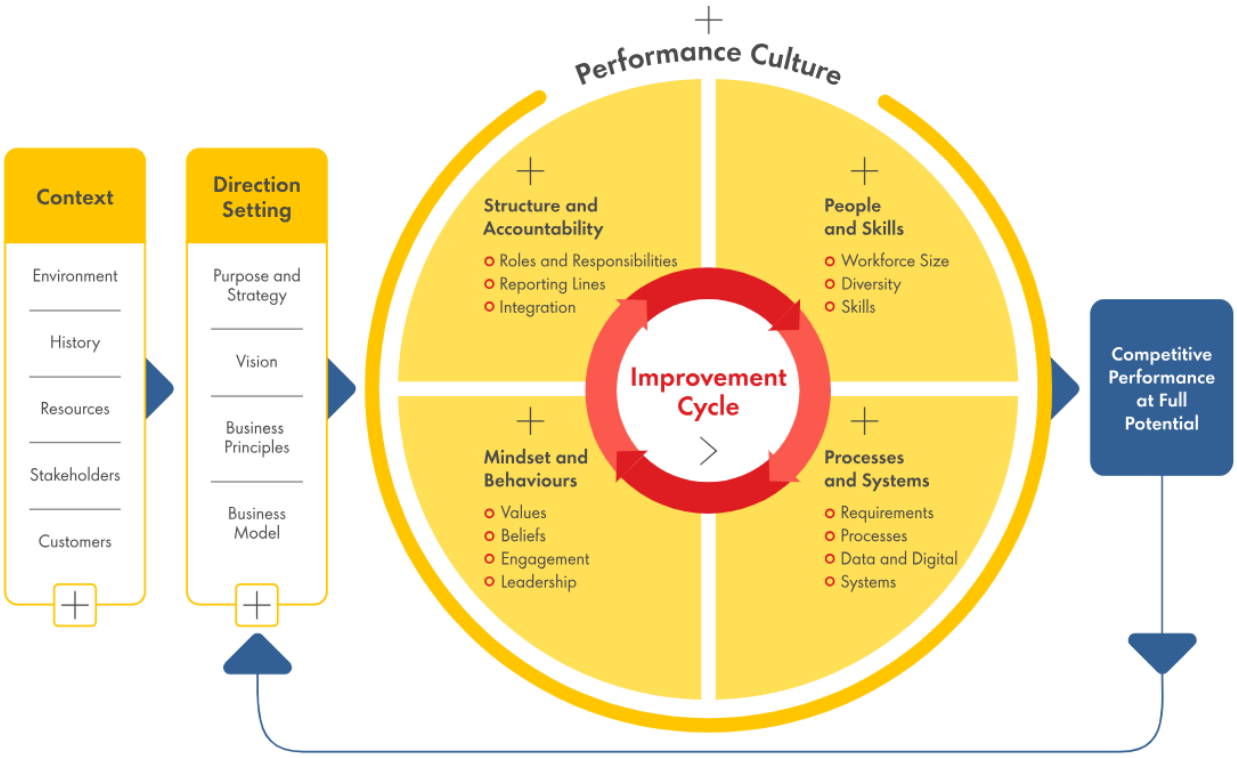


Figure 4-1: Shell Performance Framework.

4.2 HSSE & SP Policy

The Shell Commitment and Policy on HSSE & SP (Figure 4-2), which is endorsed and adopted by Shell, applies across the Shell Group and is designed to protect people and the environment. The Policy illustrates the commitment made by the senior management and all Shell staff to not only comply with environmental standards set by the Australian Government and the Shell Group, but also to continually improve performance.

Key features of the policy are to:

- manage HSSE & SP requirements to ensure compliance with the law and to achieve continuous performance improvement
- set targets for improvement and measurement, appraise and report performance
- require contractors to manage HSSE & SP in line with this policy
- effectively engage with neighbours and impacted communities.

Shell Commitment and Policy on Health, Security, Safety, the Environment, and Social Performance

Commitment

In Shell we are all committed to:

- Pursue the goal of no harm to people;
- Respect nature by protecting the environment, reducing waste, making a positive contribution to biodiversity, and reducing Greenhouse Gases;
- Use material and energy efficiently to provide our products and services;
- Respect our neighbours and contribute to the societies in which we operate;
- Develop energy resources, products and services consistent with these aims;
- Operate assets safely, efficiently and responsibly;
- Publicly report on our performance;
- Play a leading role in promoting best practice in our industries;
- Manage HSSE & SP matters as any other critical business activity; and
- Create a working environment which is psychologically safe and enables learning in support of this commitment.

In this way we aim to achieve a performance we can be proud of, to earn the confidence of customers, shareholders and society at large, to be a good neighbour and to contribute to sustainable development.

Policy

Every Shell Company:

- Has a systematic approach designed to ensure compliance with the law and achieve continuous performance improvement;
- Sets targets for improvement and measures, appraises and reports performance;
- Requires Contractors to manage HSSE & SP in line with this policy;
- Requires joint ventures under its operational control to apply this policy, and uses its influence to promote it in its other ventures;
- Engages effectively with neighbours and impacted communities; and
- Includes HSSE & SP performance in the appraisal of staff and rewards accordingly.

Originally published in March 1997 and updated January 2023.

Wael Sawan
Chief Executive Officer - Shell

Cecile Wake
SVP / Country Chair - Shell Australia

Figure 4-2: Shell's HSSE & SP Policy

4.3 Safety, Environment & Asset Management (SEAM) Standards

The Shell Group SEAM Standards are made up of one or more Requirements related to a specific risk or activity area and provide additional context to these Requirements. Shell companies are expected to adopt and apply relevant Shell Group SEAM Standards which apply to their local context. The SEAM Standards comprise the following five standards which contain all the related Requirements:

- HSSE, SP and Asset Management Foundations Standard;
- Carbon, Environment, Social Performance, Product Stewardship and Quality Standard;
- Process Safety and Asset Management Standard;
- Transport Safety Standard; and
- Workplace Health, Safety and Security Standard.

SEAM Standards Requirements are the mandatory rules that are designed to result in a consistent approach to major, Shell Group-wide risks or opportunities, external stakeholder expectations or external disclosures. They define the 'what' as opposed to the 'how' (Figure 4-3).

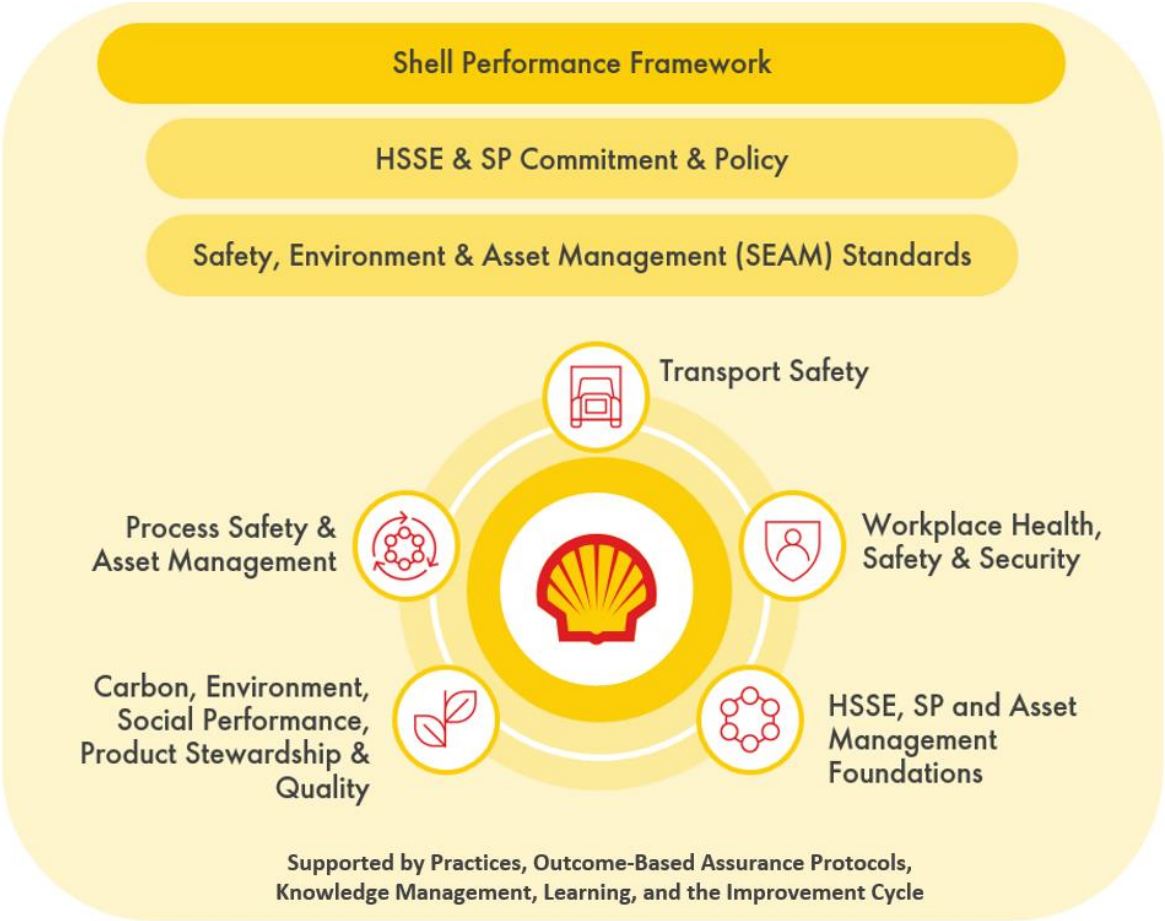


Figure 4-3: Shell Group SEAM Standards

4.4 HSSE & SP Management System (MS)

The Shell HSSE & SP-MS is a structured and documented system for effectively managing impacts and risks and it demonstrates how Shell meets local legal requirements and implements the relevant requirements of the Shell Group SEAM Standards.

Environmental management for Crux is through the implementation of the Shell HSSE & SP-MS, applied by combination of Shell Group SEAM Standards requirements and project specific HSSE systems/procedures as set out in this EP.

5 Relevant Persons Consultation

5.1 Background

Pursuant to section 25 of the OPGGS(E) Regulations a titleholder must carry out consultation in the course of preparing an EP.

In carrying out the duty to consult with relevant persons the titleholder must:

i. 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

ii. allow a relevant person a reasonable period for the consultation; and

iii. inform the relevant person that they may request information not be published.

Effective consultation enables relevant authorities, persons, and organisations whose functions, interests or activities may be affected by the proposed activity to put forward their views and to contribute to a titleholder's understanding of the environment that may be affected by the proposed activity and any associated impacts and risks. Effective consultation enables a titleholder to adopt appropriate measures in response to any concerns conveyed by the relevant person.

As the source of backfill to Prelude FLNG, proactive engagement has been ongoing for the Crux Project since the Prelude gas field was first discovered in early 2007. A range of relevant persons have been consulted throughout this time, including the State and Federal Government, commercial fishing associations, industry bodies, non-government organisations and local relevant persons in Broome and the Dampier Peninsula as well as Indigenous peoples, including Nyamba Buru Yawuru, Bardi Jawi Niimidiman and Larrakia people.

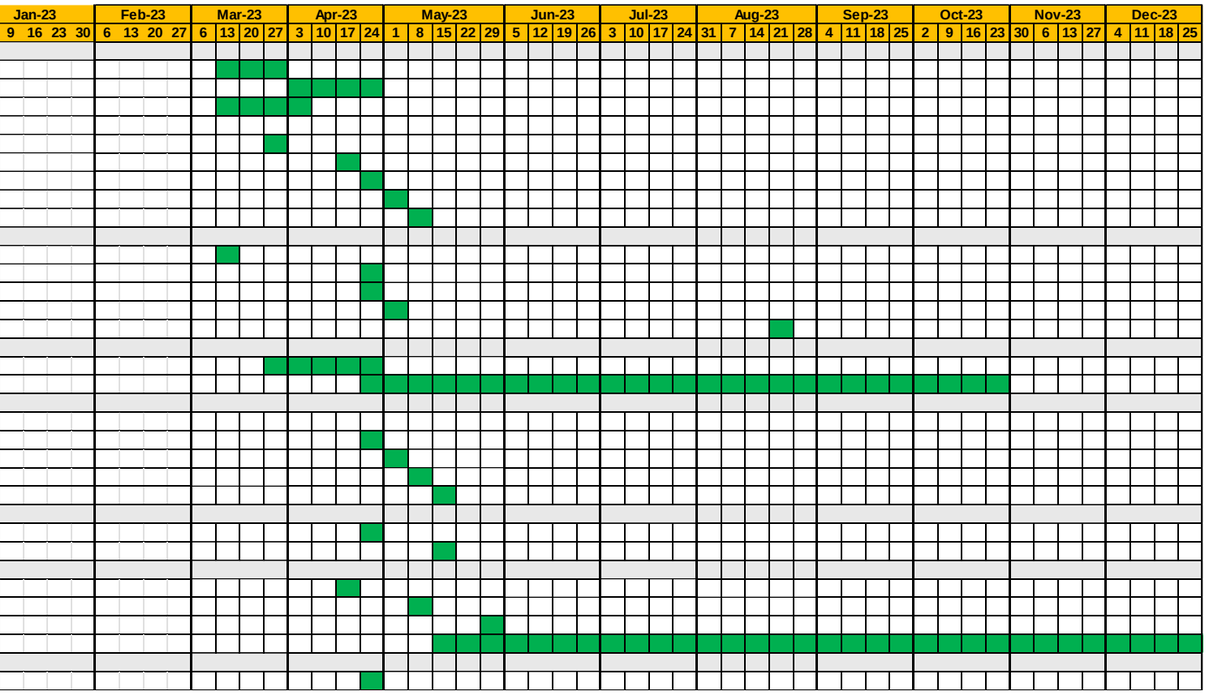
As part of the ongoing stakeholder engagement Shell undertakes, specific consultation for the Crux Project commenced in relation to the drilling of the first appraisal wells in 2007. Consultation carried out includes:

- August 2020: public invited to comment on the Crux OPP accepted and published by NOPSEMA.
- July 2021: consultation undertaken for the FDP, Production and Pipeline Licences submitted to NOPTA.

March 2023: consultation commenced for the Crux Installation and Cold Commissioning Environment Plan. Figure 5-1 provides a timeline for the consultation completed during the course of preparing this EP. This timeline is provided by way of illustration only and does not capture all of Shell's consultation activities (which are discussed in detail below).

2023

ID	Activity	Start date	End date
1	**Advertising / Public notices**		
1.1	Print advertising campaign - calling out for self-identification of RPs	13-Mar-23	31-Mar-23
1.2	Radio advertising campaign - calling out for self-identification of RPs	3-Apr-23	28-Apr-23
1.3	Social media campaign - calling out for self-identification of RPs	12-Mar-23	7-Apr-23
1.4	Print publication - drop-in session promotion		
1.41	Derby (advertised on social media only)	24-Mar-23	
1.42	Broome	20-Apr-23	
1.43	Port Hedland	26-Apr-23	
1.44	Exmouth	3-May-23	
1.45	Darwin	10-May-23	
2	**Website**		
2.1	Website optimisations	14-Mar-23	
2.2	Draft Crux Drilling Template Installation Environment Plan published	28-Apr-23	
2.3	Draft Crux Seabed Survey Environment Plan publised	28-Apr-23	
2.4	Draft Crux Development Drilling Environment Plan published	3-May-23	
2.5	Draft Crux Installation and Commissioning Environment Plan published	23-Aug-23	
3	**Consultation material**		
3.1	Consultation material mail out - sufficient information	27-Mar-23	28-Apr-23
3.2	Follow up emails, phone calls, texts or other channels	28-Apr-23	27-Oct-23
4	**Drop-in sessions**		
4.1	Derby	4-Apr-23	
4.2	Broome	27-Apr-23	
4.3	Port Hedland	3-May-23	
4.4	Exmouth	10-May-23	
4.5	Darwin	17-May-23	
5	**Community information sessions**		
5.1	Broome	27-Apr-23	
5.2	Darwin	17-May-23	
6	**Indigneous Forums**		
6.1	Perth	19-Apr-23	
6.2	Broome	10-May-23	
6.3	Darwin	31-May-23	
6.4	Targeted consultation sessions with NTRB's, RNTBC's, PBC's or Aboriginal Corporations	18-May-23	*Ongoing*
7	**Industry Forums**		
7.1	Perth	27-Apr-23	



2024

ID	Activity	Start date	End date
1	**Advertising / Public notices**		
1.1	Print advertising campaign - calling out for self-identification of RPs	13-Mar-23	31-Mar-23
1.2	Radio advertising campaign - calling out for self-identification of RPs	3-Apr-23	28-Apr-23
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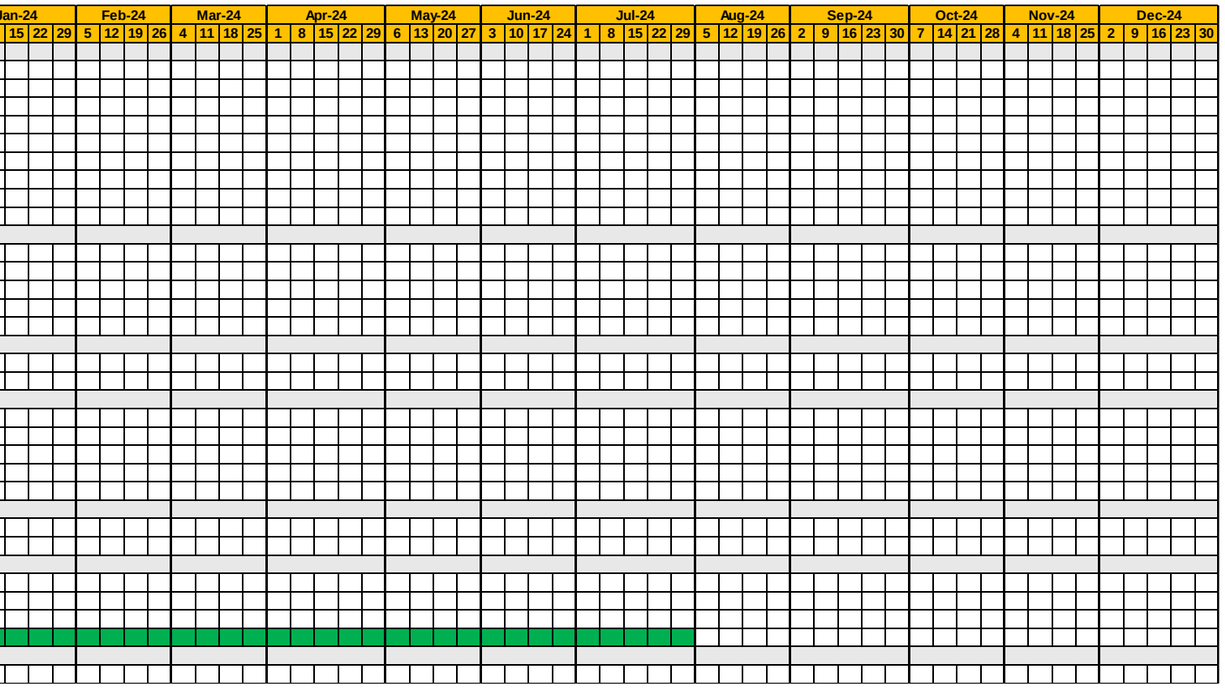


Figure 5-1: Crux Project consultation timeline

Consistent with section 4 of the OPGGS(E) Regulations, Shell ensures the environmental impacts and risks of the activity are reduced to ALARP and to an acceptable level.

The consultation process enables the titleholder to ascertain, understand, and address all the environmental impacts and risks that might arise from its proposed activity, including information that the titleholder would otherwise not be aware of. The consultation process informs the titleholder's understanding of the environment, including (amongst other things) people and communities, the heritage value of places, and their social and cultural features which may be affected by a titleholder's proposed activities.

Shell recognises the need to consult on both planned and unplanned activities. The Environment that May Be Affected (EMBA), which in this EP is defined as the 'Planning Area', has been determined based on the unlikely event of a hydrocarbon release from Shell's activities described in this EP. The Planning Area is further described and depicted in Section 7. The Planning Area is used as an initial input to develop a broad list of persons and organisations that may have functions, interests or activities in the geographical area that may be affected by Shell's activities. Each person or organisation's functions, interests or activities are then further assessed in the context of the effect that Shell's activities may have on their functions, interests or activities, to determine whether the person or organisation is a relevant person for the purposes of consultation.

The scope and duration of Shell's operations in Commonwealth and State waters in Australia, along with a track record of consistent engagement with a diverse group of individuals and organisations, has allowed Shell to compile a comprehensive list of contacts for this consultation process. This list was not intended to be an exhaustive list of those to be consulted, but rather served as a starting point to identify relevant persons for consultation on Shell's proposed activities. The list has been developed through years of experience and consultation. It contains valuable insights on the specific information that different individuals and organisations want to receive during consultation. Additionally, it includes the most appropriate means of communication and up-to-date contact information, which Shell regularly reviews and updates.

For all relevant persons, Shell consults on the basis of informed consultation, participation and co-design:

- Relevant persons are free to raise issues without being under pressure (e.g. unreasonable timeframes due to approval timeline) or duress.
- Consultation ensures that all relevant persons are aware of the consultation period and have had the opportunity to be consulted.
- Sufficient and appropriate information is provided to enable persons to identify whether they are relevant or have a connection to the EP.
- Shell will advise each relevant person that they may request information provided during consultation not be published, reflecting the legal requirements in section 25(4).

Shell recognises the *Consultation in the course of preparing an environment plan* guidance released by NOPSEMA in May 2023 and the recent judicial guidance in *Santos NA Barossa Pty Ltd v Tipakalippa* [2022] FCAFC 193 (Tipakalippa Decision), on the purpose of consultation as follows:

- At paragraph 54 of the Tipakalippa Decision: …the information that the titleholder is obliged to provide NOPSEMA is also designed to provide a basis for NOPSEMA's considerations of the measures, if any, that a titleholder proposes to take or has taken to lessen or avoid the deleterious effect of its proposed activity on the environment, as expansively defined.
- At paragraph 89 of the Tipakalippa Decision: …its purpose [section 25] is to ensure that the titleholder has ascertained, understood and addressed all the environmental impacts and risks that might arise from its proposed activity. Consultation facilitates this outcome because it gives the titleholder an opportunity to receive information that it might not otherwise have received from others affected by its proposed activity. Consultation enables the titleholder to better understand how others with an objective stake in the environment in which it proposes to pursue the activity perceive those environmental impacts and risks. As the Regulations expressly contemplate, it enables the titleholder to refine or change the measures it proposes to address those impacts and risks by taking into account the information acquired through the consultations. Objectively, the scheme intends that this is likely to improve the minimisation of environmental impacts and risks from the activity.

Consultation supports this outcome by providing the titleholder an opportunity to receive information from relevant persons that may be affected by its proposed activity. Consultation enables the titleholder to gain a

better understanding of how relevant persons with an objective stake in the Planning Area perceive those environmental impacts and risks. Consultation enables the titleholder to refine or modify the measures it proposes to address those impacts and risks by taking into account the information gained through the consultations. This is likely to improve the minimisation of environmental impacts and risks from the activity.

The consultation process also assists the titleholder to meet its obligation under section 280 of the OPGGS Act which requires that it must carry out the petroleum or greenhouse gas activity respectively in a manner that does not interfere with navigation, fishing, conservation of resources of the sea and seabed, other offshore electricity infrastructure and petroleum activities, and the enjoyment of native title rights and interests (within the meaning of the *Native Title Act 1993* (Cth) (NTA)) to a greater extent than is necessary for the reasonable exercise of the titleholder's rights and obligations.

Shell recognises that whilst it is required to consult with each relevant person pursuant to the OPGGS(E) Regulations, participating in consultation is not obligatory for relevant persons and the OPGGS(E) Regulations do not impose any obligation to seek or reach an agreement on the subject for consultation. Shell understands there may be individuals within a community (who hold communal interests) who are unable to participate for various reasons and the absence of their participation does not invalidate the consultation process, provided that reasonable efforts were made to identify the relevant persons and to consult with them.

An overview of Shell's consultation methodology for EPs is set out below, including how section 25(1) of the OPGGS(E) Regulations has been applied to identify relevant persons, the application of the consultation methodology and assessment of relevant persons for this EP, as well as the consultation information provided to relevant persons, feedback provided and Shell's assessment of the merit of objections or claims. This section also includes engagement with persons or organisations that Shell contacted directly on an individual basis.

The consultation methodology set out in this EP demonstrates that consultation has occurred with relevant persons in accordance with section 25 of the OPGGS(E) Regulations. The consultation methodology incorporates Shell's increased understanding of relevant persons through updates to its known relevant persons list, experience with other EPs, and other external feedback. Other adjustments were made in response to discussions, regulations, and suggestions made during the regulatory process of submitting and assessing this EP.

To ensure that organisations and individuals who may be affected by the proposed activity are aware of Shell's consultation process for the EP and can provide feedback in accordance with the intended outcome of consultation, an adaptive methodology has been implemented. This approach includes advertising in local, state, and national newspapers. This section summarises consultation activities with relevant persons, as well as engagement with individuals or organisations that were not relevant persons, but Shell still chose to contact.

5.2 Key Principles for EP Consultation

Key principles for consultation in preparation of an EP in accordance with section 25 are outlined in Table 5-1.

Table 5-1: Key Principles for EP Consultation

Key principle	Key concept
Consultation provides an opportunity for free and open exchange of information to occur between a titleholder and relevant person that may be affected by a proposed activity.	• The process provides a genuine opportunity for relevant persons to be heard and provide feedback. • An inclusive approach is taken by which the titleholder seeks to identify and consult with relevant persons throughout the development of the EP, takes reasonable measures to allow relevant persons an opportunity to self-identify, and identifies potentially relevant persons taking a broad (rather than narrow) approach to functions, interests or activities within the Planning Area. • The process includes mechanisms for titleholders to receive information from relevant persons that they might not have otherwise received. • The process enables a titleholder to gain better understanding about the environment that may be affected and measures that may be

Key principle	Key concept
	necessary to mitigate the potential environmental impacts and risks associated with the petroleum activity. • Consultation does not carry with it any obligation on the titleholder either to seek or reach agreement; nor requires consent on the activity subject to the consultation; however, the titleholder should be receptive to suggestions from a relevant person, where these may improve the overall environmental outcome. • Appropriate engagement techniques are selected, and consultation is tailored to the needs of relevant persons, including location, timing, cultural sensitivities, and the most suitable way to conduct engagements.
The consultation process must be capable of practicable and reasonable discharge.	• The obligation to consult is a real-world obligation that must be construed in a practical and pragmatic way that makes a process both reasonable and workable. • Where communal interests are held, the process of consultation needs to reasonably reflect the characteristics of the communal interests affected and does not necessarily require communications with each and every person who is a member of the relevant community. • The obligation to identify relevant persons for the purpose of consultation must be reasonably capable of being discharged (i.e. relevant persons need to be ascertainable) within a reasonable time.
Consultation involves provision of sufficient information on a proposed activity to relevant persons and allows for a reasonable period of time for a relevant person to consider the information.	• Information provided to a relevant person should be sufficient to allow them to make an informed assessment of the possible consequences of the proposed activity on their functions, interests or activities. • The nature, scale, and complexity of a proposed activity, as well as the extent of potential impacts and risks on a relevant person's functions, interests, or activities, is considered when determining a reasonable period for consultation.
Relevant person participation in the consultation process is voluntary.	• The voluntary participation of relevant persons in the consultation process is respected. The titleholder collaborates with them to determine their preferred method of consultation where possible. • Relevant persons are not obligated to respond to a titleholder's request to participate in the consultation process. • A titleholder is not required to wait indefinitely for a response where sufficient information and reasonable period of time has been afforded to the relevant person.

5.3 Regulations & Guidance

This methodology has been developed in accordance with the relevant regulations and guidelines, including:

- Tipakalippa Decision
- NOPSEMA Guideline GL2086 – Consultation in the course of preparing an environment plan – May 2024
- NOPSEMA Guidance Note GN1847 – Responding to public comment on environment plans – July 2022
- NOPSEMA Guidance Note GN1344 – Environment plan content requirements – January 2024
- NOPSEMA Guideline GL1721 – Environment Plan Decision Making Guideline – January 2024
- NOPSEMA Guidance Note GN1488 – Oil pollution risk management – July 2021
- NOPSEMA & DNP Guidance Note GN1785 – Petroleum activities and Australian Marine Parks – January 2024

- NOPSEMA Guideline GL1887 – Consultation with Commonwealth agencies with responsibilities in the marine area – January 2024
- NOPSEMA Brochure – Consultation on offshore petroleum environmental plans – May 2023
- NOPSEMA Policy PL2098 – Engaging gender-restricted information Policy – December 2023
- NOPSEMA Policy PL1347 – Environment Plan Assessment Policy – January 2024
- Department of Climate Change, Energy, the Environment and Water (DCCEEW): Sea Countries of the North-West; Literature review on Indigenous connection to and uses of the North-West Marine Region – July 2007
- DCCEEW – Draft Guidelines for working in the near and offshore environment to protect Underwater Cultural Heritage – 2023
- DCCEEW – The Interim Engaging with First Nations People and Communities on Assessments and Approvals under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (interim guidance) – February 2023
- International Finance Corporation Performance Standard 7 – 2012
- Australian Fisheries Management Authority: Petroleum industry consultation with the commercial fishing industry – 2023
- DAFF – Guidance framework for supporting cooperative coexistence of seismic surveys and commercial fisheries in Australia's Commonwealth marine area - 2022
- DAFF – Offshore Installations Biosecurity Guide – June 2023
- Commonwealth Department of Industry, Science and Resources – Streamlining Offshore Petroleum Environmental Approvals: Program Report – February 2014
- WA Department of Primary Industries and Regional Development: Guidance statement for oil and gas industry consultation with the Department of Fisheries – 2013
- WA Department of Transport: Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements – July 2020
- WA Department of Mines, Industry Regulation and Safety – Consultation Guidance Note (for the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009) – April 2012
- Northern Territory Environment Protection Authority – Stakeholder Engagement and Consultation: Environmental Impact Assessment – Guidance for Proponents – January 2021
- Western Australian Fishing Industry Council – Consultation approach for unplanned events
- IAP2 Public Participation Spectrum

As operator, Shell has consulted with relevant persons identified in accordance with the NOPSEMA decision-making guideline (N-04750-GL1721 January 2024) under the OPGGS(E) Regulations for this EP.

The term 'relevant person' is defined in section 25 of the OPGGS(E) Regulations. The methodology outlined in this EP sets out the processes that have been applied to identify and determine who are relevant persons for the purposes of section 25(1)(a) to (e) of the OPGGS(E) Regulations.

These requirements are summarised in Table 5-2.

Table 5-2: Division 3—Section 25 of the OPGGS(E) Regulations

Legislation	Summary	Requirement
Division 3—Consultation in	Relevant Persons	(1) In the course of preparing an environment plan (including a revised environment plan referred to in Division 5) a titleholder must consult each of the following (*a relevant person*):

Legislation	Summary	Requirement
preparing an environment plan 25. Consultation with relevant authorities, persons and organisations, etc		(a) each Commonwealth, State or Northern Territory agency or authority to which the activities to be carried out under the environment plan may be relevant; (b) if the plan relates to activities in the offshore area of a State—the Department of the responsible State Minister; (c) if the plan relates to activities in the Principal Northern Territory offshore area—the Department of 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; (e) any other person or organisation that the titleholder considers relevant.
	Sufficient Information	(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.
	Reasonable period	(3) The titleholder must allow a relevant person a reasonable period for the consultation.
	Sensitive information	(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.

Source: OPGGS(E) Regulations

5.3.1 Tipakalippa Decision

In its decision handed down on 2 December 2022, the Full Court of the Federal Court of Australia considered the meaning of 'relevant person' within section 25(d) of the OPGGS(E) Regulations.

The proceedings (brought by Mr Tipakalippa) challenged NOPSEMA's decision to accept Santos' Drilling and Completions EP, submitted as part of the Barossa Project. Mr Tipakalippa alleged that Santos did not consult with him or his clan and, as a result, NOPSEMA's approval was invalid.

The OPGGS(E) Regulations do not define what is meant by 'functions, interests or activities', and the construction of the words in this phrase was clarified by the Full Court. The meaning of these words is discussed in further detail in Table 5-3.

The Full Court also made observations on other aspects of consultation which are set out below.[4]

- Superficial or tokenistic consultation will not be enough.
- Where interests are held communally, or across a group, the titleholder has a degree of 'decisional choice' in identifying which persons are to be approached within the group, the manner of communication and the method of consultation.

The decision also clarifies that EPs must demonstrate that consultation has occurred as required by section 25 of the OPGGS(E) Regulations. In practice, this means that:

- Once titleholders have proactively identified and engaged in consultation with relevant persons, the titleholder must demonstrate to NOPSEMA that the requisite consultation has occurred, i.e. by ensuring that the EP sets out its understanding of who a relevant person is (with reference to the Full Court's reasons).

[4] Since the Tipakalippa Decision was handed down, section 25 of the OPGGS(E) Regulations has been the subject of two further Federal Court decisions (Cooper v NOPSEMA [2023] FCA 1112; Cooper v NOPSEMA [2023] FCA 1158). The Federal Court's observations on the requirements of consultation in the Cooper proceedings are consistent with the Tipakalippa Decision and emphasise the importance of consultation in ensuring that titleholders provide NOPSEMA with relevant information about the environmental impacts and risks of a proposed activity.

- If the titleholder has proceeded on an incorrect interpretation of the regulations, it may not be possible for NOPSEMA to be satisfied that the titleholder has carried out the consultations required by the OPGGS(E) Regulations.

5.3.2 NOPSEMA Consultation Guideline

NOPSEMA released a Guideline titled *'Consultation in the course of preparing an environment plan'* (the NOPSEMA Consultation Guideline) following the Tipakalippa Decision. The NOPSEMA Consultation Guideline clarifies the legal requirements for consultation by titleholders while preparing their EPs prior to submission to NOPSEMA.

In particular, the NOPSEMA Consultation Guideline provides guidance on the following aspects:

- the interpretation of 'relevant person' and each term in the phrase 'functions, interests or activities' as contained in section 25(1)(d) of the OPGGS(E) Regulations
- matters that should be considered in designing and implementing consultation processes.

5.3.3 Key Terms and Definitions

The meaning of key terms and definitions are summarised in Table 5-3 by reference to the NOPSEMA Consultation Guideline (which is informed by the Full Court's observations in the Tipakalippa Decision).

Table 5-3: List of Key Definitions

Term	Definition
Activities	In relation to section 25(1)(d) of the OPGGS(E) Regulations, activities are considered to be what other persons or organisations are already doing.
Claims	Assertion or information about the potential adverse impacts from the petroleum activities to which the EP relates.
Environment	The OPGGS(E) Regulations defines this as: • ecosystems and their constituent parts, including people and communities; and • natural and physical resources; and • the qualities and characteristics of locations, places and areas; and • the heritage value of places; and includes • the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Functions	In relation to section 25(1)(d), functions refer to a power or duty to do something.
Interests	In relation to section 25(1)(d), "interest" includes an interest possessed by an individual, whether or not the interest amounts to a legal right or is a proprietary or financial interest or relates to reputation. However, an interest does not extend to general public interest in an activity[5].
Nature and scale of effect on relevant persons functions, interests or activities	This is a broad screening assessment done for some selected relevant persons where a clearer distinction is warranted between the nature of a relevant persons functions, interests or activities may be affected. This is split into two categories: • High (nature and scale): Planned impacts which may be significant will occur to a known interest such as a cultural value or feature. Impacts are likely to be long term. • Low (nature and scale): Impacts are either from highly unlikely events, such as a major spill or planned impacts are not likely to be significant, nor long term and does not involve the direct desecration of a cultural feature.
Objection	A reason or argument about the potential adverse impacts arising from the petroleum activities to which the EP relates.
Planning Area	This is the environment that may be affected by the activity. The spatial extent of the Planning Area is determined from stochastic spill modelling or National Energy Resources Australia (NERA) reference cases using the low hydrocarbon exposure thresholds (no ecological impact)

[5] Tipakalippa Decision, paragraph [154].

Term	Definition
	as recommended by NOPSEMA. Note, the Planning Area does not define the area of affect to a relevant person's functions, interest or activities, but instead it is used as an initial input to develop a broad list of possible relevant persons that may be affected in a geographical area for the activity. Each potentially relevant person is then further assessed in direct context of the effect the activity may have on their own specific functions, interests and activities.
Reasonable period (also known as the consultation window)	A reasonable time for relevant persons to identify the effect of a proposed activity on their functions, interests or activities and provide a response detailing their objections or claims. Shell generally defines a reasonable period for a relevant person to review and provide an initial response as being 30 calendar days, subject to the nature and scale of the proposed activity. However, Shell has provided Indigenous relevant persons with a minimum consultation window of three months. Where dialogue with relevant persons is ongoing after this period, Shell will continue to consult with these persons until Shell believes that it has provided sufficient evidence/justification to close the consultation (i.e. they have been provided sufficient information and a reasonable period).
Reasonable efforts	During the consultation window, Shell will make all reasonable efforts to make contact with all identified relevant persons for the EP (where a reasonable and workable avenue exists). Shell recognises that specific consultation channels to pass on information may be more appropriate for certain groups of relevant persons.
Relevant matter	The matter raised does not fit the criteria descriptions for objections or claims with/without merit. However, the matter raised is relevant to the planned activity, comprises a request to Shell for further relevant information, or provides information to Shell that is relevant to the activity or the EP.
Not a relevant matter to this EP	Input does not relate to the planned activity or the relevant person's or organisation's functions, interests or activities affected by the activity. Matters that are not relevant may also be generic in nature with no specific issues raised (e.g. salutations, acknowledgements, meeting arrangements, etc.).
Relevant person	Can be a person, organisation, department or agency that falls within one of the categories defined by section 25(1) of the OPGGS(E) Regulations; however, it does not include those whose functions, interests or activities will only be affected by an activity in an immaterial or negligible way[6].

5.4 Overview of Relevant Person Methodology Workflow

Figure 5-2 presents Shell's workflow for the identification of and consultation with relevant persons. Identifying, categorising and engaging with relevant persons is shown in Steps 1–17. Assessment of objections or claims and relevant matters are dealt with in Steps 18–25. Section 5.6.5 details the merit of objections or claims assessment.

5.5 Identifying Relevant Persons

The NOPSEMA Consultation Guideline provides the following key guidance as to the process for the identification of relevant persons:

- The process must provide for sufficiently broad capture of ascertainable persons and organisations whose functions, interests or activities may be affected by the activity.
- The process should include reference to multiple sources of information, such as publicly available materials, review of databases and registers, published guidance, previous history, as well as advice from authorities and other relevant persons.
- Titleholders must clearly identify in their EPs who is a relevant person and the rationale the titleholder has used to determine who they consider falls within that definition.

[6] Tipakalippa Decision paragraph [67], noting that, section 4(c) of the OPGGS(E) Regulations provides that the petroleum activity is to be carried out in a manner by which the environmental impacts and risks of the activity will be of an acceptable level.

Relevant person identification is an inherently iterative process as Shell may become aware of relevant persons during the process of consultation or after the development and submission of an EP. Nonetheless, Shell has done extensive work to ensure it identified relevant persons in the course of preparation of this EP, for the purpose of complying with section 25 of the OPGGS(E) Regulations, outlined further in this EP.

5.5.1 Identification of Relevant Persons

At the commencement of preparation for this EP, a comprehensive assessment took place to review:

- Project activities related to this EP.
- Potential spatial extent of the Planning Area and the different zones and thresholds within those areas.
- Environmental, cultural, economic, and social attributes of the Planning Area.

This informed Shell's understanding of:

- The potential cultural and social values and sensitivities of the Planning Area.
- The potential functions, interests, or activities that may be affected by Shell's proposed activities.

Two key steps were then used to commence identification of relevant persons:

1. A comprehensive research methodology to identify and assign relevant persons to a thematic group (see Section 5.5.2).
2. Advertisements in local, regional and national print, social media and radio to allow for a broad capture of relevant persons.

Table 5-4 outlines the relevant persons identification considerations and this was supported by:

- encouragement of identified relevant persons during engagement activities, such as forums and community sessions as outlined in this EP, to share and communicate with those who they may think were relevant
- self-identified relevant persons
- information shared with Shell through other third parties (such as industry).

Shell was then able to identify a person or organisation's functions, interests, or activities based on the overlap with the Planning Area. This approach is outlined further in the relevant person workflow in Figure 5-3.

Table 5-4: Identification Considerations

Considerations	Justification
Planning Area	Shell used oil spill modelling to assist in the process of identifying potentially relevant persons for this EP. Shell adopted a conservative approach to this modelling, which is explained further below. If less conservative and, arguably, more appropriate oil spill modelling was used, the Planning Area would be significantly reduced and therefore fewer potentially relevant persons would have been identified.
New information	During the consultation process, new information may become available to inform the extent of effect of Shell's activity on a person's functions, interests or activities, which may result in an identified relevant person being removed from the relevant persons list. For example, new information may become available which further informs/clarifies a person's actual functions, interests or activities and how they could be affected which are not to the extent as previously perceived by Shell during the initial identification process.
Lack of environmental or ecological impact	There may be persons who have functions, interests or activities within the Planning Area at the initial time of submission, but those functions, interests or activities may not be affected by Shell's activities. Where no environmental or ecological impacts are predicted within a geographical area, there can be no corresponding impacts on a person's functions, interests or activities. There may also be instances where potential environmental or ecological impacts are predicted to occur within an area; however,

	despite a geographical overlap this will not necessarily equate to an impact on a person's functions, interests or activities.
Contact details not ascertainable	Shell may identify a group of relevant persons that are potentially affected; however, is unable to confirm individual contact details as these are not ascertainable through normal mechanisms (e.g. associated government agencies, organisations or groups who hold these details or who can advise who these individuals are). As such, consulting with such relevant persons is not capable of being discharged within a reasonable time due to the "opacity as to the identity of those with whom consultations are to take place". The opportunity exists for such persons to contact Shell, via Shell's publicly accessible website or through the advertising campaign.

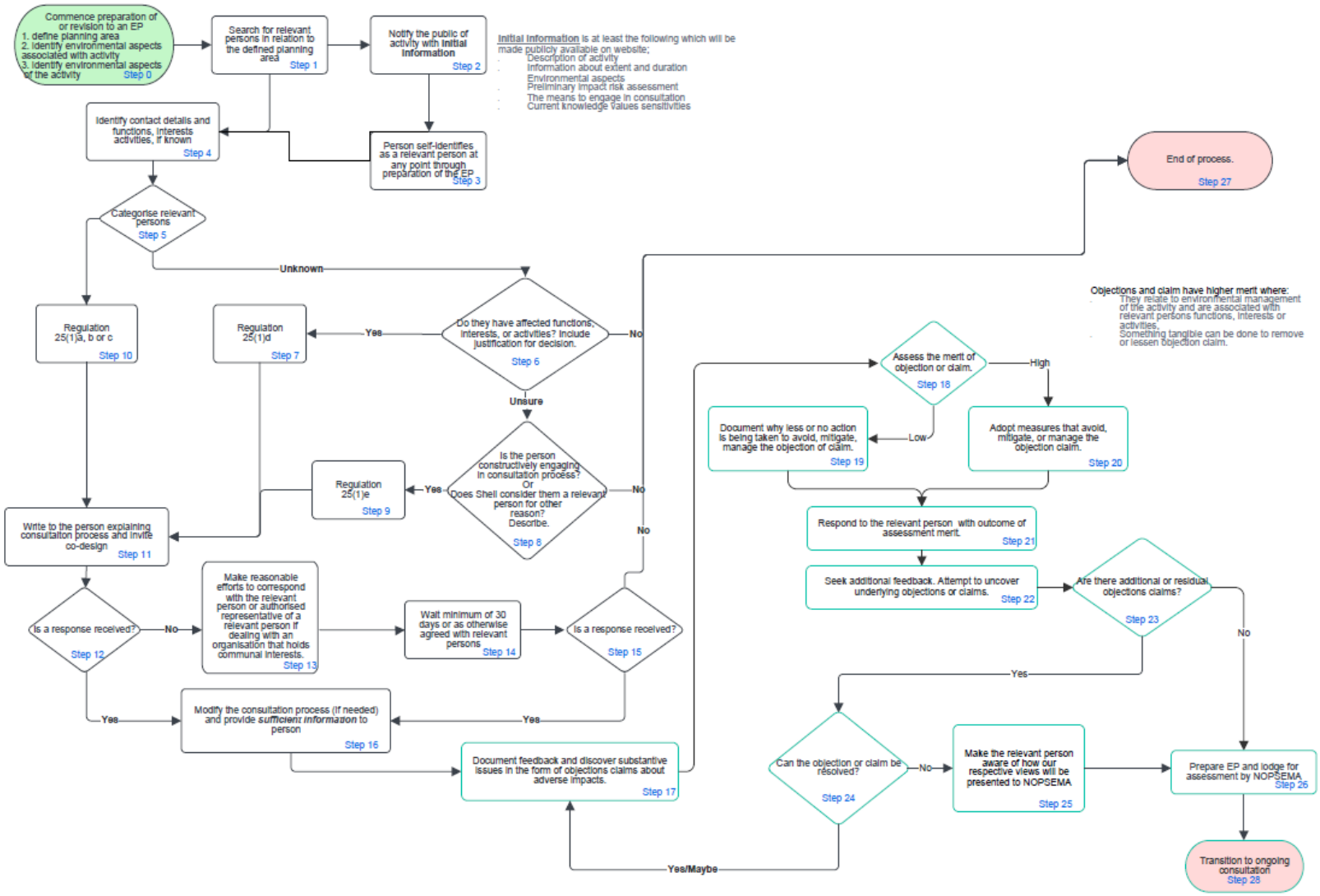


Figure 5-2: Relevant Persons Workflow

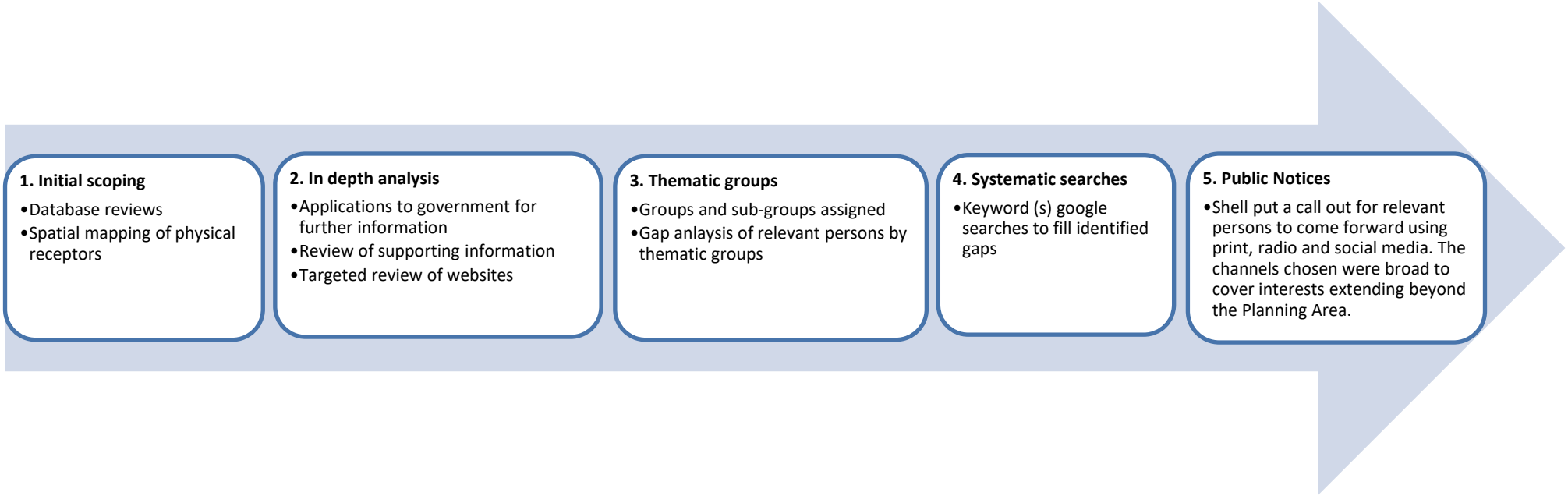


Figure 5-3: Methodology for the Identification of Relevant Persons

5.5.2 Description of Research Methodology

Table 5-5 presents the research methodology used during the search for relevant persons. A comprehensive review was conducted using a range of research activities to inform the identification of relevant persons. The details of, and methodology adopted during each research activity is presented in Table 5-5.

Table 5-5: Research Methodology

Research Activity	Detail
1. Existing Shell Australia database reviews	Shell holds an extensive database of organisations and persons identified for projects and existing operations, including from the Crux OPP and Prelude FLNG facility, located ~160 km from Crux. Existing relevant person datasets and associated recent relevant persons correspondence were reviewed in January 2023. These were merged into a register of potentially relevant persons.
2. Review of public databases and spatial mapping of datasets	A comprehensive review of publicly available databases to identify physical receptors, environmental, social and cultural values and sensitivities overlapping with the Planning Area and a further 50 km buffer was conducted. Searches of databases were also undertaken for cultural heritage (Indigenous and non-Indigenous). The 50 km buffer was introduced to go beyond the identified Planning Area in case a relevant person or social and cultural values could be identified at the edge of the Planning Area. Searches included the following: • National Native Title Tribunal (NNTT) register of Native Title Registrations, Claims, Determinations (including Prescribed Body Corporates (PBCs) and Registered Native Title Bodies Corporate (RNTBC) for the determinations), Future Acts and Indigenous Land Use Agreements. • Spatial data from the NNTT database to identify Land Councils and NT Aboriginal Trusts, and any additional Native Title material was extracted for the Planning Area. • Protected Areas including legislated lands and waters of WA and NT (e.g. Commonwealth and National Parks and Reserves), WA Lands of Interest, RAMSAR Wetlands, Australian Marine Parks, Indigenous Protected Areas (IPAs). • Heritage Areas including world and national heritage listed places, WA Heritage Council State Register, WA Heritage List, WA Heritage Council Local Heritage Survey, NT Heritage Register. • WA Aboriginal Cultural Heritage database and WA Aboriginal Cultural Heritage Survey database. (Where available information on knowledge holders was also extracted.) • Application made to the Aboriginal Areas Protection Authority (AAPA) requesting Abstract of Record for the Planning Area within Territorial waters. Petroleum exploration and operations license holders. • Key Ecological Features (KEFs) and Biologically Important Areas (BIAs). • UCH including the Australasian UCH Database. • Local Government Authorities and Town Councils. • Population centres including Indigenous communities (Indigenous, remote, town based, seasonal and permanent). • Military land. • Commonwealth fisheries, state and territory fishers, aquaculture license holders and pearl lease holders. • Spatial mapping of datasets enabled an understanding of overlaps with the Planning Area.

Research Activity	Detail
3. Review of background reports and supporting information for database searches	Using the outcomes of the initial database searches (refer to research activity 2.), relevant supporting information was accessed and reviewed to inform the identification of potentially relevant persons and organisations, their functions, interests, or activities. Key supporting information reviewed included: • Native Title application documents and any associated court documents, Indigenous Land Use Agreements (ILUAs) and Future Acts. This review identified potentially relevant RNTBCs, PBCs and RATSIBs organisations as well as individual Indigenous people and family groups. Saturation was reached once all identified Native Title claims, determinations etc. within the Planning Area (including the additional 50 km buffer) were exhausted. • WA Aboriginal cultural heritage survey reports overlapping with the Planning Area. Research organisations, Indigenous organisations and Indigenous Knowledge Holders were identified as potentially relevant persons. This review informed an understanding of overlapping cultural and social values in the Planning Area. • Management plans associated with identified protected areas, KEFs and BIAs, such as Australian Marine Parks. This process identified relevant persons (people and organisations) including Indigenous Groups with research interests in the marine environment. • Management plans and future application plans for all identified IPAs. • Healthy Country Plans for all Land Councils identified through database searches. • WA State of the Fisheries Report (2020/21) (DPIRD 2021) with a focus on the WA fisheries overlapping with the Planning Area and Bio Regions. • Commonwealth Fisheries reports.
4. Review of research journals	An online search for journal articles related to Saltwater People, Totems and Indigenous use of Sea-Country was conducted to inform an understanding of cultural values potentially overlapping with the Planning Area. This process also identified potentially relevant persons (persons and organisations) (e.g. Indigenous groups who identify as Saltwater People).
5. Targeted review of websites and other sources associated with Indigenous Organisations	In addition to searches and assessments listed in research activity 2–4, representation searches were also considered: • By whom and what organisation as well as legal standing of the organisation • Parties to ILUAs that have since had a native title determination made over the Planning Area • If an Aboriginal Corporation was an appointed Local Aboriginal Cultural Heritage Services (LACHS) • A targeted review of all Land Council, RNTBC and PBC websites and social media platforms was undertaken to identify potentially relevant persons (persons and organisations) and their interests, functions or activities overlapping the Planning Area • Importantly this process enabled the outcomes of the KEFs and BIA database searches (refer to research activity 2) to be considered within the context of Indigenous cultural values (i.e. totems, cultural activities and Indigenous land and resource use activities). This process informed the identification of some geographically remote organisations as potentially relevant persons.
6. Targeted review of websites for peak bodies	A targeted review of the websites and social media platforms associated with a range of peak bodies, representing interests identified through database searches (e.g. recreational fishing, commercial fishing, Commonwealth fisheries) was undertaken to confirm functions, interests, or activities, and to identify additional and related potentially relevant

Research Activity	Detail
	persons (persons and organisations) and their interests, functions or activities overlapping the Planning Area. This review included recreational and commercial fisheries including aquaculture activities.
7. Targeted review of websites for Local Government Authorities	A targeted review of the websites and social media platforms associated with Local Government Authorities (LGAs) identified through the database searches and spatial mapping was undertaken to identify additional potentially relevant persons and to scope functions, interests, or activities of each relevant local government authority. This process, representing interests identified through database searches (such as recreational fishing, commercial fishing, Commonwealth fisheries), was conducted to confirm functions, interests, or activities, and to identify additional and related potentially relevant persons (persons and organisations) and their functions, interests or activities overlapping with the Planning Area.
8. Review of local community directories	Where available on the internet, a search of local community services directories for each Local Government Area with an area intersecting the Planning Area for potentially relevant persons (people and organisations) and associated functions, interests or activities was conducted. This process identified a number of interest groups, service providers, sport and recreation organisations as well as accommodation providers.
9. Targeted keyword search for Indigenous and non-Indigenous commercial operations	An online search for potentially relevant persons (persons and organisations) using key words and place-based search terms (e.g. fish + Darwin) was conducted. Table 5-6 lists the key search terms used.
10. Broad based keyword search	Online searches for potentially relevant persons (persons and organisations) were deployed systematically, with search terms such as 'Darwin + tourism'. Table 5-6 lists the key search terms used. Search results were interrogated until limitations became evident.
11. Public advertising campaign and engagement with identified relevant persons	Shell also sought to identify potentially relevant persons by placing advertisements in local, regional and national print, social media and broadcast media. During engagement activities, such as the forums and community sessions outlined in this EP, Shell also encouraged relevant persons to share and communicate with those whom they considered may be relevant and those who self-identified.
12. Crux OPP persons or organisation who made public comment	The Crux OPP was published for public comment during the assessment process. There were no limitations on where public comments could come from.

Table 5-6: Key Internet Search Terms

Search Terms
beach accommodation + Broome /Kimberley /Dampier Peninsula
beachfront accommodation + Broome /Kimberley /Dampier Peninsula
bird watching + Broome /Kimberley /Eighty Mile Beach /Dampier Peninsula
Broome + helicopter
Broome academic + research organisation
caravan parks + Kimberley + Western Australia
coastal accommodation + Kimberley Western Australia
commercial fishing + Northern Territory
commercial fishing + Western Australia
conservation + Broome /Kimberley /Dampier Peninsula

Search Terms
cultural experiences + Broome
fishing tours + Broome
Indigenous fishing + Northern Territory
Indigenous Protected Areas + Australia
Land Council + Northern Territory
Land Council + Western Australia
Mud Bay + Northern Territory
[name of Local Government] + community directory
Native Title + Northern Territory
Native Title + Western Australia
ocean views hotel + Broome /Kimberley /Dampier Peninsula
Sea Country + Northern Territory
Sea Country + Totems
Sea Country + Western Australia
surf + Broome /Kimberley /Dampier Peninsula
surf lifesavers + Broome /Kimberley /Dampier Peninsula
things to do + Broome /Kimberley /Dampier Peninsula
Tiwi Island Charters
totem + Tiwi /sawfish /whale /dolphin /turtle
tourism + Beachfront accommodation + Broome /Kimberley /Dampier Peninsula
tours + Broome
volunteer and emergency services + Broome
volunteer and emergency services + Darwin
water sports + Kimberley + Western Australia
watersports or water sports +Broome /Kimberley /Dampier Peninsula

During the initial scoping task, each identified potentially relevant person was assigned to a thematic group. Two thematic groupings of relevant persons were identified as having particularly defined functions, interests, and activities within the Planning Area: Indigenous People and commercial fishing operators.

Further and targeted effort was taken to identify relevant persons within each of these thematic groups. A further two thematic groups, being commercial operators and interest groups, were also identified as having potentially relevant persons (particularly organisations) with defined interests and activities within the Planning Area. Further efforts were applied to identify relevant persons in these thematic groups.

Sections 5.5.2.1 to 5.5.2.12 describes the methodology for the identification of relevant persons in the thematic groups and the relevance of these groups for this EP.

5.5.2.1 Indigenous People

Shell has a history of engaging with Indigenous people at various levels, including local communities, Indigenous groups (Native Title determined or otherwise), and governing bodies. Shell has a deep appreciation and respect for the Traditional Owners and Custodians of the land and seas where it operates. This extends to the Crux Project. For the purposes of reporting on consultation, people and organisations with attributes described above are captured in this thematic group (Indigenous People).

Offshore projects intersect heavily with Sea Country – a part of the landscape that is equally important to Indigenous People as Land Country. Many elements within Sea Country are deeply rooted in Indigenous cultures, including their history and creation stories. Marine life, cultural sites, and places of significance are

directly connected to the wellbeing and everyday life of Indigenous Peoples. Furthermore, the health and wellbeing of Sea Country is one and the same as the health and wellbeing of the Indigenous People themselves. The approach to the identification of Indigenous People as relevant persons is guided by Indigenous relationship to Sea Country.

Additional methods (apart from those described in Figure 5-3) of identifying Indigenous People that may be relevant persons included the following activities:

- Identification and review of the total values and sensitivities of the physical environment that may be affected by the planned activities for each EP, including the spatial extent of the activities.
- Desktop research to identify any published Sea Country research (including anthropological reports where available) that could identify marine and avian species that may represent spiritual totems, relevant to the activities in the EP.
- Review of available Indigenous cultural heritage survey reports (including ethnographic reports) and supporting information for selected Indigenous cultural heritage sites identified within the Planning Area.
- Further research based around subgroupings as described below.
- Direct requests to relevant land councils or representative bodies to further identify any relevant persons.
- Any person identified by another relevant person or representative body where they consider it appropriate for cultural or other reasons (i.e. ownership of a particular site).

Shell acknowledges that existing data or information relating to Sea Country values and sensitivities in both public and from other sources is currently limited and does not exist to the same degree as research on Land Country.

5.5.2.2 Native Title Holders

Native Title recognises the traditional rights and interests to land and waters of Indigenous People. Native Title Holders are recognised by Australian legal systems as holding rights and interests (which may be exclusive or non-exclusive) in relation to land and sea within determination boundaries. For the purposes of the relevant persons identification process, all Native Title applications, determined or otherwise, were regarded as relevant. The identification process was extended beyond the western construct of mappable boundaries and approached the concept of relevance of Indigenous groups and individuals with a degree of flexibility. Where one group's Native Title boundaries may not intersect with the Planning Area, they may still hold values and interests within the Planning Area. To this end, initial searches conducted included all Native Title applications and determinations within a further 50 km buffer added to the Planning Area.

Using spatial data from the NNTT database, all relevant Native Title information (i.e. applications, registrations, determinations and ILUAs) were extracted for the Planning Area. All applications, supporting information (where available) and court outcomes (where available) were interrogated. Saturation was reached once all identified Native Title applicants and holders within the Planning Area (including the additional 50 km buffer) were exhausted.

The names of Native Title applicants and holders were identified on the extracted Native Title information. Identified relevant persons included individuals and organisations (drawing on the NOPSEMA Consultation Guidelines that relevant persons can indeed be individuals, organisations, or groups).

5.5.2.3 Native Title and Indigenous Representative Bodies

Using the same process as described in Section 5.5.2.2, together with the strong working knowledge of Native Title and Indigenous governance structures held by Shell personnel, Native Title Representative Bodies (NTRBs), Prescribed Bodies Corporate (PBCs), Registered Native Title Bodies Corporate (RNTBCs) and Native Title Service Providers (NTSPs) were identified. NTRBs and NTSPs are funded by the National Indigenous Australians Agency to assist native title claimants and holders. NTRBs and NTSPs can also be referred to as Representative Aboriginal/Torres Strait Islander Bodies (RATSIBs).

NTRBs and NTSPs were generally identified directly from the NNTT catalogue entries and included the Northern Land Council (NTRB) within the Northern Territory RATSIB Area and Kimberley Land Council (NTRB) within the Kimberley RATSIB Area. These NTRBs have a function in relation to the administration of Native Title and may represent Native Title applicants and holders' interests in relation to existing Native Title claims and determinations that extend into Sea Country. They may also be the contact point for specific RNTBCs,

PBCs or native title applicants for the purposes of consultation. Where this is the case, it is identified for the particular person or organisation in Appendix C.

5.5.2.4 Land Councils

Aboriginal Land Councils (Land Councils) have the legal power to help Indigenous People negotiate with governments and private companies over projects on their land. They also support Indigenous People to manage their land and sea, including issuing permits to enter, fish, film and perform other activities on Aboriginal land. Land Council boundaries in the WA and NT were reviewed through the databases searches and Land Councils with area intersecting the Planning Area were identified as potentially relevant persons. Saturation was achieved through spatial mapping and the identification of Land Council areas with borders or overlap with the Planning Area.

Systematic searching of the websites of potentially relevant Land Councils enabled further interrogation of potential functions, interests, or activities. Land and Sea Ranger Groups and programs associated with Land Councils were identified through these searches. Healthy Country Plans were also identified and reviewed and provided vital information to understand values and sensitivities (e.g. Sea Country use and/or totems that potentially overlapped with the Planning Area).

5.5.2.5 Aboriginal Trusts

Aboriginal Trusts were established under the *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA). ALRA recognises the traditional ownership and occupation of the land by Indigenous People and the importance of their connection to land. In the NT, Traditional Owners can be granted Aboriginal freehold land ownership under the ALRA. The ownership of this land is held by Land Trusts, which are in turn managed by Land Councils.

Under the ALRA Traditional Owners have exclusive rights over their land and they have a level of say about what happens on that land and the ability to impose conditions on how their land is used should they agree to an organisation using it. Spatial mapping of Aboriginal freehold land across the NT, and the identification of the associated Aboriginal Trusts was undertaken as part of the search for potentially relevant persons. This also included a search for any Aboriginal Trusts associated with Aboriginal freehold land that intersected with or was adjacent to the Planning Area.

5.5.2.6 Aboriginal Corporations

Aboriginal and Torres Strait Islander Corporations (Aboriginal Corporations) are registered under the *Corporations (Aboriginal and Torres Strait Islander) Act 2006* (CATSI Act) and includes RNTBCs. The identification of Aboriginal Corporations was conducted primarily through the desktop review of Traditional Owner websites and Healthy Country Plans. When a Traditional Owner group did not have a website, searches were conducted through search engines and social media to identify Facebook accounts and/or news or media articles.

5.5.2.7 Family Groups and Individuals

Family groups and individuals were identified independent of Native Title information. The rationale for this is, based on the Tipakalippa Decision; family groups and individuals may hold different values and interests from those of the Native Title applicants and holders as a collective group. These relevant persons are difficult to identify through desktop research and other communications channels, such as public advertisements and community consultation were also conducted in order to enable other relevant persons to self-identify. The list of relevant persons was derived from a comprehensive review of Native Title information, Healthy Country Plans, Land Council websites, plans of management for protected areas including National Parks and Marine Parks, WA Aboriginal cultural heritage survey reports, government websites, media and community (drop-in centres) consultation as further described in Section 5.6.4.6.1. An abstract of records for all land intersecting with the Planning Area from NT AAPA provided further information used to identify potential sacred sites (recorded and registered) and enable sourcing of knowledge holder information.

5.5.2.8 Commercial Fisheries

One of the primary relevant persons with activities that may be impacted by project activities in the Planning Area is commercial fishers. Shell used a variety of resources, including data files and fishery reports, to identify relevant persons according to the criteria set out above. The method of identifying potential commercial fishers that may be relevant persons included the following activities:

- Identified and mapped designated State, Territory (where available) and Commonwealth Fisheries overlapping with the Planning Area and identified spatial overlaps with the Planning Area.
- Identified concession holders for overlapping Commonwealth Fisheries and obtained concession holder contact details from AFMA (letters were sent to all in the EP Planning Area).
- For WA Managed Fisheries:
  - Identified 60Nm fish cube areas overlapping with the Planning Area and applied to DPIRD for effort and catch data for each WA fishery for fish cubes that were within a planned impact area (e.g. noise) based on modellings.
  - Obtained concession holder contact details for overlapping WA Managed fisheries within the EP Planning Area (letters were sent to all in the EP Planning Area).
- Applied to NT Fisheries for information on effort and catch data and concession holder contact details within the identified NT commercial fisheries.
- Reviewed WA State of the Fisheries Report 2020/21 to inform an understanding of effort and catch in the identified WA fisheries, including permit holders.
- Systematic on-line search and review for the websites of peak commercial fishing industry bodies including Western Australia Fishing Industry Council Inc (WAFIC), Northern Territory Seafood Council and the Northern Prawn Fisheries Industry (NPFI).
- Engagement of WAFIC to assist in identification and consultation with relevant WA managed fisheries.

5.5.2.9 International Persons

According to the worst-case credible oil spill model, results predicted no shoreline contact (99% probability) with the Indonesian and Timor Leste coastlines. As the Indonesian and Timor Leste coastlines are within the Planning Area, Shell has taken a conservative approach to make reasonable efforts to identify and consult with relevant persons in Indonesia and Timor Leste. Noting no relevant persons outside of Australia were identified during the preparation of this EP.

The purpose of oil spill modelling, consistent with the NOPSEMA procedure on oil pollution risk management guidance (GN1488), “is purely for the evaluation of oil pollution risks and to inform preparedness and response planning for oil spill risk management” (NOPSEMA 2021). Although Shell chose to use the Planning Area to help understand the geographic extent of its risks, and subsequent consultation of relevant persons in Australia, this approach is not seen as appropriate for international relevant persons for the reasons detailed below.

Low impact and low likelihood: Major vessel collision spills are very unlikely, with an oil spill frequency (per vessel per hour at sea) ranging from 1.4e−08 to 6.4e−08 depending on the vessel type (DNV 2011). The worst-case credible oil spill model results predict no shoreline contact (99% probability) with the Indonesian and Timor Leste coastlines. In addition, Shell puts a high focus on vessel collision prevention and emergency response to further reduce the likelihood and extent of potential impacts.

Spill Modelling used is highly conservative: Appendix D discusses model conservatisms and limitations.

By necessity over such a large domain, the model incorporates many simplifications that lead to over prediction of oil concentrations. The further away from the source, errors are compounded, particularly in nearshore areas where many physical processes are omitted (e.g. coastline resolution, surface waves, intertidal wetting and drying, refloating of oil, etc). Predictions of shoreline contact are therefore highly conservative. The modelling also does not take into consideration any spill prevention and mitigation that would be implemented in response to an incident discussed above.

Negligible nature and Scale of affect on functions, interests or activities of relevant persons in Indonesia or Timor Leste: The nature and scale of effects on the functions, interests or activities of persons in Indonesia and Timor Leste is predicted to be negligible. In addition, the Indonesian and Timor-Leste coastlines are over 300 km away from Crux.

Reasonable efforts to *identify* relevant persons in Indonesia and Timor Leste have occurred: Shell sought to ascertain the identities of relevant persons in Indonesia and Timor Leste through broadcast advertising, social media and the EP webpage. Shell provided sufficient information through the EP webpage, information booklets and broadcast media advertisements to enable relevant persons in Indonesia and Timor Leste to make themselves known to Shell.

Further, the Crux OPP has been publicly available since 2019. Those who made comment during the public comment period have also been carried forward as relevant persons. No one from outside of Australia was identified as a relevant person from public comments made on the Crux OPP.

Shell believes this approach to identification of relevant persons in Indonesia and Timor Leste is appropriate given the low nature and scale of potential impacts on their functions, interests or activities. Going forward, the opportunity for relevant persons outside of Australia to make themselves known to Shell will be available through the EP webpage.

Reasonable efforts to consult with relevant persons in Indonesia and Timor Leste have occurred:

Shell has provided all relevant persons in Indonesia and Timor Leste with sufficient information about the proposed activities within this EP in the form of information sheets, fact sheets and the draft of this EP available on the EP webpage. Relevant persons have had a reasonable opportunity to access this information by way of notifications Shell has made through broadcast media and social media.

A reasonable period for consultation has also been allowed for all relevant persons in Indonesia and Timor Leste. Shell made sufficient information available in April and May 2023 and has allowed persons in Indonesia and Timor Leste at least 30 days to consider the information and provide feedback.

Shell has received no feedback from persons outside Australia in the course of preparing this EP Shell believes that it has made reasonable efforts to consult with relevant persons in Indonesia and Timor Leste in the preparation of this EP, having regard to the low likelihood of the possibility of negligible effects on their functions, interests or activities.

Shell does not consider it proportionate or reasonable for more specific, targeted consultation to occur, beyond what Shell has already carried out. To do so would require extensive efforts by Shell (from both a time and resourcing perspective), given the geographical area and size of the population concerned, which Shell estimates to be >100 million people. Shell's position is that further consultation efforts would be unworkable and well beyond what is considered reasonably practicable.

The opportunity for relevant persons outside of Australia to provide feedback will also be available moving forward through the EP webpage and relevant matters and other inputs can still be considered by Shell through its ongoing consultation process (see Section 5.8), including updates of the EP through the MOC process as required and outlined in Section 10.1.3.

5.5.2.10 Indonesian Traditional Fishers

As described in Section 7.4.4.1, the Activity and Planning Areas overlaps the MoU Box. However, Indonesian traditional fishing effort is focussed on shallow waters such as those at Seringapatam Reef and the Scott Reef complex where target sedentary reef-species are generally encountered, rather than the deep waters of the Activity Area.

The MoU Box overlaps Australian waters, and the majority of traditional fishing activities occur at reefs and islands within AMPs whose values are described in Section 7.3.4. The AMPs are managed by the Director of National Parks with whom Shell has consulted for this Activity.

During consultation with AFMA in September 2023, AFMA confirmed to Shell that it does not directly license or regulate the traditional fishers that may be operating in the MoU Box, nor do they maintain a register of contact details for the Indonesian traditional fishers. As there is no requirement for traditional fishers to be licensed by either the Australian or Indonesian governments, there is no publicly available information to identify these individuals.

The obligation to identify relevant persons for the purpose of consultation must be reasonably capable of discharge within a reasonable time and all relevant persons must be ascertainable. Based on the opacity as to the identity of any traditional fishers operating within the MoU Box, Shell has not been able to identify or contact them in a manner which is considered to be both reasonable and workable.

This is an example of where Shell has identified a group of relevant persons that may be potentially affected. However, Shell is unable to confirm individual contact details as these are not ascertainable through normal mechanisms (e.g. associated Australian government agencies, organisations or representative bodies who may hold these contact details). As such, consulting with such relevant persons is not capable of being discharged within a reasonable time due to the “opacity as to the identity of those with whom consultations are to take place”.

Nevertheless, it can be inferred that the interests of traditional fishers (healthy fish communities) would be the same as those licensed commercial fishers operating in Australia that Shell has been able to contact via Commonwealth and State/Territory agencies such as AFMA, WA DPIRD, DITT and WAFIC. It is considered that feedback received by Shell, in relation to potential impacts to fish communities and harm to fish stocks, would be similar to traditional fishers in the MoU Box who share the same interests.

Consultation outcomes from Commonwealth and State/Territory agencies in relation to commercial fisheries included some aspects of Shell's preparedness in response to an unplanned oil spill event and impacts to fisheries. Shell has an operational and scientific monitoring plan (OSMP) which includes suitable monitoring programs to determine the impact of oil spill on commercial, traditional and recreational fisheries, which includes various assessments depending on type, nature and scale of the spill. In the event of an unplanned oil spill, consultation with the Indonesian government will be managed by DFAT.

5.5.2.11 Commercial Operators

Commercial operators form a large group of identified relevant persons for this EP and includes Indigenous and non-Indigenous tourism operators and marine transport operators. Commercial operators were primarily identified through online searches (including purposive and snowballing searching) coupled with expert and local knowledge. Online searches were deployed systematically, with search terms (see Table 5-6 for a list of key search terms used). Search results were interrogated until saturation became evident.

5.5.2.12 Interest Groups

Interest groups form a large proportion of relevant persons who are difficult to identify through desktop research. Interest groups are defined as casual and formal collections comprised of members of the public who have an interest that lies within the Planning Area. Examples of formal interest groups include conservation and environment focused groups as well as activity-based groups (e.g. Fishing Clubs). Examples of casual interest groups include bird watchers, wreck divers, and history enthusiasts.

Identification of these relevant persons was conducted in two ways: through local knowledge of interest groups likely to exist in the Western Australian setting, and through Google searching key terms (described elsewhere). Saturation is difficult to reach and identify in this category through desktop research alone. Therefore, community consultation and interrogating hyper-local knowledge was a critical element of the identification process.

5.5.3 Identification of Relevant Persons by Category

The relevant persons identified for this EP as related to these regulations, including the rational for inclusion, are described in Table 5-7. The research methodology used by Shell to identify relevant persons is described in Table 5-5. Sections 5.5.3.1 and 5.5.3.4 detail about specific categories of relevant persons referred to in section 25 of the OPGGS(E) Regulations.

5.5.3.1 Relevant Persons – Section 25(1)(a), (b) and (c) of the OPGGS(E) Regulations

These include relevant persons as:

> (a) each Commonwealth, State or Northern Territory agency or authority to which the activities to be carried out under the environment plan may be relevant;
>
> (b) if the plan relates to activities in the offshore area of a State—the Department of the responsible State Minister;
>
> (c) if the plan relates to activities in the Principal Northern Territory offshore area—the Department of the responsible Northern Territory Minister.

5.5.3.2 Relevant Persons – Section 25(1)(d) of the OPGGS(E) Regulations

Persons whose functions, interests or activities may be affected by the activities to be carried out under an environment plan are relevant persons under section 25(1)(d). Relevant persons considered to meet the requirements of section 25(1)(d) have been identified based on:

- An assessment of the totality of the relevant environment, values and sensitivities and potential activity impacts and risks.
- The overlap of functions, interests, or activities with the Activity and Planning Areas.
- Desktop research, as summarised above.

- Advertisements and other public publications and broadcasts, described below.

Persons or organisations were contacted directly through email, telephone and/or mail. This included information on consultation method and channels available for communication.

The list of relevant persons identified was not exhaustive and was further refined as consultation progressed, including any additional relevant persons that self-identified through the broadcast and print media advertising campaign.

5.5.3.3 Relevant Persons – Section 25(1)(e) of the OPGGS(E) Regulations

Section 25 (1)(e) pertains to any other person or organisation that the titleholder considers relevant. Persons or organisations who self-identified were considered if they should be identified as relevant persons assigned to this category, this consideration if further detailed in Table 5-7.

5.5.3.4 Not Relevant Persons- Section 25 of the OPGGS(E) Regulations

Where Shell received feedback related to general project or business operations, these questions or comments were responded to and managed as part of Shell's standard community consultation mechanisms and processes. Most of these queries related to job opportunities or enquiries on becoming a supplier to Shell. All persons who self-identified through the public advertisement campaign, were provided an information pack, including factsheets on the EPs, to enable them to determine whether their functions, interests or activities would be impacted. Where no further response was received, these persons were not categorised as relevant for the purposes of this EP.

Table 5-7: Assessment of relevant persons for this EP

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Commonwealth and State Government Departments or Agencies				
Australian Border Force (Maritime Border Command)	Maritime	Responsible for maritime security. Deters and prevents illegal activities in the Australian Marine Domain.	Yes	25(1)(a)
Australian Communications and Media Authority (ACMA)	Media	Responsible for matters relating to maritime communications and licensing, as well as matters relating to telecommunications networks.	Yes	25(1)(a)
Australian Fisheries Management Authority (AFMA)	Environment	Responsible for the efficient management and sustainable use of Commonwealth fish resources. Activity is within a Commonwealth fishery area. AFMA expects petroleum operators to consult directly with fishing operators or via their fishing association body about all activities and projects which may affect day to day fishing activities.	Yes	25(1)(a)
Australian Hydrographic Office (AHO) – Department of Defence Operations Branch	Maritime	Manage the development, maintenance and disposal of the Defence estate, including unexploded ordnance. Department of Defence agency responsible for the publication and distribution of nautical charts and other information required for the safety of ships navigating in Australian waters. The AHO issues fortnightly Notices to Mariners for relevant nautical products.	Yes	25(1)(a)
Australian Maritime Safety Authority (AMSA)	Maritime	Responsible for maritime safety, adherence to advice, protocols, regulations. Issue radio-navigation warnings.	Yes	25(1)(a)
Clean Energy Regulator (CER)	Regulator	Responsible for implementing legislation to reduce carbon emissions and increase the use of clean energy.	Yes	25(1)(a)
Department of Climate Change, Energy, the Environment and Water (DCCEEW)	Commonwealth Department	Responsible for preventing, responding to and recovering pests and diseases that threaten the economy and environment. Responsible for protecting Australia's ocean systems, threatened marine species and coastal blue carbon ecosystems.	Yes	25(1)(a)
Department of Foreign Affairs (DFAT)	National	Facilitates international relations with governments and other organisations. Specifically, DFAT will have functions relating to oil spills in international waters or foreign countries jurisdictions.	Yes	25(1)(a)
Department of Industry, Science, and Resources (DISR); including NOPTA	Commonwealth Department	Responsible for the OPGGSA. They are the policy maker for the offshore petroleum sector.	Yes	25(1)(a)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Director of National Parks (DNP)	Environment	The Director of National Parks is a corporation established under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), the principal Commonwealth legislation for establishing and managing protected areas. The corporation is constituted by the person appointed to the office named the Director of National Parks.	Yes	25(1)(a)
Indigenous Land and Sea Corporation (ILSC)	Statutory Body (First Nations)	An Australian federal government statutory authority with national responsibilities to assist Aboriginal and Torres Strait Islander people to acquire land and to manage assets to achieve cultural, social, environmental and economic benefits for Indigenous peoples and future generations.	Yes	25(1)(a)
National Native Title Tribunal (NNTT)	Native Title	Commonwealth government authority responsible for administering the Native Title Act 1993 (Cth) across multiple functions including reviews, mediations, and determinations for: Native title applications, and ILUAs.	Yes	25(1)(a)
The Department of Agriculture Fisheries and Forestry's (DAFF)	Commonwealth Department	DAFF maintain and create agricultural export opportunities, to provide gains for Australian agriculture, fishing and forestry. They manage biosecurity risks to Australia to protect our multi-billion-dollar industries and our way of life. They engage with international counterparts to reinforce Australia's role in shaping how the global agriculture and fibre sector addresses food security, productivity, trade, sustainability and the impacts of climate change.	Yes	25(1)(a)
Aboriginal Areas Protection Authority NT (AAPA)	Non-Government Organisation	AAPA is an independent statutory authority established under the *Northern Territory Aboriginal Sacred Sites Act*. The Authority is responsible for overseeing the protection of Aboriginal sacred sites on land and sea across the NT.	Yes	25(1)(b)
Department of Biodiversity, Conservation and Attractions (DBCA)	WA Department	Western Australian government department responsible for managing lands and waters described in the Conservation and Land Management Act 1984, the Rottnest Island Authority Act 1987, the Swan and Canning Rivers Management Act 2006, the Botanic Gardens and Parks Authority Act 1998, and the Zoological Parks Authority Act 2001, and implementing the state's conservation and environment legislation and regulations. The Department reports to the Minister for Environment and the Minister for Tourism.	Yes	25(1)(b)
Department of Environment, Parks and Water Security (DEPWS)	NT Department	This department functions to foster and protect the environment and natural resources in the NT. This includes water, land resource management, environmental issues and the parks and wildlife functions.	Yes	25(1)(b)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
		The Cobourg Peninsula is also managed as a national park (the Garig Gunak Barlu National Park) under a joint management arrangement between the Indigenous People and the Parks and Wildlife Commission of the Northern Territory.		
Department of Jobs, Tourism, Science and Innovation (JTSI)	WA Department	Deliver initiatives on behalf of the WA Government that supports the full spectrum of economic activity in WA, including large-scale mining and industrial operations.	Yes	25(1)(b)
Department of Planning Lands and Heritage (DPLH); including Heritage Council of WA and Aboriginal Cultural Heritage Committee	WA Department	Responsible for planning and managing all land use and heritage considerations within the state.	Yes	25(1)(b)
Department of Primary Industries and Region Development (DPIRD) – Fisheries Division	WA Department	Department responsible for management of WA State fisheries – including licence holders, and maintenance of fisheries.	Yes	25(1)(b)
Department of Transport (DoT)	WA Department	Legislated responsibility for oil pollution response in State Waters.	Yes	25(1)(b)
Department of Water & Environmental Regulation (DWER)	WA Department	DWER is responsible for environment and water regulation, serving as a 'one stop shop' for industry and developers, with the aim of streamlining and simplifying regulation.	Yes	25(1)(b)
Environment Protection Authority (EPA)	WA Department	Primary environmental regulator for WA. They partner with business, government and the community to reduce pollution and waste, protect human health, and prevent degradation of the environment.	Yes	25(1)(b)
Federal Member for Kimberley – Melissa Price	WA Federal Member	Member for region that overlaps the Planning Area. Likely to be interested in constituent values and interests.	Yes	25(1)(b)
State Member for Kimberley – Divina Grace D'Anna	WA State Member	State Member for region very close to Activity Area. Likely to have an interest in various aspects of the project.	Yes	25(1)(b)
Department of Industry Tourism and Trade (DITT)	NT Department	DITT supports industry development through globally competitive strategy, policy and promotion and delivers a regulatory framework that enables responsible growth, market access and stakeholder certainty.	Yes	25(1)(c)
Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	WA Department	Its mission is to support a safe, fair and responsible future for the WA community, industry, energy and resources sector.	Yes	25(1)(c)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Commercial Fisheries				
Abalone Managed Fishery Licence (25 licence holders)	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Australia Bay Seafoods	NT fisheries license holder	Involved in fisheries to the east and south of the Activity Area.	Yes	25(1)(d)
Australian Northern Prawn Fishery	Commonwealth Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Australian Southern Bluefin Tuna Industry Association	Industry Representative	Industry representative for commercial fishing of Bluefin Tuna in southern waters of Australia.	Yes	25(1)(d)
Broome Prawn	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Commonwealth Fisheries Association	Industry Representative	Peak body representing the collective rights, responsibilities and interests of a diverse commercial fishing industry in Commonwealth regulated fishers. There are Commonwealth regulated fisheries in the Installation and Cold Commissioning Planning Area.	Yes	25(1)(d)
Individual Fishery Licence Holder	Individual	Fishing vessel operator. Self-identified through online form.	Yes	25(1)(e)
Kimberley Crab Managed Fishery Licence (1 licence holder)	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Kimberley Gillnet and Barramundi Managed Fishery Licence	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Kimberley Prawn Managed Fishery Licence (65 licence holders)	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Mackerel Managed Fishery Licence (24 licence holders)	WA Commercial Fishery	Commercial fishing activities and interests in the Activity Area for the Crux Project.	Yes	25(1)(d)
Marine Aquarium Fish Managed Fishery Licence (11 licence holders)	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
North Coast Shark	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Northern Demersal Scalefish Managed Fishery Licence (6 licence holders)	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Northern Prawn Fishery Industry Pty Ltd	Northern Prawn Fishery Industry Pty Ltd	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Pilbara Crab Managed Fishery Licence	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Seafarms Group Ltd	Aquaculture	Planning to build one of the world's largest Prawn Farms near Kununurra. Activities and Interests within the Planning Area	Yes	25(1)(d)
Seafood Industry Association	Industry Representative	Industry representative for Seafood Industry.	Yes	25(1)(d)
Tropical Tuna Management Advisory Committee	Industry Representative	Industry representative for Tropical Tuna Management.	Yes	25(1)(d)
TUNA Australia	Industry Representative	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia.	Yes	25(1)(d)
WA Seafood Exporters	WA Commercial Fishery	Commercial fishing activities and interests within the Planning Area.	Yes	25(1)(d)
Western Australian Fishing Industry Council (WAFIC)	Industry Representative	Industry representative for WA Fishing Industry.	Yes	25(1)(d)
Western Rock Lobster Council	Industry Representative	Industry representative for Small Pelagic Fishery Industry.	Yes	25(1)(d)
Western Tuna and Billfish Fishery (59 licence holders)	Commonwealth Fishery	Concession holder with permission to fish in Commonwealth Fisheries that intersect the Planning Area	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Titleholders and Operators				
Carnarvon Energy Ltd	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Eni Australia Ltd	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
ENOG Resources Australia Block WA-4-488 P/L	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Finder No 1	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
INPEX	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Jadestone Energy	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Melbana Energy AC/P70	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
MEO International	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Neptune Energy Bonaparte	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
NT Gas Aust	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
PTTEP Australasia (Ashmore Cartier)	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Santos Ltd	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
SundaGas Banda Uniperssoal Lda	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Vulcan Exploration P/L	Industry	Petroleum proponent holders within the planning area.	Yes	25(1)(d)
Commercial Operators				
AAT Kings Darwin Day Tours	Tourism Operator	Tourism Operator with activities conducted within the Planning Area.	Yes	25(1)(d)
Absolute Ocean Charters	Tourism Operators	Commercial Boat Operator with activities (including whale watching) within the Planning Area.	Yes	25(1)(d)
Alure Fishing Charters NT	Tourism Operator	Tourism Operator with activities conducted within the Planning Area.	Yes	25(1)(d)
Auriga Marine	Transport Operators	Transport Operator conducting operations in and over the ocean in the NT.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Aurora Expeditions	Tourism Operator	Operates activity-based cruises on the northern WA Coastline and is a member of KMTA	Yes	25(1)(d)
Borrgoron Cultural Tours	Tourism Operator	Indigenous Tourism Operator near Cygnet Bay Pearl Farm.	Yes	25(1)(d)
Coconutz BnB	Tourism accommodation providers	Possibly relevant due to proximity to the Planning Area and may have interests in the potential impact of project activities.	Yes	25(1)(d)
Coral Expeditions	Tourism Operator	Operates cruises on the Kimberley coast. Member of Kimberley Marine Tourism Association (KMTA)	Yes	25(1)(d)
Eco Abrolhos	Tourism Operator	Cruise operator on the WA Kimberley coastline and Abrolhos Islands with marine based activities. Member of KMTA	Yes	25(1)(d)
Fishabout Fishing Tours – Bathurst Island	Tourism Operator	Fishing tours and travel agent with operations in WA and NT.	Yes	25(1)(d)
Fishing Melville Island Lodge	Tourism accommodation providers	Tourism Provider with activities in or adjacent to the Planning Area	Yes	25(1)(d)
Kimberley Air Tours	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area	Yes	25(1)(d)
Kimberley Boat Cruises	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area	Yes	25(1)(d)
Kuri Bay Sport Fishing Tours	Charter boat operator	Tourism Operator with activities in or adjacent to the Planning Area	Yes	25(1)(d)
Lady M Cruising	Tourism Operator	Cruise company operating in Kimberley. Member of KMTA	Yes	25(1)(d)
Mantiyupwi Motel	Tourism accommodation providers	Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area	Yes	25(1)(d)
Matt Wright Wild Territory	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area	Yes	25(1)(d)
Mud Crab Motel	Tourism accommodation providers	Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Munupi Wilderness Lodge (also known as Clearwater Island Lodge)	Tourism accommodation providers	Located on Tiwi Islands and is popular for guests seeking fishing charters. Also marketed as Clearwater Island Lodge Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area	Yes	25(1)(d)
Odyssey Australia (Odyssey Traveller)	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Odyssey Expeditions	Tourism Operator	Cruise boat located in the Kimberley's. Operates within the Planning Area, has social interests.	Yes	25(1)(d)
One Tide Charters	Tourism Operator	Kimberley cruise operator with activities in the marine environment	Yes	25(1)(d)
Oolin Sunday Island Cultural Tours	Tourism Operator	Indigenous Tourism Operator near the Planning Area	Yes	25(1)(d)
Port of Darwin	Port Operations	Commercial Operator with activities, functions, and interests within the Planning Area.	Yes	25(1)(d)
Sealink Northern Territory	Transport Operators	Commercial Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Seaswift	Transport Operators	Commercial Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Seven Spirit Bay (Resort)	Tourism accommodation providers	Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Spinifex Hotel	Tourism accommodation providers	Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area.	Yes	25(1)(d)
The Great Escape Charter Company	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
The Travelling Naturalist	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Tiwi Island Adventures	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Tiwi Island Retreat	Tourism accommodation providers	Accommodation provider located near the ocean. Likely to have interests and potentially activities in or adjacent to the Planning Area.	Yes	25(1)(d)
True North Kimberley Cruises	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Ultimate Watersports	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Unreel Adventure Safaris	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Walk Darwin Pty Ltd	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area Walk Darwin emailed Shell to unsubscribe from consultation on 19 September 2023	No	-
YKNOT Fishing Charters	Charter boat Operator	Commercial Operator with activities in or adjacent to the Planning Area.	Yes	25(1)(d)
Interest Groups				
10,000 Birds	Environment (Birding)	Likely to have interests in project activities that may impact the health, feeding, and breeding grounds of any migratory or seabirds within the Planning Area.	Yes	25(1)(e)
Australasian Seabird Group	Environment	Established to promote seabird research and conservation in Australasia and the South Pacific.	Yes	25(1)(e)
Australasian Wader Studies Group (AWSG)	Environment	Organisation that has functions, activities, and interests in the Planning Area. Activities including monitoring shorebird populations, partnership with research institutions, formulate and promote policies for conservation of shorebirds and their habitat, promote wetland conservation and assist with nomination of sites for RAMSAR listing.	Yes	25(1)(d)
Australian Wildlife Conservancy	Environment	NFP focused on conservation of threatened wildlife and ecosystems in Australia.	Yes	25(1)(d)
Birding in Kimberley	Environment	Interest group engaging in birding activities.	Yes	25(1)(d)
Birdlife Top End	Environment	Central forum for community activities centred around the conservation of birds and their habitats. Conducts Migratory Shorebird Monitoring Program at several sites around Darwin. Monitors Key Biodiversity Areas	Yes	25(1)(d)
BirdLife WA	Environment	Peak Body for Birdwatching in WA. Area covers WA as well as Cocos (Keeling) Islands, Christmas Island and Ashmore Reef. 6 regional groups. Carry out research projects with DBCA e.g. Australasian Bittern Recovery Team.	Yes	25(1)(e)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Non-Government Organisations				
AIATSIS (Australian Institute of Aboriginal and Torres Strait Islander Studies)	Research Institute	AIATSIS is an Indigenous-led, national institute that celebrates, educates, and inspires people from all walks of life to connect with the knowledge, heritage and cultures of Australia's First Peoples	Yes	25(1)(d)
Australian Conservation Foundation	Environment	Recognised conservation organisation with interests in marine environment that likely extent into the Planning Area.	Yes	25(1)(d)
Australian Marine Conservation Society	Environment	The Australian Marine Conservation Society (AMCS) is a peak conservation body with strong interest in activities in the marine environment.	Yes	25(1)(d)
Australian Marine Oil Spill Centre (AMOSC)	Industry	AMOSC has an interest and a function in relation to the management of the oil industry's response to major oil spill. AMOSC's also play a role in training and coordinating industry personnel ready to provide immediate emergency oil spill response.	Yes	25(1)(d)
Ben and Jerry's	Environment	Activist with strong interest in climate change, supporting action against Sea Country petroleum and gas activities.	Yes	25(1)(d)
Conservation Council of WA	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
Conservation Volunteers Australia	Environment	Conservation Volunteers is a non-profit organization that operates in Australia, New Zealand, and around the world. The organisation provides opportunities for volunteers to participate in conservation projects and initiatives, including habitat restoration, wildlife monitoring, and environmental education. Has social and environmental interests.	Yes	25(1)(d)
Environmental Defenders Office WA	Environment	The Environmental Defender's office of WA (EDOWA) is a not-for-profit and non-Government organisation that specialises in public interest environmental law.	Yes	25(1)(d)
Environs Kimberley	Environment	Environs Kimberley. Saving the nature of the Kimberley. Donate. As the peak environmental NGO for the Kimberley region in far north-west Australia, Environs Kimberley is dedicated to looking after the health of the land and waters of the region. This includes Protecting the Kimberley, which has the same email address.	Yes	25(1)(d)
Greenpeace	Environment	Activist with strong interest in climate change, supporting action against Sea Country petroleum and gas activities.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
High Seas Alliance	International	The High Seas Alliance is a partnership of organizations and groups aimed at building a strong common voice and constituency for the conservation of the high seas.	Yes	25(1)(d)
Martuwarra Fitzroy River Council	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
Northern Territory Land Corporation	Regional Development	NT Land Corporation (NTLC) is a corporate entity and land manager. The NT Land Corporation holds and maintains land in the NT for various purposes including future National Parks, land for future townships, ports, logistics and industrial uses. Some of these land holders intersect with the Planning Area e.g. the Gunn Point Peninsula. The NTLC has a function in relation to the protection and administration of this land	Yes	25(1)(d)
Save the Kimberley	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
Sea Turtle.org	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
Surfrider Foundation Australia	Environment	Dedicated to the protection and enjoyment of the world's ocean, waves, and beaches, for all people	Yes	25(1)(d)
The Wilderness Society	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
United Nations	International	An international organisation where all the world's nations can gather together, discuss common problems, and find shared solutions that benefit all of humanity.	Yes	25(1)(d)
WA Marine Science Institute	Environment	NGO with Environment protection focus that will have interest in the Planning Area and project activities.	Yes	25(1)(d)
WA Parks Foundation	Environment	NGO in WA with an Environment focus.	Yes	25(1)(d)
WWF	Environment	NGO with Environment protection focus that will have interest in the Planning Area and project activities.	Yes	25(1)(d)
Academic and Research				
Australian National University	Academic Project	Research institution that has been identified as possibly engaging in research located within the Planning Area, therefore having interests.	Yes	25(1)(d)
CSIRO	Research	Federal government agency that is responsible for scientific research and innovation in a range of fields. The organisation conducts research in areas such as agriculture, health, energy, and the environment, and aims to provide scientific	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
		solutions to key challenges facing Australia and the world. May have social and environmental interests.		
Deep History of Sea Country Research Project	Academic Project	The Deep History of Sea Country Research Project is a collaborative research initiative that aims to document and preserve the cultural and environmental heritage Indigenous Sea Countries in northern Australia. The project involves a range of Indigenous and non-Indigenous researchers, community members, and relevant persons, and focuses on using traditional knowledge, scientific research, and technological innovation to better understand and protect Australia's marine environments.	Yes	25(1)(d)
Fisheries Research and Development Corporation (FRDC)	Fisheries	Statutory corporation that manages research and development investment by the Australian Government and the Australian fishing and aquaculture commercial, recreational, and Indigenous sectors.	Yes	25(1)(d)
The Ecology Centre (UQ)	Environment	Potential interest in the Planning Area through research activities.	Yes	25(1)(d)
Industry Representative Bodies				
Australian Energy Producers (AEP)	Industry Representative	AEP is the peak national body representing Australia's upstream oil and gas sector.	Yes	25(1)(d)
Amateur Fishermen's Association NT	Recreational Fishing	Peak Body for recreational fishing in the NT. Has a function representing recreational fishers who operate in the Planning Area.	Yes	25(1)(d)
Australia's North-West Tourism	Peak Body	Tourism marketing agency in Broome, promoting tourism in the Kimberley and Pilbara regions.	Yes	25(1)(d)
Kimberley Marine Tourism Association	Peak Body	Tourism Peak Body with membership base across Kimberley. Members may have activities in the Planning Area.	Yes	25(1)(d)
North Territory Guided Fishing Industry Association (NTGFIA)	Recreational Fishing	Identified in Tiwi Islands Sea Country Plan as key relevant person. The peak body responsible for promoting, developing, and maintaining the guided fishing industry in the Territory. Interests extend to both coastal rivers, estuaries and open waters of the Timor and Arafura Seas.	Yes	25(1)(d)
Western Australian Game Fishing Association (WAGFA)	Game Fishing	Industry representative for Small Pelagic Fishery Industry.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Service Providers				
NT Emergency Service Darwin Volunteer Unit	Volunteer & Emergency Services	Volunteer emergency service in Darwin.	Yes	25(1)(d)
Local Councils				
City of Palmerston Municipal Council	Local Government	Government body/group with functions or interests in the Planning Area	Yes	25(1)(d)
Darwin City Council	Local Government	City of Darwin is the local government body responsible for the municipality of Darwin. Interest in economic development of region.	Yes	25(1)(d)
Darwin Municipal Council	Local Government	Includes waterfront areas that intersect with the Planning Area. Council has a governance function and controls activities along the waterfront	Yes	25(1)(d)
Darwin Waterfront Precinct Municipality	Local Government	Darwin Waterfront Corporation is a statutory authority responsible for developing, managing and servicing the Darwin Waterfront Precinct.	Yes	25(1)(d)
East Arnhem Regional Council	Local Government	Includes remote Aboriginal community of Galiwin'ku located on Wessel Islands, Milingimbi, Ramingining, Gapuwiyak on land and proximate to the Planning Area. Council has a governance function and controls activities/infrastructure along the waterfront	Yes	25(1)(d)
Kimberley Development Commission	Local Government	The Kimberley Development Commission is a statutory authority of the government of Western Australia. Their role is to promote the economic and social development in the Kimberley.	Yes	25(1)(d)
Litchfield Council	Local Government	Local government council on the land of the Larrakia, Woolner and Djowei Aboriginal people.	Yes	25(1)(d)
Tiwi Islands Regional Council	Local Government	Government body/group with functions or interests in the Planning Area.	Yes	25(1)(d)
Victoria Daly Regional Council	Local Government	Government body/group with functions or interests in the Planning Area including bordering waterfront.	Yes	25(1)(d)
Wagait Shire Council	Local Government	Government body/group with functions or interests in the Planning Area, including bordering waterfront.	Yes	25(1)(d)

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
West Arnhem Region Council	Local Government	Government body/group with functions or interests in the Planning Area, including bordering waterfront.	Yes	25(1)(d)
West Daly Regional Council	Local Government	Government body/group with functions or interests in the Planning Area, including bordering waterfront.	Yes	25(1)(d)
Self-identified via online form				
Person 1	Individual	Indicated a general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 2	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 3	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 4	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 5	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 6	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 7	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 8	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 9	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 10	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 11	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 12	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 13	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 14	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 15	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 16	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 17	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 18	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 19	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 20	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 21	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 22	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 23	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 24	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 25	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 26	Individual	Indicated interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 27	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 28	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 29	Individual	Indicated interest in an earlier EP – around drilling. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 30	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 31	Individual	Indicated interest in subsea. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 32	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 33	Individual	Indicated an interest in subsea. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 34	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 35	Individual	Individual was assessed as not relevant for this EP as email was anti oil and gas.	No	-
Person 36	Individual	Indicated general interest in an earlier EP – around monitoring equipment. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 37	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 38	Individual	Indicated interest in laboratory / production. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 39	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 40	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 41	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 42	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 43	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 44	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 45	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 46	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 47	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 48	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 49	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 50	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 51	Individual	Indicated general environmental interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 52	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 53	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 54	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 55	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 56	Individual	Indicated general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 57	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 58	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 59	Individual	Indicated general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 60	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 61	Individual	Indicated an interest in local opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 62	Individual	Indicated general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 63	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 64	Individual	Indicated general interest in an earlier EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 65	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 66	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 67	Individual	Indicated general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 68	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 69	Individual	Indicated general interest in an earlier EP and Prelude. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 70	Individual	Indicated general interest in this EP. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 71	Individual	Indicated an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Self-identified via community drop-in/community sessions				
Person 72	Individual	Attended the Derby drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 73	Individual	Attended the Broome drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 74	Individual	Attended the Broome drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 75	Individual	Attended the Darwin drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 76	Individual	Attended the Broome drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 77	Individual	Attended the Exmouth drop-in session, with a general interest in potential environmental risks around spills to Exmouth. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 78	Individual	Attended the Broome drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 79	Individual	Attended the Derby drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 80	Individual	Attended the Derby drop-in session, with a general interest in the Crux project site in relation to Cockatoo Island. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 81	Individual	Attended the Derby drop-in session, with general concerns around climate change. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 82	Individual	Attended the Broome drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 83	Individual	Attended the Exmouth drop-in session, with a general interest in potential environmental risks around spills. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 84	Individual	Attended the Exmouth drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was	No	

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
		assessed as not relevant for this EP as no functions, interests or activities were identified.		
Person 85	Individual	Attended the Derby drop-in session, with a general interest in the Crux offshore petroleum activity and use of water for recreational purposes. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No -	
Person 86	Individual	Attended the Exmouth drop-in session, with a general interest in the Crux offshore petroleum activity, a general interest in the environment and recreational fishing around Exmouth. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 87	Individual	Attended the Broome information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 88	Individual	Attended the Broome drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 89	Individual	Attended the Darwin information session, with a general interest in in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 90	Individual	Attended the Broome drop-in session, with a general interest in helicopter routes used in the Crux project. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Main Roads WA - Pilbara Region	Organisation	Met in Port Hedland, given on overview of the Crux project and provided with fact sheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 91	Individual	Attended the Derby drop-in session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was	No	

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
		assessed as not relevant for this EP as no functions, interests or activities were identified.		
Person 92	Individual	Attended the Broome drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 93	Individual	Attended the Derby drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 94	Individual	Attended the Derby drop-in session, with an interest in local opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Pilbara Development Commission	Organisation	Met in Port Hedland, given an overview of the Crux project and provided with factsheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Pilbara Ports Authority	Organisation	Met in Port Hedland, given an overview of the Crux project and provided with factsheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Port Hedland Chamber of Commerce and Industry	Organisation	Met in Port Hedland, given an overview of the Crux project and provided with factsheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 95	Individual	Attended the Derby drop-in session, with an interest in employment opportunities. Individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 96	Individual	Attended the Darwin community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Shire of Port Hedland	Organisation	Met in Port Hedland, given an overview of the Crux project and provided with factsheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 97	Individual	Attended the Derby drop-in session, with an interest in the safety of the Crux project. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Town of Port Hedland – Rangers	Organisation	Met in Port Hedland, given an overview of the Crux project and provided with factsheets. Once sufficient information was provided, this organisation was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 98	Individual	Attended the Derby drop-in session, with an interest in business and employment opportunities for Traditional Owners. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No-	
Person 99	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 100	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 101	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 102	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 103	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 104	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No -	
Person 105	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 106	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 107	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 108	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No -	
Person 109	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	
Person 110	Individual	Attended the Darwin community information session. This individual works for a Shell contractor and is therefore assessed as not relevant for EP consultation.,	No	-

Individual or Organisation	Group	Rationale	Relevant for the Installation and Cold Commissioning EP	Link to Section 25 of the OPGGS(E) Regulations Category
Person 111	Individual	Attended the Darwin community information session. This individual works for a Shell contractor and is therefore assessed as not relevant for EP consultation.	No	-
Person 112	Individual	Attended the Darwin community information session. This individual works for INPEX – please see RP 191.	Yes	25(1)(d)
Person 113	Individual	Attended the Darwin community information session. This individual works for the Port of Darwin – please see RP 336.	Yes	25(1)(d)
Person 114	Individual	Attended the Darwin community information session. This individual works for a Shell contractor and is therefore assessed as not relevant for EP consultation.,	No	-
Person 115	Individual	Attended the Darwin community information session, with an interest in the Crux project. Asked about opportunities local content / Shell to sponsor/collaborate/partner. This individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 116	Individual	Attended the Darwin community information session. This individual	No	-
Person 117	Individual	Attended the Darwin community information session. This individual works for a Shell contractor and is therefore assessed as not relevant for EP consultation.,	No	-
Person 118	Individual	Attended the Darwin community information session, with an interest in the Crux project	No	-
Person 119	Individual	Attended the Darwin community information session. This individual works for the Dept of Industry, Tourism and Trade in the NT – see RP 28.	Yes	25(1)(c)
Person 120	Individual	Attended the Darwin community information session, with a general interest in the Crux offshore petroleum activity and the environment. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-
Person 121	Individual	Attended the Darwin community information session. This individual works for the Dept of Industry, Tourism and Trade in the NT – see RP 28.	Yes	25(1)(c)
Person 122	Individual	Attended the Broome community information session, with a general interest in the Crux offshore petroleum activity. Once sufficient information was provided, this individual was assessed as not relevant for this EP as no functions, interests or activities were identified.	No	-

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Indigenous People and Organisations					
Tier 1					
Bardi and Jawi Niimidiman Aboriginal Corporation (BJNAC)	RNTBC / Native Title Determination	Statutory functions, interests, and activities due to role as RNTBC/ PBC for Bardi and Jawi people. Represent native title holders. The three groups of BJNAC, Mayala and Walalakoo are deeply interconnected, and disclosed cultural interests in a joint meeting. Shell received a letter on behalf of BJNAC and an individual person who is a member of BJNAC in relation to a previous EP. Shell's response offered to consult with BJNAC and the individual. The individual has not come forward and identified as relevant for this EP. Advice received from BJNAC, has directed Shell that the culturally appropriate way to consult with BJNAC members is through BJNAC as opposed to individual members. Shell has respected that advice.	Yes	25(1)(d)	1
Dambimangari Aboriginal Corporation (DAC)	RNTBC	Statutory functions, interests, and activities due to role as RNTBC/ PBC. Represent native title holders. Wunambal Gaambera, Dambimangari and Willinggin people make up the Wanjina Wunggurr Community and Wanjina Wunggurr (Native Title) Aboriginal Corporation, with each group managing its own Country identified through native title determination through separate Aboriginal Corporations.	Yes	25(1)(d)	1
Kimberley Land Council (KLC)	Land Council	KLC is the peak Indigenous body in the Kimberley region working with Indigenous people to secure native title, conduct conservation and land management activities and develop cultural business enterprises. KLC is a Native Title Representative Body.	Yes	25(1)(d)	1

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
		• KLC is the contact point for the following specific RNTBCs, and Indigenous organisations identified as relevant to this EP: • Wanjina Wunggurr (Native Title) Aboriginal Corporation. (Tier 1) including Wunambal Gaambera, Dambimangari and Willinggin people • Balanggarra Aboriginal Corporation; (Tier 2) • Mayala Inninalang Aboriginal Corporation. (Tier 1) • Miriuwung & Gajerrong #1 (Native Title Prescribed Body Corporate) Aboriginal Corporation. (Tier 3) • Bardi & Jawi Niimidiman Aboriginal Corporation (Tier 1). • Kimberley Ranger Network (Tier 3) • Bardi Jawi Rangers (Tier 3) • Balanggarra Rangers (Tier 3)			
Mayala Inninalang Aboriginal Corporation (incl Mayala 2)	RNTBC	Statutory functions, interests, and activities due to role as RNTBC/ PBC. Represent native title holders. KLC confirmed they are the correct contact point. The three groups of BJNAC, Mayala and Walalakoo are deeply interconnected, and disclosed cultural interests in a joint meeting.	Yes	25(1)(d)	1
Northern Land Council (NLC)	Land Council	NLC is the peak Indigenous body in the north part of the Northern Territory working with Indigenous people to secure native title, conduct conservation and land management activities and develop cultural business enterprises. NLC is a Native Title Representative Body, NLC is the contact point for the following specific RNTBCs, and Indigenous organisations identified as relevant to this EP:	Yes	25(1)(d)	1

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
		• Top End Aboriginal Corporation RNTBC (Tier 2) • Dak Djerat Guwe People (Tier 2) • Kenbi Rangers (Tier 3) • Wudicupildiyerr Outstation Rangers (Tier 3) • Garngi Land and Sea Management (Tier 3) • Malak Malak Land and Water Management Rangers (Tier 3) • Bulgul Land and Sea (Management) Rangers (Tier 3). • Arnhem Land Aboriginal Trust (Tier 3) • Delissaville / Wagait / Larrakia Aboriginal Land Trust (Tier 3) • Croker Island (Tier 3) • Bulgul Land and Sea Management Rangers (Tier 3) • Cobourg Peninsula Sanctuary Land Trust (Tier 3)			
Wanjina-Wunggurr (Native Title) Aboriginal Corporation	RNTBC	Statutory functions, interests, and activities due to role as RNTBC/ PBC. Represent native title holders. KLC confirmed they are the correct contact point. Wunambal Gaambera, Dambimangari and Willinggin people make up the Wanjina Wunggurr Community, with each group managing its own Country under separate Aboriginal Corporations.	Yes	25(1)(d)	1
Walalakoo Aboriginal Corporation	RNTBC	Statutory function, activities and interests due to role as RNTBC/ PBC. Represent native title holders. Identified cultural heritage sites in previous consultations. The three groups of BJNAC, Mayala and Walalakoo are deeply interconnected, and disclosed cultural interests in a joint meeting.	Yes	25(1)(d)	1
Wilinggin Aboriginal Corporation	Aboriginal Corporation	Wilinggin Aboriginal Corporation is the agent of Wanjina-Wunggurr Aboriginal Corporation in relation to the interests of the Ngarinyin people and activities on Country, which includes, but is not limited to, management of Indigenous Protected Area (IPA) as well as fire and carbon projects within the Wilinggin native title determination. Wunambal Gaambera, Dambimangari and Willinggin people make up the Wanjina Wunggurr Community and Wanjina Wunggurr	Yes	25(1)(d)	1

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
		(Native Title) Aboriginal Corporation, with each group managing its own Country identified through native title determination through separate Aboriginal Corporations.			
Wunambal Gaambera Aboriginal Corporation (including the Uunguu Rangers)	Aboriginal Corporation	Conduct Land business and interest transactions of the Wunambal Gaambera people, who hold Native Title over land and seas (Wanjina Wunggurr (Uunguu) NT determination. Wunambal Gaambera, Dambimangari and Willinggin people make up the Wanjina Wunggurr Community and Wanjina Wunggurr (Native Title) Aboriginal Corporation, with each group managing its own Country identified through native title determination through separate Aboriginal Corporations.	Yes	25(1)(d)	1
Tier 2					
Balanggarra Aboriginal Corporation	Native Title Determination	Statutory function, activities and interests due to role as RNTBC/ PBC. Represent native title holders.	Yes	25(1)(d)	2
Dak Djerat Guwe People	Native Title Claim	Native title claimants. This group has been identified as potentially having separate and unique functions, interests, and activities in their Land and/or Sea Country.	Yes	25(1)(d)	2
Djarindjin Aboriginal Corporation (DAC)	Aboriginal Corporation	Djarindjin Aboriginal Corporation (DAC) through entity Djarindjin Airport Pty Ltd (DAPL) operate airport for Prelude.	Yes	25(1)(d)	2
Jikilaruwu (Bathurst Island).	Tiwi Landowning Group	Jikilaruwu is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Larrakia Nation Aboriginal Corporation	Aboriginal Corporation	Peak body for Larrakia people. Functions, activities, interests.	Yes	25(1)(d)	2
Malawu (Bathurst Island)	Tiwi Landowning Group	Malawu is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Mantiyupwi (Bathurst and Melville Island)	Tiwi Landowning Group	Mantiyupwi is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Marrikawuyanga (Melville Island)	Tiwi Landowning Group	Marrikawuyanga is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Miriuwung and Gajerrong #1 (Native Title Prescribed Body Corporate) Aboriginal Corporation RNTBC	RNTBC	Statutory functions, interests and activities due to role as RNTBC/PBC. Represent native title holders. KLC confirmed they are the correct contact point.	Yes	25(1)(d)	2
Munupi (Melville Island)	Tiwi Landowning Group	Munupi is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Tiwi Land Council (TLC)	Aboriginal Land Council	Statutory function, activities and interests due to role as Land Council. Represents Tiwi people in the protection of land, sea and environment. The TLC is responsible to ensure that activities on the Tiwi islands are undertaken only after consultation with the relevant Tiwi Clan group. The TLC is made up of four members from each of the Clan groups of the Tiwi Islands. There are 8 landowning groups on the Tiwi Islands: • Jikilaruwu (Bathurst Island) • Malawu (Bathurst Island) • Mantiyupwi (Bathurst and Melville Island) • Marrikawuyanga (Melville Island) • Munupi (Melville Island) • Wulirankuwu (Melville Island) • Wurankuwu (Bathurst Island) • Yimpinari (Melville Island) • Tiwi Marine Rangers	Yes	25(1)(d)	2
Top End Aboriginal Corporation RNTBC	RNTBC	The Top End (Default PBC/CLA) Aboriginal Corporation is the default registered native title body corporate for a large number of native title determinations and acts as an agent for native title holders.	Yes	25(1)(d)	2

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Wanparta Aboriginal Corporation	RNTBC	Statutory function, activities and interests due to role as RNTBC/ PBC. Represent native title holders. Identified totemic species that they have a specific interest in.	Yes	25(1)(d)	2
Wulirankuwu (Melville Island)	Tiwi Landowning Group	Wulirankuwu is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Wurankuwu (Bathurst Island)	Tiwi Landowning Group	Wurankuwu is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Yimpinari (Melville Island)	Tiwi Landowning Group	Yimpinari is one of eight Landowning Groups on the Tiwi Islands, each one with connections to a spatially defined area.	Yes	25(1)(d)	2
Tier 3					
Anindilyakwa Land Council	Aboriginal Land Council	Swordfish interest	Yes	25(1)(d)	3
Arnhem Land Aboriginal Land Trust	Aboriginal Land Trust	Est under ALRA. Hold ownership of Aboriginal Land that intersects and extends within (islands) the Planning Area. Controls via Permit access the intertidal zone.	Yes	25(1)(d)	3
Bardi Jawi Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding	Yes	25(1)(d)	3
Balanggarra Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding	Yes	25(1)(d)	3
Bulgul Land and Sea (Management) Rangers	Land and Sea Management	Indigenous Rangers have functions, activities, and interests to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding. Undertaking beach patrols, monitoring of flatback turtle, ghost net clearance, sacred site protection, and work with Finnis-Reynolds Catchment Groups.	Yes	25(1)(d)	3

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Cobourg Peninsula Sanctuary Land Trust	Land Trust	Represent the people of the Cobourg Peninsula under the Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act 1981. The Trust selects the Board who then manage the Cobourg Marine Park. Under the Act, The Northern Land Council is required to take or consent to the taking of action in relation to the Land Trust.	Yes	25(1)(d)	3
Crocodile Islands Rangers / Maringa Ocean Patrol	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Croker Island	RNTBC/ Native Title Determination	Statutory functions, interests and activities due to role as RNTBC/ PBC. Represent native title holders.	Yes	25(1)(d)	3
Delissaville/Wagait/Larrakia Aboriginal Land Trust	Aboriginal Land Trust	The trust is responsible for managing and protecting traditional lands and waters on behalf of the Larrakia people of the region, including conservation and cultural heritage management. Has social, cultural, and environmental interests.	Yes	25(1)(d)	3
Garngi Land and Sea Management / Garngi Community Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Gumurr Marthakal Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding. In the process of declaring an Indigenous Protected Area and related management plan.	Yes	25(1)(d)	3
Individual Indigenous Person	Individual	Self-identified through the process.	Yes	25(1)(e)	3
Joombarn-buru Aboriginal Corporation	Aboriginal Corporation	Self-identified through the process.	Yes	25(1)(e)	3
Kenbi Rangers	Land and Sea Management	The Kenbi Rangers, are based on the Cox Peninsula. Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Kalumburu Aboriginal Corporation	Aboriginal Corporation	Local Aboriginal corporation for remote community situated on the coast. Falls within the Planning Area.	Yes	25(1)(d)	3
Kimberley Ranger Network	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Kooljaman at Cape Leveque	Tourism Operator	Indigenous Tourism Operator near the Planning Area. Kooljaman at Cape Leveque is now closed.	Yes	25(1)(d)	3
Lombadina Aboriginal Corporation (LAC); including Lombadina Accommodation & Tours	Aboriginal Corporation	Tourism and commercial activities/ interests.	Yes	25(1)(d)	3
Malak Malak Land and Water Management Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Munupi Aboriginal Corporation	Aboriginal Corporation	Registered charity/not for profit. Suspect links to the Munupi Aboriginal Arts and Craft Association.	Yes	25(1)(d)	3
Northern Australian Indigenous Land and Sea Management Alliance	Land and Sea Management	Indigenous led not-for-profit assisting Indigenous people manage their Country	Yes	25(1)(d)	3
NT Indigenous Business Network	Business Operator	The peak body representing Indigenous businesses in the Territory.	Yes	25(1)(d)	3
Nyul Nyul PBC Aboriginal Corporation	RNTBC	Statutory function, activities and interests due to role as RNTBC/ PBC. Represent native title holders. This group was identified by the KLC to Shell, including that the KLC is the correct contact point.	Yes	25(1)(d)	3
Pudakul Aboriginal Cultural Tours	Tourism Operator	Tourism Operator with activities in or adjacent to the Planning Area. Cumulative interests due to being Indigenous operated.	Yes	25(1)(d)	3
Saltwater Cultural Tours	Business Operator	Activities due to marine business out of Darwin.	Yes	25(1)(d)	3
Tarntipi Bushcamp	Indigenous business	Eco resort – activities/ interests.	Yes	25(1)(d)	3

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
Thamarrurr Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Tiwi Marine Rangers	Land and Sea Management	Indigenous Rangers have functions, interests, and activities, to maintain the health of Country and Sea – linked to Native Title Determinations, IPA agreements or Federal/ State funding.	Yes	25(1)(d)	3
Tiwi Resources Pty Ltd	Aboriginal Corporation	Purpose is to gain economic opportunities for the Tiwi People.	Yes	25(1)(d)	3
Yagbani Aboriginal Corporation	Aboriginal Corporation	Training, employment, and support to the Aboriginal people of Warruwi.	Yes	25(1)(d)	3
Wudicupildiyerr Outstation Rangers	Land and Sea Management	The Wudicupildiyerr Outstation Rangers look after 160,000 hectares of land and sea throughout the Daly River/Port Keats Land Trust. Wudicupildiyerr Outstation Rangers is now closed.	Yes	25(1)(d)	3

Individual or Organisation	Group	Rationale	Relevant for this EP	Link to Section 25 of the OPGGS(E) Regulations Category	Tier
• Nyangumarta Karajarri Aboriginal Corporation • Karajarri Traditional Lands Association Aboriginal Corporation • Nyamba Buru Yawuru Aboriginal Corporation • Gogolanyngor Aboriginal Corporation • Nimanburr Aboriginal Corporation • Warrwa People Aboriginal Corporation	RNTBC / Aboriginal Corporations	These organisations were identified by KLC for distribution of information about the broader Crux Project but have been assessed as not relevant for this EP, as they do not meet the definition of a Tier 0, Tier 1, Tier 2 or Tier 3 relevant persons as detailed in Table 5-10.	No	n/a	n/a
• Numbulwar Land and Sea Management • Mardbalk Land and Sea Management • Garawa and Waanyi / Garawa • Timber Creek • Wagiman • Yugul Mangi Land and Sea Management • Yugul Mangi Rangers	Land and sea management	NLC was identified as the contact point for these organisations for distribution of information about the broader Crux Project but have been assessed as not relevant for this EP, on the basis. they do not meet the definition of a Tier 0, Tier 1, Tier 2 or Tier 3 RP as detailed in Table 5-10.	No	n/a	n/a
• Julyardi Aboriginal Corporation	Aboriginal Corporation	Social programs	No	n/a	n/a

5.6 Consultation Approach

5.6.1 Providing Sufficient Information

Section 25(2) of the OPGGS(E) Regulations requires titleholders to provide relevant persons with sufficient information to allow relevant persons to make an informed assessment of the possible consequences of the proposed activities on their functions, interests, or activities. This section demonstrates that Shell has provided sufficient information to relevant persons because:

- Information provided was detailed enough to allow people to make an informed decision as to how their functions, interests or activities may be affected (Section 5.6.1.1).
- Information provided to relevant persons was tailored to their functions, interests, and activities with the information Shell had available at the time (Section 5.6.1.2).
- Further information was provided where a request was considered reasonable or related to EP content or supporting information (Section 5.6.1.3).
- Awareness was raised of NOPSEMA's guideline for relevant persons (Section 5.6.1.4).
- The draft EP was published on Shell's website given the Tipakalippa Decision timing (Section 5.6.1.5).

5.6.1.1 Information given allowed informed decisions by relevant persons

The initial call out for relevant persons, and the iterations of information provided throughout the consultation process were developed to ensure that a relevant person could make an informed decision as to how the activities proposed within the EP could affect their functions interest and activities. This included the initial broad advertisements, where links to the EP webpage allowed access to relevant EP information, so that anyone who was prompted to seek further information could access the information (See Section 5.6.1.2).

5.6.1.2 Tailored information to the relevant persons functions, interests, and activities

In determining information requirements, Shell considered the functions, interests and activities of the relevant persons and the nature and scale of environmental impacts and risks that could affect them. Shell recognised that different categories of relevant persons required different levels of engagement on this basis.

Further, Shell adheres to published guidance for good practice consultation relevant to different sectors and disciplines, as described below.

Materials were developed with subject matter experts, including corporate communications professionals, to ensure the content was comprehensible and appropriate for the recipient. Instead of a 'one size fits all' approach, a suite of consultation materials were developed to support the various communications channels. Table 5-9 summarises the communication channels used for each relevant person during the development of this EP.

The methodology used by Shell to provide relevant persons with sufficient information is outlined below and the evidence of the information provided can be found in Appendix B.

5.6.1.3 Provided further information for relevant persons on request

Shell created targeted consultation material that was appropriate to the category of persons, such as specific information sheets or presentation materials. This was prepared on Shell's own initiative or due to information requested by the relevant person. For example, commercial fishing licence holders and representative bodies received additional information relevant to their fishery, or bespoke information and materials created for Indigenous People, as appropriate (Refer to Appendix B). To ensure information was appropriately provided to relevant persons, Shell invited feedback, sought advice, provided information, and invited participation in forums or community drop-in sessions. Feedback on the clarity, relevance and usefulness of the materials was adopted from relevant persons throughout the consultations and the information provided was refined and improved because of that feedback (Refer to Appendix B).

5.6.1.4 Raise awareness of NOPSEMA's guideline for relevant persons

NOPSEMA released its Guideline: Consultation in the course of preparing an environment plan (N-04750-GL2086) on 12 May 2023 (updated in May 2024), during the preparation of this EP. The Guideline encourages titleholders to provide relevant persons with a copy of the NOPSEMA Consultation on offshore environment plans Brochure as part of consultation. As soon as Shell became aware of the Brochure, it was posted on

Shell's public website and was included in follow-up communications with relevant persons (Refer to Appendix B).

5.6.1.5 Publication of the draft EP

Shell made the draft EP publicly available on the Crux project website on 25 August 2023 as the EP was already drafted at the time the Tipakalippa decision was handed down by the Federal Court. The EP was published to enable relevant persons to self-select additional information, if needed. In doing so, relevant persons were also able to see any information provided in context, and in further detail than the summaries.

5.6.1.6 Change in scope during EP preparation

If the activity scope changes during the preparation of the EP, Shell will assess whether sufficient information has been provided to relevant persons to enable them to understand how their functions, interests or activities may be affected by the activity scope (as changed). Where Shell determines that further information is required, Shell will provide those relevant persons with further information appropriate to the nature and scale of the activity, and a reasonable period of time to allow them to raise any objections or claims about the changed activity scope. The assessment of changes in scope during the preparation of this EP are outlined in Table 5-8 below.

Table 5-8: Assessment of Change in Activity scope during the preparation of this EP

Change in Scope	Assessment of change in Scope of EP
Prelude Modification for Crux Tie-in activities described in section 6.9.10	The Factsheet in Appendix B used by Shell to support consultation with Relevant Persons for the Crux Installation and Cold Commissioning Environment Plan contains sufficient information for relevant persons to understand how their functions, interests or activities may be affected by the changed activity scope, given the low environmental impact of the PMCT activities. Page 1 of the Factsheet mentions that "the installed infrastructure will be integrated into the existing Prelude FLNG facility". The PMCT activities form part of this integration and do not involve any environmental management aspects that were not detailed in the Factsheet.

5.6.2 Providing a reasonable period for consultation

Section 25(3) of the OPGGS(E) Regulations provides that titleholders must give relevant persons a reasonable period for consultation to occur. Shell allows a minimum of 30 days from the date that sufficient information is provided to a relevant person, for the person to review the information and respond to Shell on the impact that Shell's proposed activities may have on their functions, interests, or activities. As noted below, in many cases, where no response is received within a 30-day period, Shell has sent follow-up communications to the relevant persons in question. Shell recognises that additional time may be required for relevant persons to provide feedback due to availability and accessibility issues and assesses requests for additional time on a case by-case basis. Shell also recognises that where interests are held communally, such as with Indigenous people, more than 30 days may be required. Where this occurred, it is documented in further detail in Table 5-12 and Table 5-13. Shell acknowledges that participating in consultation is voluntary for relevant persons, and that in some circumstances Shell may be limited in the form of consultation it can undertake, e.g., if a relevant person does not make contact details available. If comments are received from relevant persons after submission of the final version of the EP to NOPSEMA they will not have been considered or incorporated into the preparation of appropriate control measures included in the EP. In this event, Shell will consider comments and feedback as part of the Implementation Strategy for the EP (refer Section 10). Should the feedback or comments identify a significant measure or control that requires implementation or update to meet the intended outcome of consultation, Shell will apply its Management of Change (MOC) and Review process (noting the obligations under sections 19, 26, 38 and 39 of the OPGGS(E) Regulations).

Table 5-9: Consultation Channels

Channel	Purpose
Consultation emails	These are the initial contact made to relevant persons and contain project and EP information, including contact details with various options to obtain more information, ask questions or provide feedback. All relevant persons identified through the relevant person search were sent an initial email that advised on obligation of titleholders to undertake consultation and the role of relevant persons, including inviting feedback on how they would like to be consulted. Consultation emails also included follow-up emails to ensure potentially relevant persons were aware of where to find information to consider and assess potential impacts. A final email was sent to all relevant persons on 18 September, which is included in Appendix B.
Factsheets	Short sharp digestible documents that outline the key facts related to this EP. The key factsheet related to the Crux Installation and Cold Commissioning EP included: • a description of the environment • a summary of the environmental impacts and risks • a summary of the risk mitigation and management control measures The factsheet was sent directly as well as being available on the Shell website. Factsheets should never be considered the sole way to communicate and may not be appropriate for all relevant persons.
Information Booklet	An overview of the Crux Project in one booklet, outlining all the various stages of the project and relevant activities of each EP.
Indigenous People Forum	A forum designed for Indigenous People in two stages with the first to present the information and the second held later to allow for Indigenous People to digest and share the information and come back with their feedback in an environment that provides for Indigenous only discussions. These forums were made available to Indigenous People in addition to other mechanisms available including on-Country visits and direct meetings.
Industry Briefing	An opportunity for relevant persons in section 25(1)(a) (b) and (c) €the OPGGS(E) Regulations to hear directly from Shell and ask questions. The briefing was held at Shell's offices in Perth with an option to join via Microsoft Teams.
Information Sessions	A means to gather together similar relevant persons and present to them the content they require from the EP submission with an opportunity to ask questions. These were held in: • Broome • Darwin
Drop-in Sessions	Shell spent time in each of the locations identified which allowed relevant persons to 'drop-in'. This allowed for appropriate and adapted consultation delivered in a flexible way to offer relevant persons an opportunity to have two-way dialogue with Shell and view information on the project. These drop-in sessions were widely advertised to ensure appropriate representation and locations chosen appropriate to the Planning Area: • Derby • Broome • Darwin • Port Hedland • Exmouth
Tailored face to face / Microsoft Teams' meetings	These were held as required with relevant persons and provided additional opportunity to discuss matters of interest to the relevant person or organisation as well as ask questions or feedback in a two-way engagement.
Online materials and information	The website allows for more information to be included than a factsheet and allows relevant persons to handpick what interests them. The website includes a form which allows relevant persons to self-identity.
Sharing the entire draft EP via Shell's website	Transparent approach to what is included in the EP for those who want more detail.

Channel	Purpose
Newspaper adverts / Local radio	Adverts placed in print media or local radio where print media was not available to allow relevant persons to self-identify. These ads were placed in regional locations along the geographic spread of the Planning Area. Ads were also placed to raise awareness of local drop-in sessions.
Social media	Social media posts were placed tactically across social media to allow relevant persons to self-identify. These ads targeted regional locations across the geographic spread of the Planning Area.
Industry support	Sharing information via membership/industry groups.
WAFIC	WAFIC provided fee for service consultation to directly engage with WA managed fisheries who had activities or interests in the EP operations areas. Tailored materials were provided to relevant fisheries and two sessions (hosted at WAFIC's office and via Microsoft Teams) were offered to those seeking further information.
Traditional communications	Email, telephone, posted mail
Maps	Various maps were used to outline the proposed activity and overlaps with a relevant person's area of interest, for example: • A location map with relevant exclusion zones • fisheries maps • community maps.
Crux animation	Outlining the Crux activities in an easy-to-follow format.
NOPSEMA's consultation brochure	Give relevant persons a better understanding of what the regulations require when it comes to consultation including: • the obligations of titleholders in consulting on EPs • the roles and responsibilities of relevant persons • further information from relevant persons was sought on environment values and sensitivities such as cultural values or features
Power point presentations	These were tailored for relevant persons depending on specific areas or issues of interest based on feedback.

5.6.3 Government Departments or Agencies

The main consultation channels used for relevant Commonwealth and State Government Departments or Agencies was email. If no response was received to the initial email, at least one follow-up email was sent. If there was still no response, it was assumed that the department or agencies have no objection or comment on the proposed activity. This was considered reasonable as government departments have systems and the resources to consult on matters of relevance to their portfolio.

In addition, Shell held an industry briefing, providing targeted information for relevant persons from Government Departments or Agencies. This comprised of a formal presentation on the EP followed by an open forum discussion where attendees had an opportunity to ask questions.

5.6.4 Indigenous People and Organisations

Shell acknowledges that Indigenous peoples are Australia's First Peoples and the Traditional Owners of the land and waters on which we work and live. Shell has been operating in Australia for over 120 years, developing proud partnerships with more than thirty Indigenous communities. Shell is committed to building meaningful relationships with Indigenous communities based on honesty, integrity, and respect.

The Full Federal Court has held that there is good reason to adopt pragmatic and practical approaches to consultation conducted in accordance with section 25 of the OPGGS(E) Regulations. Consultation may be

through properly notified and conducted meetings, or other engagements that facilitate genuine two-way dialogue between the titleholder and relevant persons such as approaches suggested by NTRBs, RNTBCs or PBCs. Meetings should be widely advertised to ensure appropriate representation. However, it is recognised that meetings may not be attended by all members of a group.

When approaching consultation with Indigenous relevant persons, Shell started with a broad approach, reviewing the Planning Area, which overlaps a number of Native Title determinations (Figure 7-25) further described within Section 7.4.2.2.2, with a further 50 km buffer for all searches to ensure a broad capture of potentially relevant persons.

This identified more than 50 Aboriginal organisations as fitting the criteria of relevant persons comprising:

- Land Councils.
- Aboriginal Land Trusts – which exist in the Northern Territory and include land held in trust for use by Aboriginal people by another entity.
- Native Title Representative Bodies (NTRB).
- Registered Native Title Bodies Corporate (RNTBCs – the formal name given to a group once Native Title has been determined).
- Prescribed Bodies Corporate (PBCs – the legal entity formed by a group of Native Title Claimants during the determination process but used interchangeably with RNTBC).
- Aboriginal Corporations – Aboriginal run or managed businesses, often operating on behalf of, or under a RNTBC, but also independently, and including Aboriginal Tourism providers.
- Land and Sea Management Groups – primarily Ranger Groups, many of whom operate under a RNTBC, but some who operate independently on an IPA, or as the result of an ILUA.
- Aboriginal Arts and Cultural centres.
- Native Title Claim groups.
- Advisory Committees.
- Individuals.

Following extensive research and community consultation, it was clear that not all groups considered themselves responsible for cultural and spiritual care of land and sea to equal or similar degrees. For example:

- NTRBs including NLC and KLC often provide administration services such as payroll, legal and human resource services to RNTBCs or PBCs who have chosen to use the NTRB as an umbrella organisation under which to function, in addition to their primary role of assisting with matters pertaining to Native Title claims and determinations. NTRBs were used by Shell where appropriate to advise on Indigenous groups who could be relevant or have Sea Country or are located on the coast, preferred consultation approaches and to distribute consultation information to RNTBCs as deemed appropriate by the NTRB. However, the NTRBs do not consider it appropriate to represent the views of the RNTBCs or other groups who use their services, although in some circumstances they operate as a conduit or formal contact point for RNTBCs.
- Where an Aboriginal corporation operates under the umbrella of a RNTBC, they tend to be focused on running a business or service, and Native Title responsibilities (land and sea care and management) falls to the RNTBC and other appropriate sub-groups. This includes most (but not all) tourism service providers.
- Advisory Committees are comprised of individual RNTBCs, ranger groups and other Land Management groups, and do not speak with one voice on land, sea, and cultural values.
- Arts and Cultural Centres tend to be focused on their business, and again, defer land and sea cultural issues to the appropriate PBC or RNTBC.

Table 7-1 establishes that planned activity impacts are not expected to extend beyond 56.4 km from the substructure location (based on noise modelling outcomes). Shell has very conservatively considered that planned impacts to Indigenous Peoples functions, interests or activities (including cultural values or features) are unlikely to extend beyond 150 km from the Activity Area (Figure 5-4 and Figure 5-5) therefore this was considered a reasonable basis for including this distance as a criteria for tier 1 consultation efforts on those

closest to the planned activities outlined in this EP and those who could provide inputs into cultural features closest to our planned activities. These groups formed the priority of effort for Shell's consultation approach as described below. However, regardless of which tier a group was placed in, Shell's overarching approach was to be collaborative and responsive in consultation, taking on Indigenous Persons' or' Organisations' feedback about the method of consulting. This is further explained later in this section.

Table 5-10 below identifies the key Indigenous groups who were categorised into Tiers 0–3. Figure 5-4 and Figure 5-5 show the spatial location of Tier 1 and Tier 2 groups in relation to the 150 km line and the Planning Area.

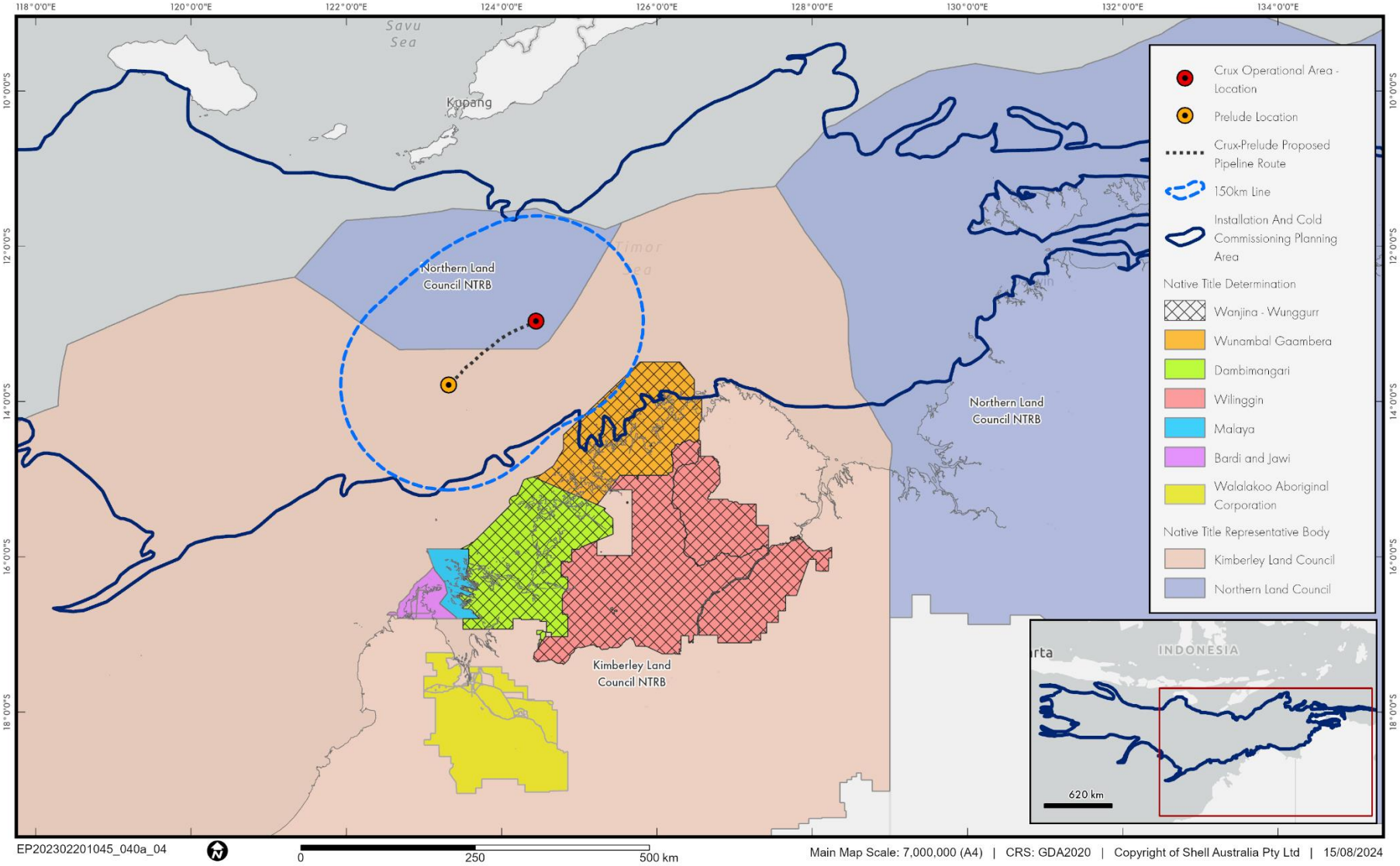


Figure 5-4: Shell Identified Tier 1 Indigenous Relevant Persons

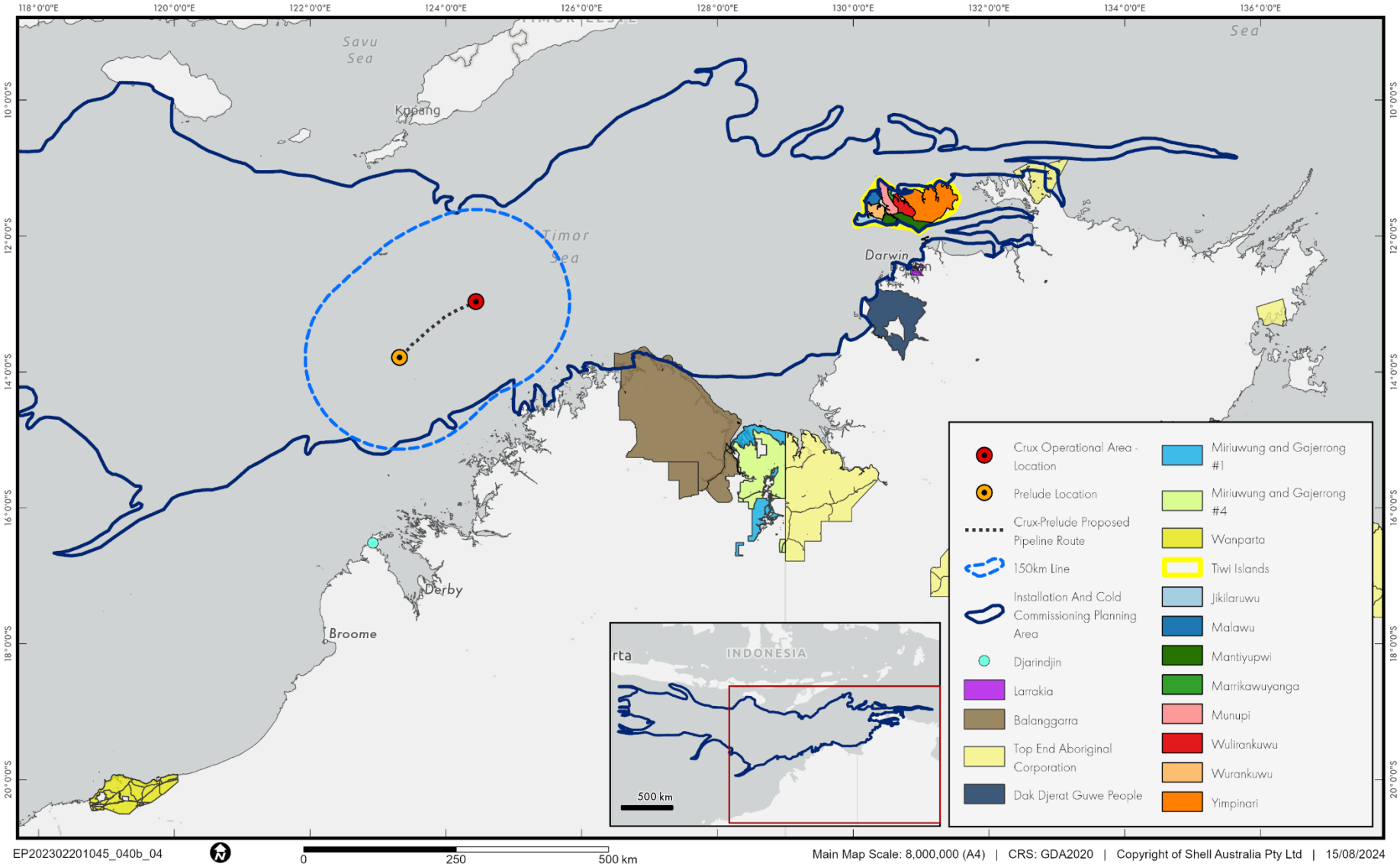


Figure 5-5: Shell Identified Tier 2 Indigenous Relevant Persons (excludes groups where spatial data was not available)

Table 5-10: Approach to Consultation with Relevant Indigenous Persons and Organisations

Shell may adjust tiering to reflect Indigenous relevant persons who identify cultural values and features throughout the consultation process for this, or previous EPs, and/or are identified as important to the broader Shell operational footprint.

Contact Methodology	Overview of Indigenous Relevant Person	Indigenous Relevant Persons	Efforts to initiate consultation
Tier 0	Direct planned impact to functions, interests, or activities of PBC, NTRB or RNTBC or those they represent. Includes planned desecration or potential significant impacts to known cultural values or features.	We have not identified any Indigenous relevant persons who have interests or activities such as cultural values or features within the Activity Area of this EP which will be impacted by the planned impacts of the activities. This is supported by an independent UCH survey by Cosmos Archaeology in 2023 which stated there are no tangible Indigenous features in the Activity Area as it is beyond the ancient coastline at 130 m below LAT, where there has never been any human occupation.	As a minimum, this would include genuine two-way dialogue with a representative of the communal interest affected seeking to reach agreement on the levels of proposed impacts to the cultural feature or value.
Tier 1	Closest to planned activities – located/or with Sea Country within 150 km of the Activity Area on the Australian mainland, in the Kimberley, WA. • PBC, NTRB or RNTBC (excluding Tier 0). • Aboriginal corporation functioning under the authority of an RNTBC (excluding Tier 0).	Bardi and Jawi Niimidiman Aboriginal Corporation RNTBC (BJNAC) Kimberley Land Council (KLC) Mayala Inninalang Aboriginal Corporation RNTBC (incl Mayala 2) Northern Land Council (NLC) Walalakoo Aboriginal Corporation RNTBC Wanjina-Wunggurr Aboriginal Corporation ○ Dambimangari Aboriginal Corporation ○ Wilinggin Aboriginal Corporation ○ Wunambal Gaambera Aboriginal Corporation	Precedence placed on consultation with these groups with focussed efforts, including attempting to contact by multiple forms of communication and seeking to establish long term relationships, where not already established and sought by relevant group.
Tier 2	• Those coastally adjacent to the planning area, defined as areas of coastline which are within 150 km of the planning area[7]. PBC, NTRB or RNTBC who are coastally adjacent to the Planning	• Balanggarra Aboriginal Corporation • Dak Djerat Guwe People • Djarindjin Aboriginal Corporation • Larrakia Nation Aboriginal Corporation	Concerted effort to contact these groups by attempting multiple forms of communication as necessary, to gather inputs on cultural values or features and other matters to inform preparation of this EP.

[7] Beyond 150km from the planning area, there are deemed to be no 'coastally adjacent' areas to the planning area and therefore relevant persons are deemed too far away to be impacted more than an immaterial or negligible way.

Contact Methodology	Overview of Indigenous Relevant Person	Indigenous Relevant Persons	Efforts to initiate consultation
	Area[7] (excluding Tier0, Tier 1 and Tier 3). Aboriginal corporations who are coastally adjacent to the Planning Area (excluding Tier 0, Tier 1 and Tier 3).	• Miriuwung and Gajerrong #1 (Native Title Prescribed Body Corporate) Aboriginal Corporation RNTBC Top End Aboriginal Corporation RNTBC • Tiwi Land Council (TLC) representing the following clan groups: • Malawu (Bathurst Island) • Mantiyupwi (Bathurst and Melville Island) • Marrikawuyanga (Melville Island) • Munupi (Melville Island) • Jikilaruwu (Bathurst Island) • Wulirankuwu (Melville Island) • Wurankuwu (Bathurst Island) • Yimpinari (Melville Island). • Wanparta Aboriginal Corporation RNTBC	
Tier 3	PBC, NTRB or RNTBC whose members are at the periphery of the Planning Area (excluding Tiers 0–2). All other Indigenous people or organisations.	Remaining Indigenous relevant persons.	Emailed sufficient information with at least one follow-up.

When engaging with Indigenous relevant persons, Shell adopted a culturally appropriate tailored approach, in addition to the broader community engagement plan outlined in this EP. For example, where many face-to-face meetings occurred with RNTBC's and Aboriginal Corporations, Shell tailored the presentation material or verbal delivery of information to what Shell considered to be the primary ways their functions, interests or activities could be affected, or what was considered to be culturally appropriate to a particular group, such as have a local photo representing the title slide and Acknowledgement of Country. Tailoring of a verbal nature can be evidenced within meeting summaries emails or minutes within Appendix C.

At the commencement of consultation, Shell approached Indigenous relevant persons, including NTRB's, with a co-design strategy, offering various options (such as on-Country visits, meetings, yarning circles, phone calls, Indigenous Forums) to consult. This offered the opportunity for consultation to be led by Indigenous relevant persons, or the groups like NTRBs which represented them. This helped ensure that engagements could be culturally appropriate, respectful, and tailored to meet the needs of each person or group. The relevant persons consultation approach taken with Indigenous Persons and Organisations is outlined in Table 5-11. Shell is also cognisant to varying degrees of potential communication barriers experienced by relevant persons and as such ensured information was delivered in layman's terms across several methods including verbal, visual and written. See Section 5.6.4.2 on Indigenous Forums.

The consultation co-design approach aimed to minimise negative impacts being experienced by relevant Indigenous persons and organisations, primarily due to consultation fatigue and ensure cultural obligations were carefully considered.

5.6.4.1 Consultation summary

Table 5-11 outlines a summary of the relevant persons consultation approach taken with Indigenous persons and organisations. Further details of the consultation carried out with Indigenous persons and organisations is found in Table 5-12 and Table 5-13, along with full details of all consultation provided in Appendix C.

Table 5-11: Timeline of Consultation with Indigenous relevant persons

Date	Detail	Location
March/April 2023	Initial contact: Shell's initial contact by email focussed on a co-design approach to consultation for this EP and other Crux project EPs. The email was an invite to an Indigenous Forum with a survey attached with the purpose of seeking feedback on how Indigenous relevant persons preferred to be contacted. The survey included: • attendance options for the Indigenous Forums • travel and accommodation support • a vote on the preferred location for the forum • request for feedback on preferred consultation method • an offer for on-Country consultation as an alternative to the Indigenous Forums	Appendix B: 7.01 and 7.02
19 April 2023	Indigenous Forum held in Perth.	Appendix B: 7.03
End of April 2023	Reminder emails were sent about the Indigenous Forum in Broome including links to the Crux website and offer of travel assistance. Shell also asked for relevant persons to share this with others who may be interested.	Appendix B: 7.09
10 May 2023	Indigenous Forum held in Broome.	Appendix B: 7.04
Late May	Reaching out again to share: • EP factsheets • details of the Independent environmental panel • video footage from the first Indigenous forum • offer to meet with Shell.	Appendix B: 7.10

Date	Detail	Location
	• details of the final forum in Darwin and request to pass onto others, especially with Sea Country.	
31 May 2023	Indigenous Forum held in Darwin.	Appendix B: 7.05
15 August 2023	Bardi Jawi Niimidiman Aboriginal Corporation, Mayala Inninalang Aboriginal Corporation and Walalakoo Aboriginal Corporation "Meeting.	Sensitive Information Report
16 August 2023	Wanparta Aboriginal Corporation Meeting.	Sensitive Information Report
5 September 2023	Larrakia Nation Aboriginal Corporation and Larrakia Development Corporation meeting.	Sensitive Information Report
15 September 2023	Wunambal Gaambera Aboriginal Corporation Meeting	Sensitive Information Report
18 September 2023	Email sent to RPs with final opportunity to comment on the Installation and Cold Commissioning EP	Summarised in Appendix C and available in the SIR.
19 September 2023	Dambimangari Aboriginal Corporation Meeting.	Sensitive Information Report
May–October 2023	Email correspondence included attachment of the NOPSEMA Consultation on Offshore Petroleum Environment Plans Brochure after publication.	Appendix B: 8.01
May–October 2023	Follow-ups through phone and/or email seeking consultation meetings.	Summarised in Appendix C.
17 October 2023	Final call out sent to selected Indigenous RPs (Tier 1 and 2)	Summarised in Appendix C.
19 January 2024	Bardi Jawi Niimidiman Aboriginal Corporation Teams Meeting	Sensitive Information Report
19 February 2024	Bardi Jawi Niimidiman Aboriginal Corporation Meeting	Sensitive Information Report
22 February 2024	Nyul Nyul Aboriginal Corporation Meeting	Sensitive Information Report
27 March 2024	Djarindjin Aboriginal Corporation Meeting	Sensitive Information Report
10 April 2024	Dambimangari Aboriginal Corporation Meeting	Sensitive Information Report
19 April 2024	Bardi Jawi Niimidiman Aboriginal Corporation Meeting	Sensitive Information Report
2 May 2024	Nyul Nyul Aboriginal Corporation Meeting	Sensitive Information Report
26 June 2024	Joombarn Buru Aboriginal Corporation Meeting	Sensitive Information Report

Shell explored alternative approaches to consultation to achieve an effective and culturally respectful engagement method. To implement the co-design approach, which also helps demonstrate reasonable efforts, Shell adopted specific suggestions by Indigenous people or organisations, including and in particular, NTRBs like KLC, where these occurred through the consultation period. This is because Shell relied significantly on the direction and input received from NTRB's, in the consultation approach which was used with the Indigenous people and organisations they support and represent. For example, following feedback from Indigenous organisations including KLC at Traditional Owner Forum 2 on the 10 May 2023 and one individual Indigenous person, Shell adopted more focused consultation measures as suggested by the feedback, including but not limited to:

- Specific advice from NTRBs on consulting and obtaining appropriate contact details to consult with certain RNTBC's was received.
- Prioritising face to face meetings where possible.
- Prioritising phone call contact with known leaders of different Indigenous groups to establish rapport and relationship where contact details are freely available.
- Offering to meet at a time and location of choice with people identified by them as appropriate.
- Holding meetings that followed a format and approach determined and agreed by both parties (Indigenous person/organisation and Shell). For example, Bardi Jawi, Walalakoo and Mayala expressed a desire to meet as one group initially, as they consider themselves a coherent people group. Shell met with representatives of the three RNTBCs in Broome, in a format and location of their choosing.
- The Tiwi Land Council expressed a desire that Shell meet with them at Wurrumiyanga (their offices). This request was accommodated.
- Wanparta requested a meeting with the Board members in Port Hedland. This request was accommodated.
- Full details on consultation co-design measures adopted during consultation with Indigenous persons and organisations is outlined in Appendix C.

5.6.4.2 Indigenous Forums

Following feedback from initial discussions with Indigenous Peoples, several requests were made to facilitate the consultation. A forum was designed with input from Indigenous People in two stages, with the first to present the information and the second a few weeks later to allow for Indigenous People to digest and share the information and come back with their feedback in an environment that provides for Indigenous only discussions. These forums were available to Indigenous People in addition to other mechanisms, including on-Country visits and direct meetings. These were offered to Indigenous relevant persons in addition to any other request for engagement (e.g., one on one, on-Country visits).

To support informed participation, attendance, and engagement by invited relevant Indigenous persons and organisations, the following measures were adopted:

- All Indigenous participants were provided with travel allowance support to travel to and from the forums in April and May 2023.
- The Registered Native Title Body Corporates or Prescribed Body Corporates could receive an administrative fee for participation in the forums and any other tailored consultation as required by them, including legal representation.
- Indigenous service providers were also sourced, such as local Indigenous facilitators for both forums in WA and NT, including a Welcome to Country being performed and a 100% Indigenous owned and operated Indigenous business specialising in group conference travel and accommodation support to Indigenous People and organisations living in metropolitan, regional, or remote areas of Australia.
- A panel of four environmental subject matter experts, three were wholly independent of Shell, was established. The environmental panel was made available to all relevant Indigenous persons and Indigenous organisations identified, and associated costs covered by Shell. The key role of the environmental panel members was to provide advice to all relevant Indigenous persons and organisations, with no obligation or expectation to provide feedback or advice to Shell. Representatives from the panel attended the Perth and Broome forums and the panel's availability was further reiterated to many Indigenous relevant persons during follow-up communications.

- Where relevant Indigenous persons and organisations indicated a preference to be engaged on-Country (or other locations) with Shell leaders, additional meetings were accommodated according to each request.
- A Recording of the Perth presentation was made available and disseminated within Indigenous persons and organisations' broader communities and groups alongside any further information requested based on feedback and questions received.

5.6.4.3 Summary of Consultation with Tier 1 and Tier 2 Indigenous Relevant Persons

Table 5-12 provides a summary of consultation with Indigenous relevant persons who were consulted via Consultation Method – Tier 1, as detailed in Table 5-10.

Table 5-13 provides a summary of consultation with Indigenous relevant persons who were consulted via Consultation Method – Tier 2, as detailed in Table 5-10.

Table 5-12 and Table 5-13 are intended to demonstrate that consultation has been carried out for all Tier 1 and Tier 2 Indigenous relevant persons. The full summary of consultation for all relevant persons is provided in Appendix C.

Table 5-12: Tier 1 Indigenous Relevant Persons Consultation Completion Statement

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
31. Dambimangari Aboriginal Corporation (DAC) Wanjina-Wunggurr Aboriginal Corporation is the formal RNTBC for the Dambimangari, Uunguu Part A, Uunguu - Area B, Wanjina - Wunggurr Wilinggin Native Title claim, determined between 2004 and 2012. However, day to day management of the Determined area is in the hands of three separate Aboriginal Corporations: Dambimangari Aboriginal Corporation Wunambal Gaambera Aboriginal Corporation and Wilinggin Aboriginal Corporation.	Approx 230 km from the Crux field to closest part of DAC Country Represents Indigenous people located in the North Kimberley region of Australia. KLC is the NTRB for DAC, via WWAC. Sea Country Cultural heritage values Cultural heritage features traditional activities (e.g., fishing) Have responsibility for Sea Country within the Kimberley Marine Park.	Spill risks have the potential to affect DAC's functions, interests, or activities.	Low, in accordance with Table 5-3 DAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts predicted to DAC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to DAC on 19, 25, 26 May, and 28, 31 August. Face to face meeting held with DAC Advisor on 19 September 2023, with a tailored presentation pack (Appendix B). Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Shell has been attempting to meet DAC face to face since March 2023 when an invitation to consult on the EP was first sent to them as well as their representative body, KLC. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at Indigenous forums which were run at 3 locations (Table 5-11). DAC was invited to attend a specific meeting in Broome on 2 May 2023, this was also shared via the KLC with Wanjina-Wunggurr Aboriginal Corporation. DAC was phoned on multiple occasions between May and August 2023. In addition, during this time, Shell brought to the attention of DAC the NOPSEMA Consultation on offshore petroleum environmental plans which Shell posted a link to on the EP webpage soon after it was published in May 2023 in order for them to be sufficiently informed about the objective of consultation and their rights in the process. A consultation meeting with a DAC advisor occurred on 19 September 2023 where Shell explained the activities of this EP and the impacts and risks which may affect DAC's functions, interests, or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we may not be aware of, and some input was provided as a result of this. Shell also asked if any other issues or input on the EP by DAC. No response was provided. Shell also reiterated the availability of independent environmental consultants which DAC could use free of charge to help them through as assessment of information related to the EP (Refer to Appendix B and the measures adopted column of this table). Shell received no further feedback or correspondence from DAC until Shell provided a further opportunity on the 17 October 2023 to provide input to Shell to support EP preparation. DAC confirmed they were not in a position to provide input on the EPs soon to be submitted to	Shell has been reaching out to DAC both directly and through KLC since March 2023. Sufficient information (such as factsheets and website as well as a published version of the draft EP) was provided to DAC in May 2023. DAC had more than 5 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell has also agreed to pay reasonable costs to support their participation and attendance in consultation meetings. Shell considers that DAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	Shell adopted measures, through suggestions to consult in a face-to-face meeting in Perth in September 2023. Shell also updated the acceptable levels of impact from a major spill. The update was to reflect and reinforce it is unacceptable for a spill from Crux activities to impact DAC Sea Country. Shell provided DAC with a copy of the Crux OPP.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					NOPSEMA. Following this, multiple attempts through phone calls and emails up to 6 November 2023, were made to clarify some items and the requirements for consultation in preparation of the EP and Shell's obligations to this end, as distinct to engagement on other matters, and ongoing consultation related to the EP. Shell also assured DAC that suitable processes and procedures were in place to address any relevant new information DAC may raise relevant to this EPs impacts and risks. Shell also made our position clear that consultation had been carried out with DAC as required by the regulations in preparation of this EP. On 10 November, the CEO of DAC advised there would not be an opportunity for Shell to meet with the DAC board until March 2024, and that DAC did not accept that Shell had engaged with DAC since March 2023. A further request for any feedback related to this EP was offered on 1 December 2023, with feedback requested by 12 January 2024. Further phone calls occurred over January and March of 2024 and Shell presented to the DAC Board on 10 April 2024. The presentation covered the key activities in the overall Crux Project, focusing on the Crux Completions, Hot Commissioning, Start-Up and Operations EP. No new relevant matters were raised. Shell gave an update on the underwater cultural heritage work it had undertaken. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potentially relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP (Appendix B).		

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons (Indigenous people or organisations) to cover all reasonable costs associated with attending consultation meetings/forums (e.g. accommodation, travel and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. DAC were requested multiple times between March and September 2023 to provide contacts for other RPs we should consult (no response provided). Shell considers that DAC and the community it represents have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete. DACs functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to DAC functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Shell has had multiple, meaningful two-way dialogues with DAC representatives, and they have provided input which led to multiple measures being adopted in the EP. Therefore, further consultation is unlikely to further improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Shell has provided sufficient information to inform DAC how their functions, interests and activities may be affected, made reasonable efforts to consult, provided a reasonable period for DAC to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Given the remote likelihood and scale of potential risks to DAC's functions, interests, and activities, that sufficient information and a reasonable period for consultation has been provided and appropriate measures adopted, consultation has been carried out in accordance with section 34(g) of the OPGGS(E) Regulations.							
38. Kimberley Land Council (KLC)	KLC has a function as the NTRB in relation to the administration of Native Title and may represent Native Title applicants and holders' interests in relation to existing Native Title claims and determinations that extend into Sea Country. They are also the contact point for the following specific RNTBCs, PBCs or native title applicants identified as relevant persons for the purposes of this EP. 55. Wanjina Wunggurr (Native Title) Aboriginal Corporation including Wunambal Gaambera, Dambimangari and Willinggin people 122. Balanggarra Aboriginal Corporation 44. Mayala Inninalang Aboriginal Corporation	Spill risks have the potential to affect KLC's, functions, interests, or activities or the RNTBCs, PBCs or Aboriginal Corporations they represent.	Low, in accordance with Table 5-3. KLC's area of responsibility as an NTRB overlaps with the Planning Area. KLC's interests and activities do not extend near the Activity Area. There are no planned impacts predicted to KLC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to KLC on 26 May 2023. Multiple phone calls occurred throughout May 2023. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Shell has consulted with KLC since March 2023 when an invitation to consult on the EP was first sent. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at Indigenous forums which were run at 3 locations. Shell has also made multiple attempts to meet face to face with KLC. As the peak Indigenous body in the Kimberley, KLC were also used to make contact with the RNTBCs, PBCs and Aboriginal Corporations they represent. The KLC is the formal contact point for the groups outlined in the second column. Shell therefore determined that the appropriate way to consult with these organisations was through their formal contact point, KLC. While KLC is the formal contact point, Shell also welcomed any opportunity for direct	Shell has been reaching out to KLC since March 2023. Sufficient information (such as factsheets and website as well as a published version of the draft EP) was provided to KLC in April 2023. The KLC was also requested to forward it on to other RNTBCs, PBCs and Aboriginal Corporations. KLC had more than 6 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell considers that KLC and the community it represents have been afforded a reasonable period to	Shell has incorporated feedback from KLC related to how best to identify and contact Indigenous relevant persons that they have functions to represent as an NTRB. There has been no other feedback which has required updates to the EP from KLC.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
	105. Miriuwung & Gajerrong #1 (Native Title Prescribed Body Corporate) Aboriginal Corporation 29. Bardi & Jawi Niimidiman Aboriginal Corporation 39. Kimberley Ranger Network KLCs interests and activities include, for example: Sea Country Cultural heritage values Cultural heritage features Indigenous traditional activities (e.g., fishing) Responsible for Sea Country within the Kimberley Marine Park.				consultation, as was demonstrated with the Mayala meeting on 15 August 2023. KLC also provided an additional conduit to contact other groups in the region for which it was not a formal contact point (recognising KLC's ability to assist Shell in identifying First Nations relevant persons and organisations). Throughout all consultation with KLC, and the groups it is the formal contact point for, no objections or claims have been raised. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potentially relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP (Appendix B). Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. Shell considers that KLC and the organisations it is the formal contact point for have been afforded a reasonable opportunity to consult with Shell in preparing this EP.	understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	

Justification that consultation is complete.

KLC is the peak Indigenous body and NTRB in the Kimberley region working with Indigenous people to secure native title, conduct conservation and land management activities and develop cultural business enterprises. KLC have received sufficient information and whilst they didn't have any claims or objections themselves, they have shared the information with the groups they represent to ensure they also get sufficient information and reasonable period to provide input, claims or objections. Shell has adopted appropriate measures related to all relevant matters raised by KLC during consultation where suggestions were made on how to better reach members, they support which may be affected by the activities of this EP. Therefore, consultation has been completed in accordance with section 34(g) of the OPGGS(E) Regulations.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
55. Wanjina-Wunggurr (Native Title) Aboriginal Corporation (WWAC) Wanjina-Wunggurr Aboriginal Corporation is the formal RNTBC for the Dambimangari, Uunguu Part A, Uunguu - Area B, Wanjina - Wunggurr Wilinggin Native Title claim, determined between 2004 and 2012. However, day to day management of the Determined area is in the hands of three separate Aboriginal Corporations: Dambimangari Aboriginal Corporation (DAC) Wunambal Gaambera Aboriginal Corporation (WGAC) Wilinggin Aboriginal Corporation (WAC). The KLC is the formal contact point for WWAC as listed on the NNTT website.	○ Approx 140 km from the Activity Area to closest part of WWAC.	Spill risks have the potential to affect WWAC functions, interests, or activities.	Low, in accordance with Table 5-3. WWAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts predicted to WWAC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to WWAC through KLC for onward distribution on 26 May 2023. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	WWAC is the RNTBC for the Dambimangari, Wanjina Wunggurr Wilinggin and Uunguu Part A and Part B Native Title Determination. KLC is the administrative contact point for WWAC, as WWAC has no employees or income as listed on the ORIC website. Given that WWAC have no staff or employees, Shell carried out consultation with WWAC through KLC as its formal contact point. The KLC confirmed in May 2023 that it had passed information on to the WWAC. Further, DAC, WGAC and WAC together represent the Wanjina Wunggurr community. They are all active Aboriginal Corporations who manage their own Country, culture, and business. Shell consulted with these three groups separately, see relevant persons numbers 31, 57 and 125. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potentially relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft EPs. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP (Appendix B). Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell.	Shell has been reaching out to WWAC through KLC since March 2023. Sufficient information (such as factsheets and website as well as a published version of the draft EP) was provided to WWAC via KLC in May 2023. WWAC had more than 5 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell considers that WWAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	No measures were required to be adopted as a result of consultation with WWAC for this EP.
Justification that consultation is complete. WWAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to WWAC's functions, interests and activities is predicted to be Low. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Given the remote likelihood and scale of potential risks to WWAC's functions, interests and activities, Shell provided sufficient information to inform WWAC how							

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
their functions, interests and activities may be affected, provided information to make WWAC sufficiently informed of their rights and their opportunity to be consulted, made reasonable efforts to consult WWAC. Shell also provided a reasonable period for WWAC to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Shell supported WWAC in this process by providing access to reasonable support in the form of environmental consultants to support advising WWAC and offers of reasonable financial support to attend forums. Since Shell has provided WWAC sufficient information and a reasonable period to consider the information and be able to respond, consultation has been carried out in accordance with section 34(g) of the OPGGS(E) Regulations.							
57. Wilinggin Aboriginal Corporation (WAC) Wanjina-Wunggurr Aboriginal Corporation is the formal RNTBC for the Dambimangari, Uunguu Part A, Uunguu - Area B, Wanjina - Wunggurr Wilinggin Native Title claim, determined between 2004 and 2012. However, day to day management of the Determined area is in the hands of three separate Aboriginal Corporations: Dambimangari Aboriginal Corporation Wunambal Gaambera Aboriginal Corporation Wilinggin Aboriginal Corporation.	Approximately 260 km from Activity Area to closest part of WAC WAC represents the eastern part of the Wanjina Wunggurr Native Title Determination and the interests of the Ngarinyin People and their Country. Only a very small part of WAC area is Sea Country Cultural heritage values Cultural heritage features Indigenous traditional activities (e.g., fishing) KLC is the NTRB for WAC, via WWAC.	Spill risks have the potential to affect WAC functions, interests, or activities.	Low, in accordance with Table 5-3. WAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts from the Shell's activities predicted to occur to WAC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to WAC on 26 May 2023. Emails and phone calls directly to WAC in June 2023. Direct contact made with WAC staff 19 June 2023, and full emails with all relevant information sent to CEO and administration. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Shell has been attempting to meet face to face with WAC since March 2023 when an invitation to consult on the EP was first sent to them as well as their representative body, KLC. The request suggested multiple ways which consultation could occur, from on-Country meetings through to attendance at Indigenous forums which were run at 3 locations. Direct contact was made with WAC staff in June 2023, and on the same day, detailed information and factsheets were sent to the CEO and administration. No response was received. Multiple further attempts through phone calls and emails were made throughout September and October 2023 attempting to arrange a meeting with the WAC Board at a location of their choosing. Shell provided a further opportunity on the 17 October 2023 for WAC to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell asserted that sufficient information and a reasonable period had been provided for WAC to provide a response, however Shell offered a further 10 days to provide the requested input, before Shell needed to make final preparations of the EP in readiness of resubmission of the EP to NOPSEMA. WAC did not respond to the offer. From the end of March 2023, Shell undertook a targeted media campaign in the region in which WAC are located, using newspaper ads, geotargeted social media and radio. The campaign urged potential RPs to contact Shell and provided a link to the Shell website with details about the Crux project and the Environment Plan. These materials enabled RPs to make an informed decision about how their functions, interest or activities may be affected, and a mechanism to	Shell has been reaching out to WAC both directly and through KLC since March 2023. Sufficient information (such as factsheets and website as well as a published version of the draft EP) was provided to WAC in May 2023 and direct contact was made in June 2023, when the information was supplied again. WAC had more than 3 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell has also agreed to pay reasonable costs to support their participation and attendance in consultation meetings. Shell considers that WAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	None.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					consult with Shell on the EP (Appendix B). Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel and where appropriate reasonable costs of time) and contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. Shell considers that WAC and the community it represents have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete. WAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to WAC's functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Given the remote likelihood and scale of potential risks to WAC's functions, interests and activities, Shell provided sufficient information to inform WAC how their functions, interests and activities may be affected, provided information to make WAC sufficiently informed of their rights and their opportunity to be consulted, made reasonable efforts to consult WAC. Shell also provided a reasonable period for WAC to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Shell supported WAC in this process by providing access to reasonable support in the form of environmental consultants to support advising WAC and offers of reasonable financial support to attend forums. Since Shell has provided WAC sufficient information and a reasonable period to consider the information and be able to respond, consultation has been carried out in accordance with section 34(g) of the OPGGS(E) Regulations.							
114. Northern Land Council (NLC) 530. Top End Aboriginal Corporation RNTBC 81. Dak Djerat Guwe People 601. Kenbi Rangers 599.Wudicupildiyerr Outstation Rangers 85. Garngi Land and Sea Management 100. Malak Malak Land and Water Management Rangers 78. Bulgul Land and Sea (Management) Rangers 74. Arnhem Land Aboriginal Trust 82. Delissaville / Wagait / Larrakia Aboriginal Land Trust 80. Croker Island	NLC has a function as the NTRB in relation to the Ashmore and Cartier Islands area.	Spill risks have the potential to affect NLC's, functions, interests, or activities.	Low, in accordance with Table 5-3. NLC's area of responsibility as an NTRB overlaps with the Activity Area and Planning Area. There are no planned impacts predicted to NLC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to NLC on 19 May 2023. Face to face meeting occurred on the 26 May 2023. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Shell has consulted with NLC since March 2023 when an invitation to consult on the EP was first sent. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at Indigenous forums which were run at 3 locations. As the peak Indigenous body in the Northern Territory and Ashmore and Cartier Island territories, NLC were requested by Shell to forward information to NLC members outlined in the second column: On the 26 May 2023 Shell met face to face with the NLC. At the meeting, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests, or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we were not aware of (Refer to Appendix B and the measures adopted column of this table). No input was provided to Shell by this request. However, NLC did raise relevant matters they would like addressed	Shell has been reaching out to NLC since March 2023. Sufficient information (such as factsheets and website as well as a published version of the draft EP) was provided to NLC in May 2023. Consultation with NLC is considered to be complete, noting a two-way dialogue with feedback which was incorporated into this EP. NLC was provided reasonable time to digest information and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell considers that NLC have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	Table 10-8 includes requirement for NLC to be notified in the event of an emergency spill event which has the potential to impact communities and environments in the Top End.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					within the EP related to provision of further information related to oil spill preparedness and response. It also included adding NLC to the notification table in the EP for contact in the event of a level 2 or 3 spill. Shell addressed all the requests made by NLC to their satisfaction. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potentially relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP (Appendix B). Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel and where appropriate reasonable costs of time) and contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. Shell considers that NLC have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete. NLC is the peak Indigenous body and NTRB in the north part of the Northern Territory and Ashmore and Cartier Island Territories. Shell has provided sufficient information and a reasonable period for consultation with the NLC as demonstrated by the provision of the information, followed by a face-to-face meeting and follow-up information requests and incorporation of NLC input into the development of this EP. Shell has adopted appropriate measures related to all relevant matters raised by NLC during consultation. Therefore, consultation has been completed in accordance with section 34(g) of the OPGGS(E) Regulations.							
125. Wunambal Gaambera Aboriginal Corporation (WGAC) Wanjina-Wunggurr Aboriginal Corporation is the formal RNTBC for the Dambimangari, Uunguu Part A, Uunguu - Area B, Wanjina - Wunggurr Wilinggin Native Title claim, determined between 2004 and 2012. However, day to day management of the Determined area	Approximately 140 km from the Activity Area to closest part of WGAC Country WGAC represents the northern part of the Wanjina Wunggurr Native Title Determination and the interests of the Uunguu People. Cultural heritage values	Spill risks have the potential to affect WGAC's functions, interests, or activities.	Low, in accordance with Table 5-3. WGAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts from Shell's activities predicted to occur	Fact sheets and the draft EP were provided to WGAC on 26 May 2023. Direct contact made with WGAC on 01 September 2023. Face to face meeting held on 15 September 2023, with	Shell has been offering to meet face to face with WGAC since March 2023 when an invitation to consult on the EP was first sent to them. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at indigenous forums which were run at 3 locations.	Shell has been reaching out to WGAC since March 2023. Sufficient information (such as factsheets and website) was provided to WGAC in May 2023. A published version of the draft EP was available from Aug 2023. WGAC had more than 5 months to review the information, and make an informed assessment about how	Shell updated its environment description of cultural values based on information provided by the WGAC representative during a face-to-face meeting.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
is in the hands of three separate Aboriginal Corporations: Dambimangari Aboriginal Corporation Wunambal Gaambera Aboriginal Corporation and Wilinggin Aboriginal Corporation.	Cultural heritage features Indigenous traditional activities (e.g., fishing) Have responsibility for Sea Country within the Kimberley Marine Park.		to WGAC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	a tailored presentation pack (Appendix B). Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Eight further follow-up emails between March and the end of August 2023, through multiple available means including the KLC, existing contact networks which Shell's Indigenous Engagement adviser contacted WGAC. Subsequent to this, a consultation meeting with a Wunambal Gaambera representatives occurred on 15 September 2023. At the meeting, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests, or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we were not aware of, and some input was provided as a result of this (Refer to Appendix B and the measures adopted column of this table). Following an agreement at this meeting on 15 September to meet again at a face-to-face on Country on 25 October 2023, multiple further attempts through phone calls and emails were made throughout September and October 2023 attempting to arrange this further meeting with the WGAC Board on Country. Shell's four call attempts did not result in a further meeting occurring with WGAC. Shell provided a further opportunity on the 17 October 2023 for WGAC to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell asserted that sufficient information and a reasonable period had been provided for WGAC to provide a response, however Shell offered a further 10 days to provide the requested input, before Shell needed to make final preparations of the EP in readiness of resubmission of the EP to NOPSEMA. WGAC did not respond to the offer even with a further call made before the period closed. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potentially relevant	their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell considers that WGAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP– Appendix B. Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. Shell considers that WGAC and the community it represents have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete. WGAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to WGAC's functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Given the remote likelihood and scale of potential risks to WGAC's functions, interests and activities, Shell provided sufficient information to inform WGAC how their functions, interests and activities may be affected, provided information to make WGAC sufficiently informed of their rights and their opportunity to be consulted, made reasonable efforts to consult WGAC. Shell also provided a reasonable period for WGAC to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Shell supported WGAC in this process by providing access to reasonable support in the form of environmental consultants to support advising WGAC and offers of reasonable financial support to attend forums. Shell has also adopted appropriate measures as a result of consultation carried out with WGAC. Since Shell has provided WGAC sufficient information, a reasonable period to consider the information and be able to respond and appropriate measures have been adopted, consultation has been carried out in accordance with section 34(g) of the OPGGS(E) Regulations.							
54. Walalakoo Aboriginal Corporation (WAC)	Approx 470 km from the Crux field to closest part of WAC Country WAC identified a culturally sensitive reef in the region. Cultural heritage values Cultural heritage features	Spill risks have the potential to affect WAC's functions, interests, or activities.	Low, in accordance with Table 5 3. WAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts from Shell's activities predicted to occur to Walalakoo's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and the draft EP were provided to WAC on 26 May 2023. Direct contact made with WAC on 27 June 2023. Face to face meeting held on 15 August 2023, with a tailored presentation pack (Appendix B). Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 (Appendix B).	Shell has been engaging with WAC since May 2023, when an invitation to consult, face to face, on the EP was first sent. This included an offer to meet on-Country. At their request, led by Bardi Jawi Niimidiman Aboriginal Corporation, a joint face-to-face meeting was held with WAC, Bardi Jawi Niimidiman Aboriginal Corporation and MIAC on 15 August, in Broome, at a venue and with representative participants of their choosing. At the meeting, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests or activities. Shell also asked for input on particular	Shell has been reaching out to WAC since May 2023. Sufficient information (such as factsheets and website was provided to WAC in May 2023. A published version of the draft EP was available from August 2023. WAC had more than 5 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing	Description of heritage values in the EP (e.g. Section 7.4.2.2.2) updated to incorporate information received and updated information considered in risk assessment (e.g. Section 9.14.6.3). Section 7.4.2.1.4 notes that a number of the heritage sites in the Planning Area have not been recorded.

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					values or features which may be affected by Shell's activities which we may not be aware of and some input was provided as a result of this (Refer to Appendix A and the measures adopted column of this table). Shell also offered to hold additional meetings at locations and with participants of WACs choosing, but no response to this was received. Shell provided a further opportunity on the 17 October 2023 for WAC to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell asserted that sufficient information and a reasonable period had been provided for WAC to provide a response, however Shell offered a further 10 days to provide the requested input. WAC did not respond to the request.	information and raising issues or input on Shell's proposed activity. Shell considers that WAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	
Justification that consultation is complete. WAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to WAC's functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Given the remote likelihood and scale of potential risks to WAC's functions, interests and activities, Shell provided sufficient information to inform WAC how their functions, interests and activities may be affected, provided information to make WAC sufficiently informed of their rights and their opportunity to be consulted, made reasonable efforts to consult WAC. Shell also provided a reasonable period for WAC to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Shell supported WAC in this process by providing access to reasonable support in the form of environmental consultants to support advising WAC and offers of reasonable financial support to attend forums. Shell has also adopted appropriate measures as a result of consultation carried out with WAC. Since Shell has provided WAC sufficient information, a reasonable period to consider the information and be able to respond and appropriate measures have been adopted, consultation has been carried out in accordance with section 34(g) of the OPGGS(E) Regulations.							
29. Bardi and Jawi Niimidiman Aboriginal Corporation (BJNAC)	Approximately 340km from the Crux Activity Area to closest part of BJNAC Country. The function of the RNTBC is to represent Traditional Owners and hold native title in trust. Jointly manage the Bardi Jawi Gaarra Marine Park with WA DBCA. Sea Country Cultural values Cultural Features Indigenous traditional activities (e.g., fishing) Have responsibility for Sea Country within the Kimberley Marine Park.	Spill risks have the potential to affect BJNAC's functions, interests, or activities.	Low, in accordance with Table 5 3. BJNAC's functions, interests and activities do not extend near the Activity Area. There are no planned impacts from Shell's activities predicted to occur to BJNAC functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and draft EP provided to BJNAC on 17 May 2023. Face to face meeting held on 15 August along with two other Aboriginal Corporations, (Walalakoo and Mayala) and a following face to face meeting on 25 August 2023 with a tailored presentation pack – Appendix A. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 – Appendix A	Shell has been engaging with BJNAC since March 2023, when an invitation to consult, face to face, on the EP was first sent. This included an offer to meet on-Country. In addition to this direct contact between Shell and BJNAC, KLC informed Shell that they had passed on EP information to BJNAC on 3 May 2023. From April through to August 2023, Shell and BJNAC exchanged emails with a focus on meeting, as well as putting in place a resourcing / consultation protocol (**protocol**) in relation to the broader relationship between the parties, (i.e., broader than consultation under regulation 11A). Shell provided comments and proposed amendments to the draft consultation protocol to BJNAC on 26 June 2023. Separately to the formal consultation protocol which is yet to be	Shell has been reaching out to BJNAC since March 2023. Sufficient information (such as factsheets and website links was provided to BJNAC in May 2023. A published version of the draft EP was available from August 2023. BJNAC had more than 5 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. BJNAC were also allowed reasonable time to consider the information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity. Shell has also agreed to pay reasonable costs to support their participation and attendance in consultation meetings.	Shell adopted location preferences for meeting in Broome. Shell updated its description of heritage values in the EP (Section 7.4.2.2.2) to incorporate information received. Shell also updated the risk assessment (Section 9.14.6.3). Section 7.4.2.2.3 noting that a number of the heritage sites in the Planning Area have not been recorded in Government databases. Shell committed to progressing a local spill response with BJNAC (Refer to Table 5-13).

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					agreed, Shell offered to cover BJNAC's reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel, and reasonable costs of time). Shell has also provided BJNAC with the contact details of independent environmental consultants, (paid for by Shell), to support BJNAC and other relevant persons in assessing information and providing feedback to Shell. On 10 July 2023, Shell brought to the attention of BJNAC the NOPSEMA Consultation on offshore petroleum environmental plans. A face-to-face consultation meeting between Shell and BJNAC occurred on 15 August 2023, along with two other Aboriginal Corporations (Walalakoo and Mayala). Shell paid Indigenous peoples' reasonable costs of participating and attending the meeting. This format of meeting with other groups was requested by BJNAC. At this meeting Shell explained the activities of the EP which may affect the functions, interests or activities of the groups. Shell also asked for input on particular values or features which may be affected by Shell's activities. As a result of input provided by BJNAC, the EP was updated as summarised in the 'Appropriate measures adopted' column in this Table. BJNAC did not raise any objection or claims related to the EP. A follow up meeting was held solely with BJNAC on 25 August 2023, where the consultation protocol to support broader engagement between Shell and BJNAC was discussed. Shell provided a further opportunity on 17 October 2023 for BJNAC to provide input to Shell for EP preparation. On 27 October 2023, Shell received confirmation from BJNAC that this email had been received. In its response, BJNAC suggested that consultation had not yet started. In a follow-up telephone call initiated by Shell on 2 November 2023, BJNAC contended that consultation would not formally start until a consultation protocol was in place with Shell. Shell disagreed with BJNAC's contention and noted that it had provided BJNAC	Shell considers that BJNAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell to raise any claims or objections or for further discussion	

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					sufficient information on the EP, and a reasonable period to consider this information and respond to Shell. On 7 November 2023, Shell restated in writing that BJNAC had been provided sufficient information on the EP and a reasonable period within which to respond. Shell reiterated that it would very soon be resubmitting the EP to NOPSEMA for further assessment. Further correspondence and meetings with BJNAC (19 January, 19 February and 24 May 2024) continued over the following months in relation to this EP, including advice that this EP would be submitted in February. Shell also met with BJNAC on 19 January 2024 and 19 February 2024. Shell received a letter on 13 May 2024 from BJNAC's lawyers raising concerns with consultation. Shell responded to this letter on 15 May 2024. Shell has been trying to progress a consultation protocol with BJNAC throughout the consultation period, as requested by BJNAC and in alignment with Shell's approach to developing genuine ongoing relationships with Traditional Owner groups. Shell held a face to face meeting with BJNAC and its lawyers on 20 June 2024 in Broome to discuss the consultation protocol in detail. BJNAC and Shell have not been able to reach alignment on this the consultation protocol as the current draft contains certain conditions that go over and above the requirements in the Regulations. Shell has been clear in its explanation around why this cannot be agreed. Shell has offered to cover all of BJNAC's reasonable costs related to consultation, to meet on country with culturally appropriate representatives, at an appropriate time as advised by BJNAC as well as offering access to an independent Environment Panel with costs covered by Shell. In relation to the individual mentioned in the Armal Legal Letter of 13 May 2024 which concerned the Development Drilling Project EP, Shell responded to that letter on 15 May offering to consult. The individual is a member of BJNAC, but has not been		

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					put forward by BJNAC as an RP in relation to this or any other Shell EP, and nor has that person self identified in relation to this EP. As per the terms of BJNAC's draft consultation protocol, BJNAC has made it clear to Shell that it is not appropriate to go around BJNAC and direct to their members. Shell sent further correspondence on 8 November 2024 to BJNAC and Arma Legal offering to consult with the individual, with no response at the time of writing. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potential relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP – Appendix A. Shell considers that BJNAC and the community it represents have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete and that Regulation 34(g) acceptance criteria has been met BJNAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to BJNAC's functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. The nature and scale of how BJNAC's functions, interests or activities could be affected is low. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Shell met with BJNAC in a face to face meeting where Shell presented sufficient information on this EP. BJNAC maintain Shell has not started consultation but Shell has (i) provided sufficient information to inform BJNAC how their functions, interests and activities may be affected; (ii) made reasonable efforts to consult; and (iii) provided a reasonable period for BJNAC to review information and determine if their functions, interests and activities may be affected, and provide feedback to Shell. Given the remote likelihood and scale of potential risks to BJNAC's functions, interests and activities, that sufficient information and a reasonable period for consultation has been provided and appropriate measures adopted, the EP demonstrates that the acceptance criteria in Regulation 34(g) have been satisfied.							
44. Mayala Inninalang Aboriginal Corporation (MIAC) (incl Mayala 2)	Approx 350km from the Crux Activity Area to closest part of MIAC. Represent Indigenous people located in the North Kimberley region of Australia. KLC is the NTRB for MIAC. Sea Country Cultural values Cultural Features Indigenous traditional activities (e.g., fishing) Have responsibility for Sea Country within the Kimberley Marine Park.	Spill risks have the potential to affect MIAC's functions, interests, or activities.	Low, in accordance with Table 5 3. MIAC's functions, interests and activities do not extend near the Activity Area for this activity. There are no planned impacts predicted to MIAC's functions, interests, and activities. They may be affected to a limited extent if a major spill event were to occur.	Fact sheets and draft EP provided to MIAC via the KLC on 3 May 2023 (Appendix A). Face to face meeting held on 14 August along with two other Aboriginal Corporations, (Walalakoo and BJAC) with a tailored presentation pack – Appendix A. Shell published in social media, radio and newspapers which were targeted at groups or individuals within this region from March to April 2023 – Appendix A.	Shell has consulted with MIAC since March 2023 when an invitation to consult face to face on the EP was first sent via KLC. The request suggested multiple ways which consultation could occur, from on-Country meetings through to attendance at Indigenous forums which were run at 3 locations (Appendix A). From March through to August, all consultation correspondence from Shell has been sent the KLC. In addition, during this time, Shell brought to the attention of MIAC the NOPSEMA Consultation on offshore petroleum environmental plans which Shell posted a link to on the EP webpage soon after it was published in May 2023, in order for	Shell has been reaching out to MIAC through KLC since March 2023. Sufficient information (such as factsheets and website) was provided to MIAC in May 2023. A published version of the draft EP was available from Aug 2023. MIAC had more than 3 months to review the information, and make an informed assessment about how their functions, interests or activities may be affected. It also allowed reasonable time to digest information provided and to access the offer of a consultant panel to support them in reviewing information and raising issues or input on Shell's proposed activity.	Shell adopted additional appropriate consultation measures, through feedback received in June and July 2023, from a Walalakoo representative (joint entity) (Refer to RP54 in Appendix C).

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					them to be sufficiently informed about the objective of consultation and their rights in the process. At their request, led by Bardi Jawi Niimidiman Aboriginal Corporation, a joint face to-face meeting was held with MIAC, Bardi Jawi Niimidiman Aboriginal Corporation and Walalakoo Aboriginal Corporation on 15 August, in Broome, at a venue and with representative participants of their choosing. At the meeting, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we currently are not aware of and some input was provided as a result of this (Refer to Appendix A and the measures adopted column of this table). Shell also offered to hold additional meetings at locations and with participants of MIACs choosing, but no response to this has been received. Shell provided a further opportunity on the 17 October 2023 for MIAC to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell asserted that sufficient information and a reasonable period had been provided for MIAC to provide a response, however Shell offered a further 10 days to provide the requested input, before Shell needed to make final preparations of the EP in readiness of resubmission of the EP to NOPSEMA. MIAC did not respond to the offer. From the end of March 2023, Shell undertook a targeted media campaign in the region, using print, geotargeted social media and radio ads. The campaign urged potential relevant persons to contact Shell and provided a link to the Crux project on the Shell website with access to draft Environment Plans. These materials enabled relevant persons to make an informed decision about how their functions, interests, or activities may be affected, and a mechanism to consult with Shell on the EP. Shell's further reasonable efforts to consult	Shell has also agreed to pay reasonable costs to support their participation and attendance in consultation meetings. Shell considers that MIAC and the community it represents have been afforded a reasonable period to understand how this EP impacts their functions, interests or activities and engage with Shell for further discussion.	

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which May Affect Relevant Persons Functions, Interests, or Activities	Nature and Scale of Affect on Relevant Persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview For a full summary of contact, see Appendix C	Reasonable Period Provided	Appropriate Measures Adopted
					with all these relevant persons has been demonstrated through offers to all relevant persons (Indigenous people or organisations) to cover all reasonable costs associated with attending consultation meetings/forums (e.g. accommodation, travel and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell (Appendix A). Shell considers that MIAC and the community it represents have been afforded a reasonable opportunity to consult with Shell in preparing this EP.		
Justification that consultation is complete. MIAC's functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to MIAC's functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Shell has provided sufficient information to inform MIAC how their functions, interests and activities may be affected, made reasonable efforts to consult, having met in a face-to-face meeting, and provided further opportunity for follow-up meeting if they wanted. Shell has also provided a reasonable period for MIAC to determine if their functions, interest and activities may be affected and to review information, with support offered by Shell through providing options for environmental consultants to support MIAC and provide feedback to Shell. Given the remote likelihood and scale of potential risks to MIAC's functions, interests and activities, MIAC has been provided sufficient information, a reasonable period to consult, having been sufficiently informed of the purpose of consultation and their rights in the process. Therefore, consultation has been carried out in accordance with Regulation 10A(g).							

Table 5-13: Tier 2 Indigenous Relevant Persons Consultation Completion Statement

Indigenous relevant person	Relevant person's Functions, Interests and Activities	Petroleum Activity Impacts and Risks which may affect relevant persons Functions, Interests, or Activities	Nature and scale of effect on relevant persons Functions, Interests, or Activities	Sufficient Information Provided	Consultation Overview	Indigenous relevant person	Relevant person's Functions, Interests and Activities
122. Balanggarra Aboriginal Corporation 81. Dak Djerat Guwe People 32. Djarindjin Aboriginal Corporation (DAC) 129. Larrakia Nation Aboriginal Corporation 105. Miriuwung and Gajerrong #1 (Native Title Prescribed Body	All more than 200km from the Activity Area to the closest part of native title interest and other known potential interests or activities. The NRTB's and Aboriginal Corporations represent the interests of the groups they represent and their Country, located coastally adjacent to the Planning Area.	Spill risks have the potential to affect the relevant persons functions, interests, or activities.	Low, in accordance with Table 5-3. There are no planned impacts from the Shell's activities predicted to occur to these relevant persons functions, interests, and activities. Their functions, interests and activities do not extend near the Activity Area. They may be affected if a major spill event were to occur.	Fact sheets and the draft EP were provided to relevant persons between April and May 2023. Follow up emails and phone calls where information was available were sent between April and October 2023. Shell published in social media, radio and newspapers which were targeted at groups or	All relevant persons have been provided with an EP factsheet and the draft EP between March and May 2023. The initial request to consult suggested multiple ways which consultation could occur, from face to face on-Country meetings through to attendance at face-to-face indigenous forums which were run at 3 locations. Shell's further reasonable efforts to consult with all these relevant persons has been demonstrated through offers to all relevant persons to cover all reasonable costs associated with attending consultation meetings/forums (e.g., accommodation, travel	Shell has been reaching out to these relevant persons since March 2023 and all of them have had all the information including the draft EP since May 2023. Reasonable period has also been allowed to disseminate and digest information provided and to access the offer of the independent consultant panel to support them in reviewing information and raising issues or input with Shell's proposed activity. Shell has also provided offers of financial support to help participate in the	Because of the lack of response from these relevant persons, this prompted a final attempt to reach the RNTBC, PBC or Aboriginal Corporation (refer to Section 5.6.4). In cases where a two-way dialogue did occur, in many cases, relevant matters were addressed through adopting appropriate measures within updates of EP content such as description of cultural values and features and associated environmental impact and risk evaluations. Refer to Appendix C for full details.

Corporate) Aboriginal Corporation RNTBC 119. Tiwi Land Council 530. Top End Aboriginal Corporation RNTBC 123. Wanparta Aboriginal Corporation 35.Joonbarm-Buru Aboriginal Corporation	Cultural heritage values Cultural heritage features Indigenous traditional activities (e.g., fishing)			individuals within this region from March to April 2023 (Appendix B).	and where appropriate reasonable costs of time) and also contact details for environmental consultants, some independent, paid for by Shell to support the relevant persons in assessing information and providing feedback to Shell. In addition, from the end of March 2023, Shell undertook a targeted media campaign in the region in which the relevant persons are located, using newspaper ads, geotargeted social media and radio. The campaign urged potential RPs to contact Shell and provided a link to the Shell website with details about the Crux project and the Environment Plan. These materials enabled RPs to make an informed decision about how their functions, interest or activities may be affected, and a mechanism to consult with Shell on the EP (Appendix B). More detailed consultation summaries and full text record for these relevant persons can be found in Appendix C. Shell considers that all these relevant persons and the communities they represent have been afforded a reasonable opportunity to consult with Shell in preparing this EP. **122. Balanggarra Aboriginal Corporation** (BAC) Shell has consulted with BAC since March 2023.Multiple emails were sent throughout March to May 2023 including factsheets and the draft EP. Multiple further attempts through phone calls and emails were made throughout September and October 2023 with no response. Shell provided a further opportunity on the 17 October 2023 for BAC to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell asserted that sufficient information and a reasonable period had been provided for BAC to provide a response, however Shell offered a further 10 days to provide the requested input, before Shell needed to make final preparations of the EP in readiness of resubmission of the EP to NOPSEMA. A follow up phone call was made on 20 October, confirming that BAC had received information directly and via the KLC. BAC did not respond to the offer. **81. Dak Djerat Guwe People** Shell has consulted with the DDGP through a phone call to their legal representatives and subsequent email providing sufficient information on 6 September 2023. It was confirmed by their legal representatives the information was passed onto the correct people. Shell followed-up DDGP on two	consultation process (e.g., forum attendance costs).	EP Section 7.4.2 updated to include reference to an underwater cultural site near Croker Island. Assessment of risks to cultural heritage (Section 9.14.6.3.1) amended to specifically identify areas around Croker Island. Table 10-8 includes requirement for Larrakia and JBAC to be notified in the event of an emergency spill event. Shell has also been made aware of the existence of songlines along the west Kimberly coastline as well as an ancient ceremonial site of the Bardi Jawi people underwater on the Dampier Peninsula coast (outside of the Planning Area).

					further occasions seeking any input they had on this EP. No input was provided. **32. Djarindjin Aboriginal Corporation** Shell has had ongoing dialogue with DAC since March 2023 when an invitation to consult on the EP was first sent to their CEO and Chairperson. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at Indigenous forums which were run at 3 locations. Direct contact was made with DAC staff in April 2023 when confirmation of attendance at the Indigenous Forum 1 was made by the CEO and Chairperson. DAC CEO and Chairperson attended the Indigenous Forum 1 held on 19 April 2023 and on the same day, detailed information and factsheets were provided. DAC Chairperson and CEO also attended Indigenous Forum 2 held on 10 May 2023 with follow-up factsheets and draft EP provided on 26 May 2023. A further face to face meeting was held with DAC on 27 March on Country. No new relevant matters were raised. Meaningful two-way dialogue and genuine consultation has occurred for several months. This is demonstrated in detail within the consultation summaries and full text records. **119. Tiwi Land Council (TLC)** Statutory function, activities and interests due to role as Land Council. Represents Tiwi people in the protection of land, sea, and environment. The TLC is responsible to ensure that activities on the Tiwi islands are undertaken only after consultation with the relevant Tiwi Clan group. The TLC is made up of four members from each of the Clan groups of the Tiwi Islands. At the request of the TLC, Shell met with the Council, including additional TLC employed subject matter experts (i.e., anthropologist and environmental advisor) on 26 May 2023. At the meeting, Shell explained the activities of this EP and the impacts and risks which may affect the TLC's functions, interests, or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we were not aware of (Refer to Appendix C). Multiple information requests were made by the TLC which were subsequently responded to by Shell. Shell also specifically requested for further meetings with clan groups of the Tiwi Islands, to which the TLC said it was important to first consult with the TLC and that the TLC would make a decision about the need for further consultation with clan groups of the Tiwi Islands based on an assessment of whether their functions, interests or activities may be affected. Shell		

					followed up with a further request to confirm the TLC's position on consultation with clan groups on 19 June 2023 and TLC responded on 11 July 2023 stating there were no further relevant matters to raise for the preparation of this EP. The following groups were considered to be consulted via the Tiwi Land Council: 91. Jikilaruwu (Bathurst Island) 101. Malawu (Bathurst Island) 102. Mantiyupwi (Bathurst and Melville Island) 104. Marrikawuyanga (Melville Island) 107. Munupi (Melville Island) 519. Wulirankuwu (Melville Island) 520. Wurankuwu (Bathurst Island) 127.Yimpinari (Melville Island) 120. Tiwi Marine Rangers 129. Larrakia Development Corporation (LAC) Shell has consulted with LAC since March 2023. At the meeting with the LAC representatives on 5 September 2023, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests, or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we may not be aware of to which they provided some input which informed the content of this EP (Refer to Appendix B and measures adopted column in this table). No further relevant matters or objections or claims were raised by LAC. **129. Larrakia Nation Aboriginal Corporation** Shell has consulted with Larrakia since March 2023. At the meeting with the Larrakia representatives on 5 September 2023, Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we may not be aware of to which they provided some input which informed the content of this EP (Refer to Appendix A and measures adopted column in this table). No further relevant matters or objections or claims were raised. **105. Miriuwung-Gajerrong (Western Australia)** Shell has been attempting to meet face to face with Miriuwung-Gajerrong since March 2023 when an invitation to consult on the EP was first sent to them directly and via KLC. The request suggested multiple ways which consultation could occur, from on-Country		

					meetings through to attendance at Indigenous forums which were run at 3 locations. Multiple emails and phone calls have been made directly to Miriuwung-Gajerrong and via KLC from March to October 2023, including provision of the EP fact sheet and the draft EP. KLC confirmed on 3 May 2023 that information has been sent to Miriuwung-Gajerrong. Shell has provided the opportunity for Miriuwung-Gajerrong to provide input to Shell for EP preparation, clearly restating the purpose of consultation, the request for their input on matters we may not be aware of, such as cultural values or features, or objections or claims they may have about the activity. Shell has provided sufficient information and a reasonable period for Miriuwung-Gajerrong to provide a response, however Miriuwung-Gajerrong has not raised any objections or claims, or other relevant matters related to this EP. **530. Top End Aboriginal Corporation RNTBC** Top End Aboriginal Corporation were consulted via the NLC, who Shell has been consulting with since March 2023 when an invitation to consult on the EP was first sent. The request suggested multiple ways which consultation could occur, from on Country meetings through to attendance at Indigenous forums which were run at 3 locations. On 20 June 2023, Shell called the Top End Aboriginal Corporation and spoke with a representative. Shell was advised that they are a legal entity only and represented by NLC. Communications with Top End can be directed through NLC but there is no specific representative to whom they will be sent. Board of Top End is constituted of members of NLC Executive. **123. Wanparta Aboriginal Corporation (WAC)** Shell has consulted with WAC since March 2023. At the meeting with the WAC board on 16 August 2023 Shell explained the activities of this EP and the impacts and risks which may affect their functions, interests or activities. Shell also asked for input on particular values or features which may be affected by Shell's activities which we may not be aware of (Refer to Appendix A). Wanparta provided information on cultural values which has been incorporated in section 7. **35.Joombarn-Buru Aboriginal Corporation** (JBAC) Shell has consulted with Joombarn-Buru Aboriginal Corporation since April 2023, when		

					event details for Forum 2 were shared. Further discussions occurred about the most appropriate way to consult. Shell confirmed it was open to organising culturally appropriate meetings. On 26 June 2024, Shell met with JBAC which including an update on this EP under ongoing consultation.		

Justification that consultation is complete.

All Tier 2 relevant persons functions, interests and activities are only potentially impacted by the spill risk from Shell's activities (through dissolved/entrained oil). Any impact to their functions, interests and activities is predicted to be slight. Other than source control options which are already planned to be implemented by Shell in the event of a spill, there are no other available options to directly mitigate or reduce the impacts of dissolved/entrained oil during spills which could occur from this activity. Therefore, further consultation is unlikely to improve risk management or further reduce the environmental impacts of a spill in accordance with the objects of consultation in preparing an EP. Shell took those relevant persons who did not respond to requests to provide feedback, which Shell then made further attempts by alternate available means to elicit a response up until October 2023. Shell has provided sufficient information to inform them how their functions, interests and activities may be affected, made reasonable efforts to consult with all of them, provided a reasonable period for them to determine if their functions, interests, and activities may be affected and to review information and provide feedback to Shell. Shell also adopted appropriate measures from input from relevant persons it did hear from through consultation. Given the remote likelihood and scale of potential risks to their functions, interests and activities, consultation has been completed in accordance with section 34(g) of the OPGGS(E) Regulations.

5.6.4.4 Consultation with Commercial Fisheries

Based on the nature of Commercial Fisheries and their interests, Shell approached consultation with these relevant persons separately to broader community consultation.

In addition to the processes outlined above for general community and industry consultation, Shell employed a variety of resources to identify and classify relevant commercial fisheries. This included fisheries that overlap the Planning Area, as well as fisheries whose interests or activities overlap the Planning Area but not the location of Shell's planned activities. Shell also determined that where licence holders are active or potentially active within the Planning Area, the licence holder should be engaged as a potentially relevant person to provide them with sufficient information to assess whether they have any interest in or may be impacted by Shell's proposed activities.

In summary, identification and consultation with commercial fisheries was conducted as follows:

- Government authorities (AFMA, DCCEEW, DPIRD, and NT DITT) were engaged regarding the proposed activity and engagement with relevant persons from commercial fisheries groups. Materials were made available by government authorities, including WA FishCube (fishing effort) data files and fishing reports.
- Fishing industry associations that represent fisheries with license areas that overlapped the Planning Area, such as WAFIC and Commonwealth Fisheries Association, were consulted with regarding the proposed activity and engagement with their members.
- WAFIC was engaged on a fee-for-service basis to engage with their members with regards the proposed activity and this EP.

Appendix C summarises the fisheries related feedback. Shell notes the advice from NOPSEMA to WAFIC (contained in the Appendix C) that confirms WAFIC's ability to carry out these duties. This summary includes acknowledgment from NOPSEMA that WAFIC is the appropriate body to carry out these duties. In addition, Shell consulted directly with licence holders in order to provide an additional means of assurance that all relevant persons had received sufficient information to assess the proposed activity in terms of their own interests and any potential impacts.

License holders in commercial fisheries were consulted using the following consultation methodology:

- Letters to WA and NT fishers of managed fisheries within the Planning Area.
- Email and letters via registered post to Commonwealth registered fishers.
- Tailored factsheets and information describing the proposed Activity, including relevant location coordinates.
- Consultation via WAFIC, including a virtual session for those seeking further information.

5.6.4.5 Titleholders and Operators

Email was used to consult with petroleum titleholders and operators. If there was no response it was assumed, they had no objection or comment on the proposed activity. This was considered reasonable effort as titleholders and operators have systems and the resources to consult on matters of interest to them.

5.6.4.6 Community and other

This encompasses the groups identified in the relevant person search under Commercial Operators, Interest Groups, NGOs, Community Groups, academic research or persons or organisations outside of Australia. Consultation undertaken was a combination of targeted emails containing factsheets and links to the Crux website, community drop-in sessions, targeted information sessions and a media campaign. This was considered a suitable approach to consult with this group given the low nature and scale of potential affects to a relevant person's functions, interests, or activities.

5.6.4.6.1 Community drop-in sessions

These sessions were held in accessible public locations in relevant communities and attended by Subject Matter Experts (SMEs) from relevant Shell disciplines.

Criteria for selection of locations for drop-in sessions was based on:

- whether there is a community located within or immediately adjacent to the coastal boundary of the Planning Area; and
- where there are several small communities in close proximity, the most populated community in these areas was selected as the representative location.

Awareness was generated via appropriate targeted public advertisements (both print and social media) for each session and information was also provided to local level government, local business chambers and community organisations for dissemination to amplify awareness. Sessions were supported with consultation materials for the Planning Area. Materials were appropriate to the audience to maximise their understanding of relevant EP activities (including activity description/location, the EP process and environmental management [potential aspect and proposed control]). The materials encouraged high-level two-way discussions between SMEs and attendees to ensure adequate consultation and opportunity for relevant persons to provide feedback and inform the EP. Materials included videos, fact sheets and maps.

Community Drop-in sessions were held in the following locations:

- Broome
- Darwin
- Port Hedland
- Derby
- Exmouth

To complement these sessions, proactive visits to local organisations, such as local Shires, chambers of commerce, local port authorities, Police, and tourism offices, at each of the above locations were completed to provide further opportunity for consultation. Shell also offered community sessions in the various locations above in order to provide an opportunity for relevant persons who may be interested in the activity set out in this EP but may be geographically located outside of the Planning Area to provide comments or feedback.

5.6.4.6.2 Targeted Information Sessions

In addition to community drop-in session consultation, Targeted Information Sessions were held with relevant persons from the community, including the business community (via chambers of commerce). A formal presentation on the EP was completed followed by an open forum discussion where attendees were provided with an opportunity to ask questions. These sessions also acted as an awareness amplification method for community drop-in sessions and the broader EP consultation process with potentially relevant persons. Information sessions were held in the following locations:

- Broome
- Darwin

5.6.5 Assessment of Merit of Objections and Claims

Shell's assessment of relevance and assessment of merit considers four broad categories:

1. objection or claim has merit – the objection or claim raised is relevant to both the planned activity and the relevant person's or organisation's functions, interests, and activities. The objection or claim has merit if there is a reasonable / scientific basis for related effects or impacts to occur and/or there is a reasonable basis for the objection or claim to be addressed in the EP.
2. objection or claim does not have merit – the objection or claim raised may be relevant to the planned activity or the relevant person's or organisation's functions, interests, and activities however, the objection or claim raised has no credible or scientific basis.
3. relevant matter – the matter raised does not fit the criteria descriptions for objections or claims with/without merit. However, the matter raised is relevant to the planned activity, comprises a request to Shell for further relevant information, or provides information to Shell that is relevant to the activity or the EP.
4. not a relevant matter – correspondence does not relate to the planned activity or the relevant person's, or organisation's functions, interests or activities being affected by the activity. Non relevant matters

may also be generic in nature with no specific issues raised (e.g., salutations, acknowledgements, meeting arrangements, etc.).

Appendix C contains Shell's assessment of the feedback received from relevant persons during consultation, the merits of objections or claims, measures adopted, and any changes incorporated into the EP as a result of the feedback.

In compliance with section 26(8) of the OPGGS(E) Regulations, sensitive information (if any) contained in an EP, as well as the full text of any response by a relevant individual to consultation under section 25 of the OPGGS(E) Regulations during the preparation of the EP, must be included in the sensitive information section of the EP and not elsewhere.

5.7 Summary of Consultation for the Environment Plan

Shell considers that consultation will be complete when:

- each relevant person has received sufficient information and reasonable time to assess the impacts of the activity on their functions, interests, or activities.
- all objections or claims have been discussed and, where reasonably practicable, resolved by Shell.

Appendix C summarises all consultation carried out with relevant persons during the preparation of this EP in accordance with section 25 of the OPGGS(E) Regulations.

5.8 Ongoing Consultation as part of EP Implementation Strategy

Consistent with section 22(15) of the OPGGS(E) Regulations, Shell will undertake consultation as part of the EP Implementation Strategy (refer Section 10), with the intent to acquire and preserve an up-to-date understanding of relevant persons' functions, interests, and activities during the execution of Shell's proposed activities. Specific ongoing consultation activities Shell has undertaken to carry out are set out in Table 5-14. It should be noted that this is not an exhaustive list of all ongoing consultation activities Shell may undertake in the future.

The ongoing consultation under the Implementation Strategy will enable Shell to maintain relationships with relevant persons and foster a continued improvement in Shell's understanding of the features and values of the existing environment, and where new risks or impacts are identified, the establishment of appropriate controls to reduce risks and/or impacts to ALARP.

Matters raised post-acceptance of the EP will be assessed as detailed in Section 5, to confirm if the matter raised is a relevant matter or if objections and claims have merit. Any new risks or impacts that are discovered through ongoing consultation will be subject to Shell's Environment MOC process, which considers the requirements of sections 26, 38 and 39 of the OPGGS(E) Regulations and establishes the mechanisms to assess change to the EP. Section 10.1.3 describes this MOC process in detail. Further ongoing consultation requirements, in the form of notifications of various kinds, are outlined within Sections 10.6.1 and 10.6.2.

Table 5-14: Ongoing Consultation Programme for the Crux Project

Ongoing Consultation Topic	Relevant Persons	Timing	Nature of Ongoing Consultation
Underwater cultural heritage survey will be progressively completed. Once completed, Shell will utilise the initial outputs as part of Shell's ongoing consultations in a culturally appropriate manner, with Indigenous people and organisations who want to help Shell better understand the tangible and intangible Cultural Values and Features within the Activity Area and Planning Area.	Consultation with relevant persons (including indigenous relevant persons and other organisations) on this topic will occur where they chose to voluntarily participate.	The underwater cultural heritage survey will be progressively completed throughout 2024 as agreed with relevant persons.	This ongoing consultation will occur through co-design, at the express preference of the relevant persons concerned. Where relevant persons are Indigenous People, it is anticipated this could be on Country of the relevant Indigenous persons.
Industry collaboration on Indigenous people involvement in oil spill preparedness. Given the program is a novel approach, the activity is planned to be a pilot project initially. Shell believes an industry collaboration with involvement from AMOSC (or similar organisation) is the best vehicle to progress this request in a mutually beneficial manner. Shell will seek to work with AMOSC in establishing an industry collaboration and if successful, progress ongoing consultation with traditional owners in the codesign of a suitable training program, with input from WA DoT, as the control agency for oil spill response within WA state waters.	It is not reasonably practical to implement a pilot such as this with many Indigenous people. However, Shell acknowledges the importance of ongoing consultation in relation to this matter with Indigenous people. Initially this pilot was offered to Bardi-Jawi people however due to competing priorities it has been discussed with other Indigenous people including Nyul Nyul people.	This is a long-term commitment, which is subject to the success of a pilot program. The establishment of this program commenced in 2023. Due to a number of influencing factors which are outside of Shells control such as appetite for industry collaboration, DoT's acceptance of the program (given they are the control agency) a more specific timeframe cannot be committed to. Shell has commenced planning, with initial Indigenous group engagement, industry engagement and DoT engagement (outside of EP section 25 of the OPGGS(E) Regulations consultation requirements) have started.	This ongoing consultation will occur through co-design, at the express preference of the specific Indigenous people.
Social Investment and Community Contributions: Where Shell has an operational footprint it provides a range of social investment and community contributions to create a positive legacy. Through consultation Shell heard from numerous relevant persons that social investment was important. Shell considered this and will raise greater awareness and invite participation in its existing social investment and community contribution programs for suitable relevant persons. Shell is also evaluating its social programs	• Kimberley Land Council • Bardi Jawi Aboriginal Corporation • Broome Shire (including Djarindjin community) • Nyamba Buru Yawuru • Darwin Community	Shell is currently implementing these social investment and community contribution programs and are continuing to build awareness and encourage participation in these on an ongoing basis. Engagement has commenced to inform the 2026-28 Social Investment Strategy inclusive of with Traditional Owner Groups in our operational footprint.	Ongoing consultation will be achieved through delivery of Shell's social investment programs and invitation to applicable relevant persons to participate / apply for community contributions when available.

(programs, budgets, and geographical reach) to achieve a greater reach. The programs are designed on the pillars of regional economic development, supporting stronger first nations and jobs for the future. Current programs being delivered or planned for 2023 include: - Kimberly Business Network - Supporting stronger first n leadership and governance program - Disaster Resilience fund - Deadly Sista Girlz - Bardi Jawi Oorany Women's Rangers - Rise up to Work Program: Nyamba Buru Yawuru - Preludes Communities Fund - Prelude to the Future Group Training NT - Indigenous Business Support Program NT These programs have been communicated to the relevant persons as part of the consultation to date and will play an ongoing role			
Local Content and supply opportunities were a topic of interest for numerous relevant persons during the community and Traditional Owner consultations. Shell is committed to giving Australian suppliers, local, regional, and Indigenous businesses genuine opportunities to participate in our supply chain. It uses a supplier portal to publish work packages and has dedicated staff resources to support Indigenous business to enter and then remain in Shell's supply chain.	• Bardi Jawi Aboriginal Corporation • Joombarn-Buru Aboriginal Corporation • Dambimangari Aboriginal Corporation • Broome Shire (including Djarindjin community) • Nyamba Buru Yawuru	Two full time Shell resources are responsible for this remit and will communicate relevant opportunities to the relevant persons as they arise and continue to raise awareness of potential opportunities via emails and phone calls.	Shell will continue to raise awareness of its supplier portal at all consultations. Supplier Information sessions will be held as required in the project support bases based on upcoming project and business demands to encourage local content via discussion of procurement categories and upcoming work tenders.
Shell will carry out ongoing consultations with Indigenous people in the Kimberley, adjacent to the Planning Area for the Crux		Subject to preferences of each specific group, Shell is aiming to set-up regular meetings with these Indigenous groups.	This consultation will be driven by the preferences of the Indigenous people e.g., cadence and on Country meetings.

Project, outside of this activity scope, to better understand cultural features and values of the environment to better inform current and future impact and risk assessments on the Crux Project.			
Where Indigenous people have identified cultural features and values which may be affected by major spills, Shell has committed to further ongoing consultation with them to better inform an effective response to mitigate the effects of a major spill, inclusive of potential impact to identified cultural features or values.	• Bardi Jawi Aboriginal Corporation • Walalakoo Aboriginal Corporation • Mayala Inninalang Aboriginal Corporation • Wanparta Aboriginal Corporation	Further consultation will occur in the event of a major spill which threatens the area where identified significant song lines and ceremonial sites occur.	This consultation will be driven by the preferences of the Indigenous people e.g., on Country meetings.
In preparation of this EP, DCCEEW requested that ongoing consultation with the Departments UCH Team occur in relation to activities that have the potential to impact UCH.	DCCEEW UCH Team	During the execution of the activity, where potential impacts to UCH are established.	This consultation will be driven by the discovery of potential impacts to UCH. To date, through relevant person consultation and the execution of a First Nations UCH Impact Assessment (Cosmos Archaeology 2023), no planned impacts to UCH have been established. Shell has committed to a chance find process as detailed in Table 9-35, which may trigger this ongoing consultation requirement, should a discovery be made. Additionally, through ongoing consultation with Indigenous persons, if an impact to UCH is established, Shell will consult the DCCEEW UCH Team.

6 Description of the Activity

6.1 Scope of the EP

This section describes the petroleum activity, including details of the location where the activities will occur, in accordance with section 21(1) of the OPGGS(E) Regulations.

This EP relates to the Crux installation and cold commissioning activities (referred to as the 'Activity'), which comprise the infrastructure listed in Table 6-1 and Table 10-2 lists the typical specifications. This infrastructure has been designed to support the production wells (with provision for future wells) and integrate into the existing Prelude FLNG facility. Section 6.5 to Section 6.7 summarise the key infrastructure, including a detailed description of the key infrastructure associated with the topsides facility, which will be operated under the future Crux Hot Commissioning, Start-up and Operations EP/s. Table 6-2 lists the work packages, the estimated schedule and the associated indicative key activities that comprise the Activity.

The key activities for this EP include:

- project vessel and other supporting operations (Section 6.8)
- installation and other supporting activities (Section 6.9)
- cold commissioning activities (Section 6.9.10)
- contingency activities, if required (Section 6.11)
- bunkering, refuelling and chemical transfers (Section 6.12)
- Inspection, Maintenance and Repair (IMR) activities (Section 6.13)
- staged preservation activities (Section 6.14).

Table 6-1: Key Infrastructure, Structure, Equipment, and Installation Aids

Summary of Key Infrastructure, Structure, Equipment and Installation Aids
~155 km of 26″ outer diameter (OD) pipeline
~170 m fibre-optic jumper
~360 m long static umbilical including Umbilical Termination Head (UTH)
12 (plus two contingency) insert piles (total weight ~5,000 t)
16 steel primary piles (total weight ~13,000 t)
2 Pipeline End Terminations (PLETs) (including subsea diverless connector) and PLET foundations
4 leg mating units (LMUs)
5 upper completions with 7″ production tubing
Electrical Flying Leads (EFL) and Steel Flying Leads (SFL)
five 10-3/4″ inner tie-back string, with a lower sleeve latching into the 10-3/4" production casing hanger wellhead profile
five 22″ outer tie-back string/riser, connected to the 18-3/4" high pressure wellhead housing
one 16″ flexible riser (~970 m long)
one dynamic umbilical (~1.1 km long) including UTH
one topsides (length ~106 m, width ~45 m) including decks, substructure to topsides interface, brace elevation launch rail, pig launcher and floatover slot
scour protection and span rectification structures (includes mattresses, skirts, mudmats and grout bags)
spools and mattresses
substructure (fixed steel lattice-type jacket ~28,000 t, ~ 190 m high, with pre-installed 26″ rigid riser)

Summary of Key Infrastructure, Structure, Equipment and Installation Aids
ancillary permanent equipment and structures (including bracelet anodes, continuity cables, buoyancy modules, clamps, bend restrictor, clump weight clamps, collars, UTH buoyancy units [if required], EFL/SFL basket and leads, j-tube, spools, hydraulic lines, umbilicals, centralisers and five dry Xmas trees) temporary installation aids and equipment (e.g. free-fall arrestor, underwater acoustic positioning, beacons, internal lifting tools, pile hammer and upending clamps, drilling rig setup, scaffolding, guideposts, guides, initiation anchor/structure, weighted waverider buoy (e.g. connected to clump weight), clump weights, Remotely Operated Vehicle [ROV] baskets, winches, turning bollards), EFL/SFL basket, flying lead deployment frame, transponder stands, pig launcher and receiver, grillages, sea fastenings, mooring lines [no seabed contact], fenders, guides, bumpers, mating equipment, survey equipment, grillages, tide gauge buoy, optical position and motion monitoring systems).

Table 6-2: Work Package Indicative Durations, Schedule and Activities and Applicable Tenure

Work package	Tenure	Estimated Duration	Estimate Execution Year				Indicative Activities
			2024	2025	2026	2027	
Install and cold commission the export pipeline	AC/PL1 and WA-33-PL	~5 months (split campaign)	No	Yes	Yes	No	project vessel and other supporting operation survey and inspections underwater acoustic positioning activities metocean monitoring scour protection and span rectification export pipeline installation Crux topsides tie-ins cold commissioning activities bunkering, refuelling and chemical transfers contingency activities, if required IMR, if required
Install and cold commission the Prelude–end flexible riser and umbilical	WA-33-PL	~6 weeks	No	Yes	Yes	No	project vessel and other supporting operation survey and inspections underwater acoustic positioning activities metocean monitoring scour protection and span rectification prelude-end flexible riser and umbilical installation cold commissioning activities

Work package	Tenure	Estimated Duration	Estimate Execution Year				Indicative Activities
			2024	2025	2026	2027	
							bunkering, refuelling and chemical transfers contingency activities, if required preservation period activities IMR, if required
Install the Crux substructure	AC-L10	~3 months	No	Yes	No	No	project vessel and other supporting operation survey and inspections underwater acoustic positioning activities metocean monitoring scour protection and span rectification Crux substructure installation cold commissioning activities bunkering, refuelling and chemical transfers contingency activities, if required IMR, if required
Install topsides	AC-L10	~6 months	No	Yes	Yes	No	project vessel and other supporting operation survey and inspections underwater acoustic positioning activities metocean monitoring Crux substructure installation topsides installation contingency activities, if required IMR, if required
Crux topsides tie-ins and cold commissioning activities	AC-L10	~2 years	No	Yes	Yes	Yes	project vessel and other supporting operation survey and inspections underwater acoustic positioning activities metocean monitoring scour protection and span rectification

Work package	Tenure	Estimated Duration	Estimate Execution Year				Indicative Activities
			2024	2025	2026	2027	
							Crux topsides tie-ins cold commissioning activities bunkering, refuelling and chemical transfers contingency activities, if required IMR, if required
Prelude modifications for Crux Tie-in (PMCT)	WA-3-IL	~2 years	Yes	Yes	Yes	No	modifications to the Prelude FLNG to enable future processing of Crux products on the Prelude FLNG and remote operations of the Crux facility from the Prelude FLNG. The scope is broadly captured below: • Turret Modifications; • Inlet Facilities Modifications; and • Instrument Control and Telecom (ICT) Scope
Staged preservation period	WA-33-PL and AC/PL1	~2 years	No	Yes	Yes	No	preservation period activities

6.2 Location and Tenure

The Activity Area is defined as the petroleum title AC/L10, WA-3-IL and pipeline licences WA-33-PL and AC/PL1, as shown in Figure 6-1. The coordinates, tenure and water depths of key infrastructure are listed in Table 6-3. As described within the Crux OPP, the pipeline route includes a 1 km buffer either side of the nominal pipeline route, and a slightly larger buffer (approximately 2 km), has been allowed at the Prelude end of the pipeline to allow for tie-in to the northern quadrant of the FLNG turret. All petroleum activities described within this EP will occur within the Activity Area.

A Petroleum Safety Zone (PSZ) for the Prelude FLNG turret (including riser base manifold, moorings and drill centre) was gazetted in 2015 (Commonwealth of Australia Gazette Notice: A441884) and a PSZ for the Crux Project (500 m radius around the substructure drilling template location) will be established.

The Activity Area is within Commonwealth waters, 200 km offshore north-western Australia and 460 km north-north-east of Broome, WA (Figure 6-1). Water depths range from ~90–260 m from mean sea level. The Activity Area is ~80 km from Cartier Marine Park, ~128 km from Ashmore Marine Park and ~80 km from Kimberley Marine Park (see Figure 2-1) and does not contain any emergent reefs/islands. The nearest island is Browse Island, which is ~42 km south-south-east of the Activity Area. The nearest shoals or banks are ~8 km from the Activity Area—Goeree Shoal north-north-west and Eugene McDermott Shoal east-south-east.

Table 6-3: Approximate Coordinates and Water Depths

Location	Tenure	Water Depth (~m)	Longitude	Latitude
Crux Production Licence	AC/L10	160	12°54′55″S	124°25′04″E
		95	12°54′55″S	124°35′04″E

Location		Tenure	Water Depth (~m)	Longitude	Latitude
			125	12°59′55″S	124°35′04″E
			180	12°59′55″S	124°25′04″E
Export pipeline	Start KP0–~KP78	AC/PL1	168	12°57′55″S	124°26′31″E
	End ~KP78–~KP154	WA-33-PL	250	13°46′52″S	123°18′59″E
Prelude FLNG	Prelude-end PLET	WA-33-PL	250	13°46′52″S	123°18′59″E
	Prelude flexible riser	WA-33-PL	250	13°47’11″S	123°19’03″E
	Prelude FLNG facility	WA-3-IL	250	13°47’11″S	123°19’03″E
Upstream flange Riser Emergency Shutdown Valve (RESDV) on Prelude FLNG[8]		WA-33-PL	N/A	13°47’11″S	123°19’03″E

[8] Coordinates are approximate and based on the Prelude FLNG turret centre nominal position, which may move slightly based on sea states and weather.

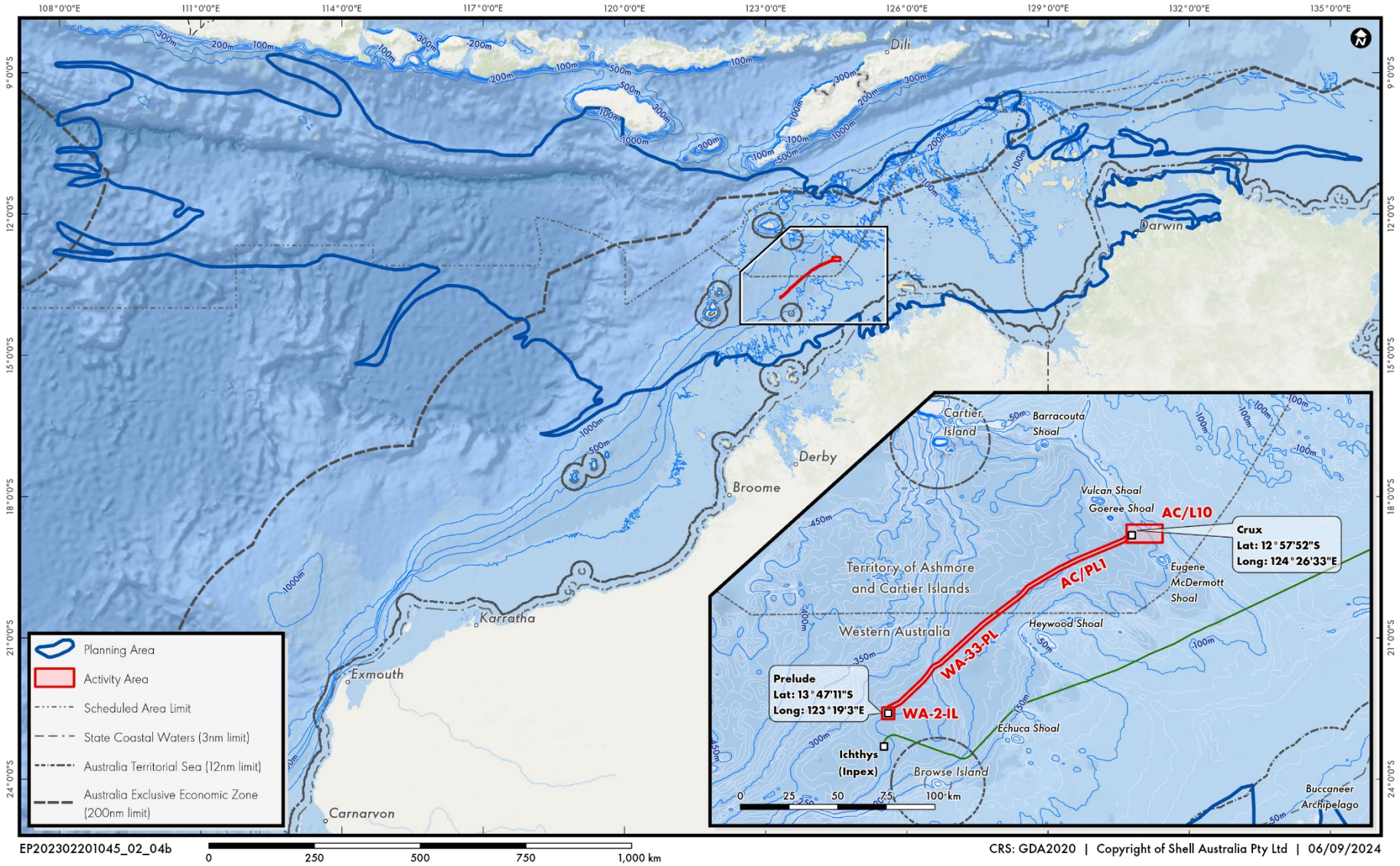


Figure 6-1: Proposed Activity Area

6.3 Timing

The Activity is scheduled to be undertaken from approximately Q4 2024 to the second half of 2027, pending regulatory approvals and project schedule interfaces. The Activity is estimated to be completed in approximately three years with activities occurring in multiple work packages. Table 6-2 lists the estimated duration and schedule for each work package—subject to vessel availability, operational efficiencies and weather conditions. Table 6-4 summarises the Activity schedule within each tenure.

Each work package will occur 24 hours a day, seven days a week—subject to operational and safety considerations. This EP was developed based on activities occurring at any time during the year to ensure all project planning scenarios were assessed. Cold commissioning and preserving the Crux Project infrastructure is critical to maintaining the integrity of the infrastructure before operations with produced hydrocarbons commence. While the infrastructure has been designed to minimise the need for inspection or intervention, certain events, such as third-party interaction or a severe cyclone, may require these activities to occur. This EP provides for IMR activities that may occur.

Table 6-4: Indicative Activity Schedule for Each Tenure

Tenure	Indicative Activity Schedule			
	2024	2025	2026	2027
AC-L10	No	Yes	Yes	Yes
AC/PL1	No	Yes	Yes	No
WA-33-PL	No	Yes	Yes	No
WA-3-IL	Yes	Yes	Yes	No

6.4 Titleholder and Liaison Person

Table 6-5 lists details of the titleholder, liaison person and arrangements for notifying of changes, in accordance with section 23 of the OPGGS(E) Regulations.

Table 6-5: Details of Titleholder and Liaison Person

Titleholder Details	Liaison Person Details
Company Name: Shell Australia Pty Ltd	Name: Rama Gunturi
562 Wellington St, Perth WA 6000	Position: Crux Project Director
Phone: (08) 9338 6600	Phone: (08) 9338 6600
ACN: 14 009 663 576	Email: SDA-crux-project@shell.com

If the titleholder, titleholder's nominated liaison person or the contact details change, Shell will notify NOPSEMA (in writing) of the change within two weeks or as soon as practicable.

6.5 Pipeline and Subsea Infrastructure Description

The Crux pipeline is laid between the Prelude and Crux PLETs and the pipe sections are welded together. This pipeline is comprised of the following components, all of which has been designed for full removal as further detailed in Table 10-2:

- A 26" outside diameter corrosion resistant alloy rigid riser from the RESDV on the Crux platform topsides to the base of the jacket structure.
- A 26" outside diameter corrosion resistant alloy tie-in spool connecting the Crux riser and PLET.
- A PLET which includes a subsea isolation valve SSIV located near the Crux platform.
- A welded 26" outside diameter concrete coated carbon steel export pipeline of approximately 155 km length. The pipeline crosses the Offshore Area of the Territory of Ashmore & Cartier Island and the

Offshore Area of Western Australia. The pipeline design includes a series of scour protection and span rectification structures (including mattresses, skirts, mud mats and grout bags).

- A second PLET inside the Prelude 1500 m petroleum safety zone, which also includes a SSIV.
- A 16" inside diameter flexible riser that transports fluids from the seabed to Prelude topsides and terminates the pipeline facility at the upstream flange of the RESDV in the Prelude turret.

Other subsea infrastructure including electrical flying leads, steel flying leads, static and dynamic umbilicals, and umbilical termination heads; in addition to, ancillary equipment and structures including bracelet anodes, continuity cables, buoyancy modules, clamps, bend restrictors, clump weight clamps, collars, buoyancy devices, spools, hydraulic lines, umbilicals, centralisers, and related piping components. Small, localised discharges of fluids may occur during operation of subsea valves.

The topsides will be controlled and operated remotely via a fibre optic connection to the existing Fitzroy fibre optic cable, with back up communication by satellite communications (VSAT). A Closed-Circuit Television (CCTV) system provides a visual feed back to the control room.

6.6 Crux Substructure Description

The Crux substructure is part of the hydrocarbon system and consists of a jacket substructure (approximately 190 metres high and approximate gross weight of 24,000 tonnes) fixed to the seabed with piled foundations (approximate weight 18,000 tonnes) which penetrate approximately 155 metres in the seabed. The topsides are fixed to the substructure and supports all processing equipment (approximate length 106 metres, approximate width 45 metres, and approximate gross weight 12,000 tonnes). The substructure is positioned above the wellheads on the seabed, the tie-back risers connecting the wells to the dry trees on the topsides are supported and protected by the substructure. The substructure also supports the rigid riser from the export pipeline. The five production wells are contained within the footprint of the steel jacket substructure.

6.7 Platform Topsides Description

The following gives a detailed description of key components of the Crux topsides facility, which are constructed outside of Australia and installed at Crux as a single facility as described within Section 6.9.8. Appendix A provides additional detail on the environment in design considerations and outcomes. This EP covers the installation of the topsides facility (Section 6.9.8) and associated cold commissioning and contingent activities (Section 6.9.10 and Section 6.11). The hot commissioning, start-up and operation of the topsides facility are subject to future EP submission/s and do not form part of this EP.

6.7.1 Hydrocarbon Process Description

The topsides have been designed to export approximately 550 million standard cubic feet per day of hydrocarbons per day to Prelude FLNG primarily in the form of multiphase dehydrated gas and condensate, consisting of the following key functional components (refer to Figure 6-2):

- Five dry tree wells producing gas, condensate and associated well fluids.
- Bulk liquids and gas separation to divert each phase off for separate processing.
- Gas dehydration using triethylene glycol (TEG) to dehydrate the gas component.
- Condensate bulk water removal to remove water from hydrocarbon condensates.

The separated and dehydrated gas is commingled with the condensate prior to exporting to Prelude FLNG as a multiphase hydrocarbon stream. The export stream may contain residual free water and chemicals injected in the process and associated hydrocarbon components. Some of the key functional components of the topsides that support the hydrocarbon process include:

- Gas Turbine Generators (GTG) for power generation for all topsides electricity users.
- Black Start Diesel Generator (BSDG) to provide power to start-up the topsides from a depressurised state.
- Low Pressure (LP) and High Pressure (HP) flare system to safely dispose of hydrocarbons that cannot be exported.
- Produced water treatment system to remove dispersed oil from separated condensed and formation water.

- Segregated drains system and open drain separator to remove dispersed oil for drain water emanating from potentially hydrocarbon contaminated areas.
- Chemical injection system to manage materials integrity, flow assurance and oil in water separation, as required.
- Diesel, service water, nitrogen, and propane utility systems.

Engineering assessments enabled the project to eliminate gas compression equipment from the design benefiting simplification, reliability, NNM functionality and emissions reduction (by significantly reducing power generation demand / fuel gas consumption). Crux design does make provision for the installation of a future compression module if required for future operating modes. Crux has not designed compression equipment for flash gases.

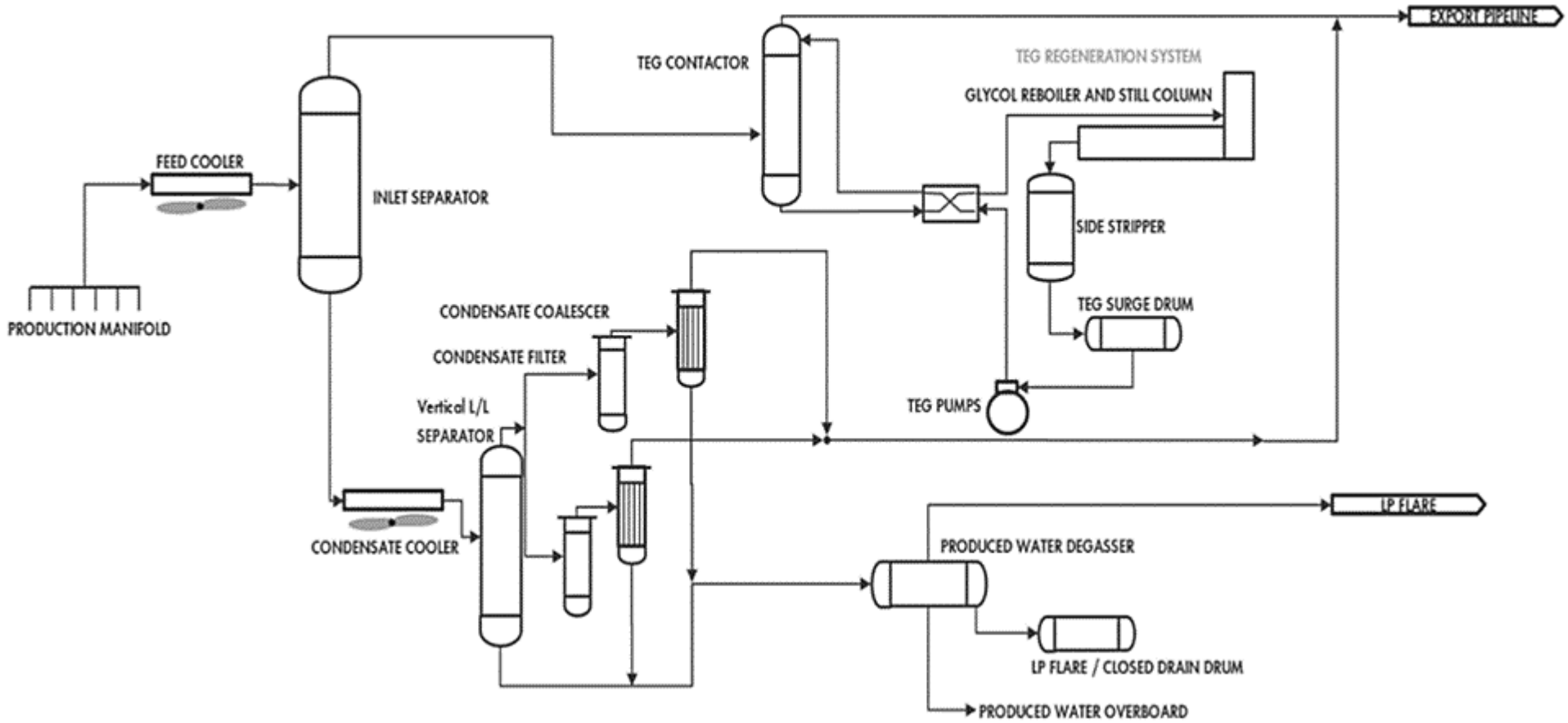


Figure 6-2: Simplified topsides process flow

6.7.2 Layout

The Crux platform topsides consists of a sub-cellar deck, cellar deck with mezzanine floor, main deck, and an upper main deck with use of plated and grated decking depending on environmental and safety drivers. A helideck is installed for campaign visits, unplanned visits, and medical evacuation purposes, and will be in use through all activity phases. Laydown areas are provided on the upper main deck, main deck, and on the cellar deck including additional crane and wells laydown areas. An electrical equipment and battery room is located on the cellar along with an electrical transformer area, temporary refuge equipped with telecoms and instrumentation. Equipment and workshop buildings, temporary laboratory and drone launchers are also located on the main deck. The cellar deck includes bunkering hoses for TEG, service water and diesel, and spare J-tubes and spare topside umbilical termination assemblies for future subsea tiebacks or subsea developments, and provisions for future produced water treatment hydrocyclone system, export pipeline pig launchers, produced water pumps and future sewage treatment (for future living quarters module). Future development to the Crux platform may require subsea wells and subsea tieback to the platform.

6.7.3 Wells, Chokes and Production Manifold

The five production wells are contained within the footprint of the steel jacket substructure. Each well is connected to a Xmas tree on the topsides (i.e., 'dry tree'). The fluid flow from the wells is controlled via motor actuated choke valves and flow controllers that can be remotely controlled. These controllers take their measured variables from individual wet gas venturi flowmeters on each flowline and include a water cut meter to detect formation water break through. The flow from the five wells is commingled in the production manifold prior to being routed to the inlet cooler and inlet separator. End flanges are provided on the production manifold for potential future subsea tiebacks. A surface-controlled subsurface safety valve is designed to reliably shut-in each well (fail safe) if a catastrophic event occurs, allowing operators to maintain safe operations and reduce potential for hydrocarbons loss of containment. During initial start-up, the inlet system is designed to enable well clean-up directly from the wellheads to temporary chokes, piping, and equipment, with the produced fluids disposed of via a temporary flare system. A Hydraulic Well Control Unit provides the hydraulic power for opening of the well valves.

6.7.4 Inlet Cooling and Gas Separation System

The well fluids are cooled in the electric inlet air cooler downstream of the production manifold to cool production fluid thereby reducing gas water content and water load on the TEG contactor, reduce the design temperature of downstream equipment and protect the coating on the export pipeline riser. The cooled gas, condensate and water mixture enters the vertical inlet separator for gas and liquid separation to remove liquid from the gas. Following reservoir fluids gas / liquid separation in the inlet separator, gas is sent to the dehydration system, and the fluids to the liquid separator. The electric air cooling was designed to avoid the need for seawater cooling (and subsequent treatment and discharge) with lower maintenance requirements for minimally manned operation.

6.7.5 Gas Dehydration System

Dehydration is required to prevent water condensation (which can cause corrosion) or hydrate formation in the export pipeline and at the Prelude FLNG facility. Gas from the inlet separator is routed to the TEG contactor vessel where it is dehydrated to the export specification by counter-current contact with lean TEG (wet gas flows upward through a structured packing section which provides a large surface area where it contacts the descending lean TEG). Dehydration is required to prevent water condensation or hydrate formation at Prelude FLNG facility and in the export pipeline. TEG is regenerated for reuse in the TEG regeneration system. Fuel gas is also taken off the TEG contactor, passed through a scrubber, coalescer and superheater, then distributed to the gas turbine generator for power generation and other fuel gas users on the topsides.

6.7.6 TEG Regeneration System

The TEG regeneration system uses a reboiler to regenerate the rich TEG from the TEG contactor by removing water (as well as residual hydrocarbons). The TEG reboiler heating uses an electric heating bundle, which provides the bulk of TEG regeneration. However, the required moisture content cannot be reached by a reboiler alone, therefore dry low pressure fuel gas from the topsides fuel gas system is used as stripping gas to remove the remaining water in lean TEG, therefore enabling supply of renewable lean TEG for reuse in the TEG contactor. The fuel gas also performs as safety blanketing gas through the system. During this process, off gases are flashed off the TEG flash drum to the low-pressure knockout drum. TEG filters and activated charcoal filters are installed downstream of the flash vessel to provide to enhance removal of residual hydrocarbon, removal of well treatment chemicals and degraded TEG. Off gas from the stripping gas process is also routed from the TEG still column to the LP flare, downstream of the knockout drum to avoid introducing

residual TEG and soluble hydrocarbons into the LP flare Knockout (KO) drum. Lean TEG is stored in a TEG storage vessel to cover TEG consumption that will require periodic replacement and replenishment with renewable supply of lean TEG delivered to the topsides.

6.7.7 Condensate Dehydration System

The liquids from the inlet separator are sub cooled by the electric fan liquid cooler with energy efficient variable speed drives. The liquid cooler is provided to reduce the level of dissolved water in the condensate, by separating it out as free water, and sub-cool the condensate to prevent vapour break out which can affect coalescer performance adversely leading to water carry over in the condensate. After the cooler, the liquids are routed to the liquid separator to separate the produced water from the condensate (bulk water removal), with the condensate then routed to the condensate filters and coalescers to appropriately dehydrate the condensate prior to being sent to the export pipeline. The condensate filters remove solids and protects the subsequent condensate coalescers and therefore may accumulate environmental hazardous contaminants for consideration during disposal. The coalescers are horizontal cartridge type coalescers and are designed to reduce the free water in the condensate stream to meet the water specification of the export pipeline. The dehydrated condensate is sent to the export pipeline and the produced water to the produced water treatment system. A water-in-oil analyser is provided on the line to the export riser and pipeline to monitor the quality of the condensate, and a flowmeter and flow totaliser are installed in the line to the export riser to measure the total condensate production.

6.7.8 Produced Water Treatment System

The produced water treatment system is designed to remove dispersed hydrocarbons from the produced water (to a concentration of ≤30 mg/l dispersed oil-in-water) and to dispose of the treated produced water overboard. The system is designed for the full range of flows and conditions expected during field life from zero flow to ~19,020 b/d (~3,029 m^3). The predicted flow is from ~400 to 1,500 b/d (~69 to 235 m^3/d) expected in early to mid-field life (comprised mainly of condensed water), up to ~19,020 b/d (~3,029 m^3/d) (comprising condensed and formation water) that may be experienced later in field life (in the event there is breakthrough of formation water). Process chemicals that may partition into the degasser and water discharge stream include residual MEG during well start-up for hydrate inhibition and for opening valves; clarifier or demulsifier if injected into the degasser to aid oil-water separation, and scale inhibitor if injected into the wellhead at any stage in the future (refer to Section 6.7.14).

The system includes a produced water degasser, which is a liquid-liquid separator with additional treatment by a Dissolved Gas Flotation (DGF) system that passes gas through gas dissolving tubes to provide enhanced dispersed oil removal. The DGF system requires fuel gas to dissolved and injected into the degasser, where the fuel gas bubbles out and strips out entrained oil, enabling the produced water treatment system. Once the oil water separation has been enhanced, the off gas from the degasser is routed to the LP flare which consists of off gas generated in the degasser plus fuel gas remaining after passing through the gas dissolving tubes. The oil separated and recovered in the degasser is routed to the LP flare liquid header and therefore the LP flare KO drum.

The degasser vessel is provided with nozzles to allow a temporary sand cleaning package to be connected for sand bagging and removal during platform turnarounds or as required. Produced sand that accumulates within the vessel will be mobilised using the nozzles to prevent the sand hardening, such that removal is possible during the maintenance campaigns.

Two independent Advanced Sensors EX-1000M online oil-in-water analysers (which include microscopy for dispersed oil measurement) monitor the oil concentration of the produced water discharged overboard with high alarms connected to the Distributed Control System (DCS). These analysers have the flexibility to be operated either both online, or one online and one on standby. Each analyser has two sensors; the first uses laser induced fluorescence to measure mainly the aromatic proportion of hydrocarbons which fluoresce, while the second uses microscopy for measurement of the dispersed oil-in-water concentration which is directly comparable to the project limit of ≤30 mg/l dispersed oil-in-water. The analysers can be fully monitored remotely. In addition, a flow meter and flow totaliser are installed in the line overboard to measure the total produced water discharge flow with a manual sample installed. The system also includes switchover valves than enable the produced water flow to be routed to the LP flare KO drum (instead of overboard). The platform provides space and weight provision on the cellar deck for the installation of another produced water treatment package should this be required in the future to in order to meet required discharge specifications in future.

6.7.9 Fuel Gas System

The fuel gas system takes process gas for use as fuel gas, which is supplied to the following consumers:

- Power generation gas turbines.
- TEG regeneration stripping gas and blanket gas.
- Produced water gas dissolving tubes.
- HP and LP flare headers purge gas.
- Flare ignition pilot gas.
- MEG storage vessel blanket gas.

The fuel gas is taken from the outlet of the TEG contactor, where it is pre-heated, passed through a scrubber and filter coalescer, to remove any liquids or solids, before finally passing through a superheater to ensure no moisture in the fuel gas prior to distributing to the users. Fuel gas can also be imported from Prelude FLNG to start-up the GTGs (referred to as backflow). This backflow will be undertaken in hot commissioning phase, and any subsequent activity phase during platform start-ups to pressurise the topsides and bring the topsides fuel gas and power generation system into stable, efficient operating mode. In these circumstances, for the initial and subsequent start-ups, when the facility is in a depressurised state, gas from the export pipeline is routed directly to the fuel gas system thus allowing the HP/LP flare systems and the GTGs to operate without the topsides being pressurised. The topsides can also be pressurised with gas from the export pipeline via the Fuel Gas Preheater. Fuel gas distribution to all major users is monitored by flowmeters and flow totalisers.

6.7.10 Flare System

The flare is approximately 118 m above the mean sea level and approximately 81.4 m above the deck level. The facility is provided with HP and LP flares:

- HP Flare System – to safely dispose of emergency streams; and
- LP Flare System – to safely dispose of low-pressure streams.

The main streams for each flare system are:

- HP Flare:
  - Pilot fuel gas (continuous during normal operation).
  - Purge fuel gas (continuous during normal operation).
  - Start-up and blowdown flared gas from all hydrocarbon system components (intermittent).
- LP Flare:
  - Pilot fuel gas (continuous during normal operation).
  - Purge fuel gas (continuous during normal operation).
  - TEG regeneration off gas (continuous during normal operation).
  - Rich TEG flash drum off gas (continuous during normal operation).
  - Produced water degasser off gas (continuous during normal operation).
  - DGF fuel gas (continuous during normal operation).

The HP flare system is designed, in case of emergency, to enable depressurization of the facilities in a sufficient time that reduces the risk of vessel failure and loss of facility integrity. The LP flare is designed to dispose of routine relief and off gases. Each system includes a flare header with liquids knockout drum prior to the exit of gas through the flare boom pipework where the waste gas is combusted in separate HP and LP flare tips. The LP flare KO drum also receives liquids separated out and recovered from the produced water degasser vessel, rich TEG flash drum intermittently, and closed drains and is purged with fuel gas. Gases from the LP flare knockout drum are routed to flare, liquids can be routed back to the production manifold for reprocessing or routed to the waste oil storage tank.

The flare tips are designed for efficient combustion of ~98% over the anticipated flow ranges for continuous flaring, for the remainder of flaring (start-up/shut-down) combustion efficiency is assumed to be ~98%. The height of the flare tips and structure is governed by personnel safety considerations (to maximise dispersion and minimise thermal radiation to protect personnel on the platform). Fuel gas is used for the flare pilots, and a remotely triggered flare ignition package is provided; with primary flare ignition provided by a high energy

ignition (HEI) system, whilst manual remote back-up flare ignition is provided by a flame front generator (FFG) system. Both ignition systems are selectable, self-sufficient, and independent of each other. The FFG is used to create a flammable gas/air mixture within the flame front line. When this mixture completely fills the line between the flare ignition package and the HP or LP flare tip, a spark is produced in the ignition chamber automatically and the flammable mixture is ignited. The resulting flame front travels through the mixture and will arrive at the flare tip where it will discharge via the pilot nozzles and ignite the pilot flames.

Each pilot is fitted with a flare pilot monitoring system, which includes thermocouples for automatic pilot flame monitoring. The pilot status is displayed on the DCS and by red/green lamps on the front of the flare ignition panels. A CCTV thermal imaging camera provides visual flame indication to the operator, with analytical software that will automatically detect flare tip flame out. In case of loss of main power this will be powered by the 90 minute Uninterruptable Power Supply (UPS) battery system. Thermocouples are used for primary flame detection, and a fixed thermal CCTV camera with automatic flame detection software is used as backup. The flare pilots also have backup propane gas supply for up to approximately 72 hours. Ultrasonic flow meters are installed on both the HP and LP lines to the flare tips to measure the total gas flow to each flare tip. All flare monitoring and detection systems enable the flare systems to be remotely monitored and controlled from Prelude FLNG or the IOC using a combination of visual imagery, status lamps and alarms in the control room. The back-up flare ignition flame front generator (FFG) system can be remotely initiated from Prelude FLNG or the IOC.

The HP and LP flare headers are continuously purged by fuel gas to prevent air ingress into the system. On loss of fuel gas for purge gas, back-up nitrogen (inert gas) is provided for a limited duration. There is continuous low-pressure flaring from the LP flare when the TEG regeneration and produced water systems are in operation (in addition to the pilot and purge gas). There will also be intermittent flaring associated with starting up the fuel gas system and GTGs, during initial start-ups to test the emergency systems, and for facility shutdowns, trips and restarts throughout all activity phases. Flaring may also occur for uncertain periods for the time required to achieve stable operation during initial start-up and ramp-up activities, and any subsequent start-up during development life.

Nitrogen, supplied via the normal flare header purges, is provided to allow the flare headers to be swept immediately prior to hydrocarbons being introduced to the flare header during the restart process following a shutdown (and upon initial or subsequent start-ups).

In terms of the flare streams described in this section, to differentiate between the gas stream required to maintain a lit flare pilot (for safety reasons) and other continuous operational streams, the following information has been provided using classifications that are consistent with the definitions utilised by the World Bank, IPIECA, and GHG Protocol and quantification of tonnes carbon dioxide equivalents (CO_2-e) consistent with global warming potentials and emission factors from the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and National Greenhouse Account Factors, based on Operating Plan production estimates is as follows:

- Purge and pilot gas for LP and HP flares ~1% of the total GHG emissions from flaring (or ~0.01 $MtCO_2$-e over field life) as required to maintain a lit flare and safely purged piping system.
- LP flaring of offgas from the TEG system ~57% of the total GHG emissions from flaring (or ~0.549 $MtCO_2$-e over field life) as required to safely dispose of offgas from TEG regeneration.
- LP flaring of offgas from the produced water system ~23% of the total GHG emissions from flaring (or ~0.098 $MtCO_2$-e over field life) as required to safely dispose of offgas from the produced water system degasser and dissolved gas flotation during oil in water removal.
- HP flaring from shutdowns and restarts ~19% of the total GHG emissions from flaring (or ~0.313 $MtCO_2$-e over field life) as required to safely dispose of high-pressure gases.

The platform has been designed with a pressure relief system that is ensures the safe disposal of hydrocarbons by combustion in the flare rather than cold venting, and therefore there are no planned venting activities. There is potential for fugitive releases to the atmosphere from platform equipment. Sources include process vessels and tanks, breathers, valves, piping components, analysers, instrumentation, piping connections, well test and workover equipment, HVAC systems, and switchgear.

6.7.11 Power Generation System

The power generation system comprises three Solar GTGs (rated at approximately 2.8 MW each) which provide the main source of platform power when in steady state operations, a BSDG (rated at approximately 800 kW), and a battery powered UPS. The thermal efficiency is assumed to be ~27.9% which depends on the

operating conditions and can vary based on factors such as ambient temperature and the load factor. The system is designed to API Standard 616 Gas Turbines for Petroleum, Chemical, and Gas Industry Services and the basis of design for the platform and system is specified to meet a target system reliability standard of 99.81% (3 x 50% GTG configuration with one GTG in cold standby mode), and across all equipment ~97% with assumed three unplanned topsides visits per year. A large range of factors affect availability and Shell manages this by reliability, availability and maintenance assessments which support optimisation of maintenance schedules and intervention strategies and development maintenance and logistics plans.

Temporary diesel generators (various rating from small units up to approximately 1200 kW) will also be utilised on the platform topsides throughout all activity phases to provide additional power demand as required for completions, hot commissioning, start-up, and operations activities including minor and major maintenance and repairs, refurbishment, turnarounds, well interventions and workovers. During completions, hot commissioning, and start-up, two temporary diesel power generators of approximately 1200 kW each (primary and backup) may be in operation to supply temporary electrical loads during these phases, in addition to standalone temporary generators used by the completions spread contractor.

Users of electrical power include the TEG reboiler (Section 6.7.6), electric motors for pumps, air cooler fans (etc), fuel gas heater (Section 6.7.9), utilities such as air compressors and Heating, Ventilation and Air Conditioning (HVAC), electric crane, lighting, small power and the UPS battery units. Intermittent and temporary users through all activity phases may also include temporary engines, pumps, compressors, lighting, small power, and batteries, as required.

Under normal conditions, two GTGs will be in operation with a spinning reserve for each running GTG while the third unit will be on cold standby (therefore not combusting fuel). In the event of failure of one GTG, the fast load shedding system removes sufficient non-critical loads to match the remaining generated power until the standby unit is up and running, thus avoiding a shutdown scenario. Given the remote location and improved efficiency, the GTGs are equipped with conventional burners, and fuel gas consumption is metered for each GTG.

The BSDG provides power to the platform when no production gas is available to generate electricity from the GTGs, when the production is shut-down and depressurised. The BSDG may also provide emergency power when an emergency shutdown is initiated, and the production process is shutdown, plus provide power to temporary users during all activity phases.

The UPS units will provide for backup power for critical items, instrumentation and telecom loads in the event of loss of power from the GTGs. These systems are essential for safe monitoring and control of the production process and for essential communications. Battery power is provided for functions such as emergency shutdown and depressurising systems; DCS functions required to monitor blowdown; UHF, marine VHF, public address, and platform audible alarms; status lights; emergency and escape lighting; switchboard assembly (e.g., protective relays, auxiliary relays, etc.); fire and gas detection and alarm systems; CCTV; DCS functions required for fire and gas, communications, and remote black start; SOLAS communications equipment; and satellite or fibre optic telecommunications system functions required for remote operation/monitoring; navigation aid systems (which also have solar power).

The platform has a Power Management System which is part of power generation package required to gather real time data and balance the generation & consumption on Crux platform, load shedding functionality, load-sharing, remote switching operation and interfaces with high voltage protection modules. An electrical distribution system (including transformers and cables) is installed to distribute power to the electrical users via high voltage and low voltage distribution switchgear.

The GTG and BSDG both have fire suppression / water mist systems delivered by the service water network and the GTGs a periodic water wash system including engine cleaning vessel located on the main deck (that may use imported demineralised water) to remove deposit built-up on the GTG blades.

6.7.12 Open Drains System

The system is segregated into following categories based on drain source (refer to Figure 6-3):

- Oily water open drains
- Chemical open drains
- Overboard open drains.

The oily water open drain system is open to the atmosphere and is designed to safely collect, contain, remove oily water in an open drains separator, and therefore dispose of deck run-off and liquids from potentially

oil/hydrocarbon contaminated surfaces (which may be in hazardous or non-hazardous area classifications) as a consequence of storm events, accidental spillage or washdown. The open drains separator is a horizontal three-phase separator with a single weir arrangement (for liquid-liquid separation), and a plate pack for oil droplet removal. The only continuous influent to the open drain separator is the small stream from the produced water oil-in-water analysers which discharges reject sample water. All other influents to the open drain separator occur during rainfall events, washdown/jetting operations when manned, or following accidental spills and any subsequent responses such as suppression mists.

The first flush of stormwater from potentially contaminated areas will be captured for treatment; drainage water above the first flush will be considered clean and discharged directly overboard via overflow piping in the system. The wellbay area is classified as potentially oil contaminated when well activities are being undertaken and provided with containment for that period, but otherwise in normal operations classified as not contaminated (overboard drains).

The chemical open drain system is designed to safely collect and contain TEG/ chemical contaminated liquids to prevent these liquids from being discharged overboard (given chemicals are not removed in the open drains separator). Deck drains, bunds, and tundishes from all areas with inventories of water soluble or high specific gravity chemicals (including TEG) are routed through the TEG / chemical drain system to the oil bucket of the open drains separator, and the collected fluids disposed to the waste oil storage tank for disposal onshore.

The overboard open drain system is open to the atmosphere and is designed to safely collect, contain, and dispose of deck run off water from non-hazardous areas. Non-hazardous area open drain liquids are considered uncontaminated with oil, and as such are routed directly overboard for both rainfall and washdown events. During periodic testing or actual emergency use, suppression water or the deck integrated firefighting system may be discharged overboard through grated decking. Similarly, emergency uncontrolled spills have potential to lose containment in grated decking areas directly overboard depending on the size of the event.

Bunding is provided for chemical and waste oil storage tanks with bund drain boxes and valve connections that can be closed during maintenance or refilling to avoid accidental discharge to the environment. Chemical storage areas can be routed to the open drain separator oil bucket (for transfer to waste oil storage tank) and oil/diesel storage areas routed to the open-drains separator for oil separation.

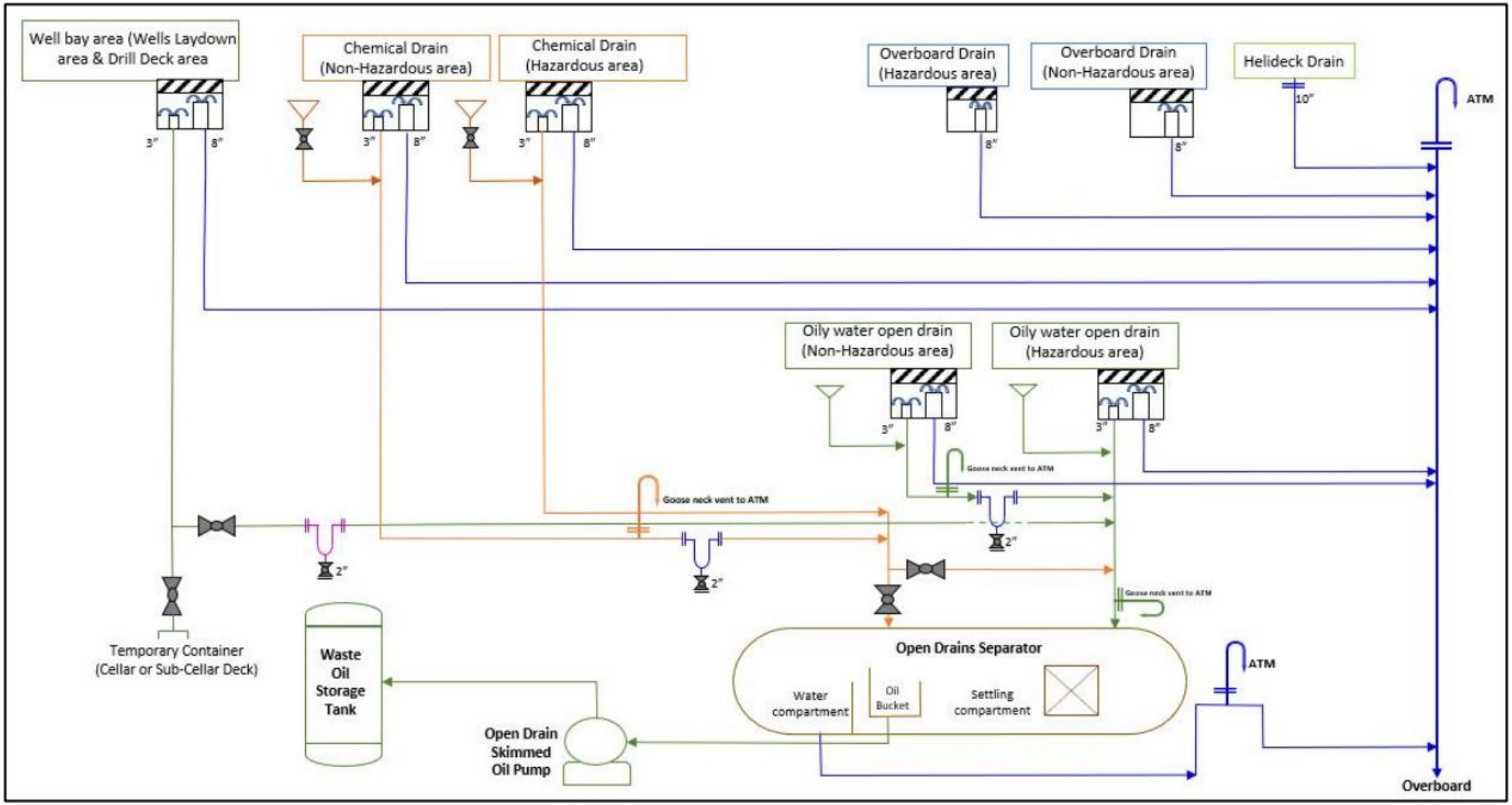


Figure 6-3: Simplified open drain system schematic

6.7.13 Closed Drains

The closed drains system is a non-atmospheric piping system that collects the depressurised liquids from equipment and piping low points in preparation for maintenance and routes them to LP flare KO drum that also acts as a closed drain drum (refer to Section 6.7.10). Filling of the LP flare KO drum from the closed drain is managed procedurally since this a manual operation. This activity only occurs when the vessel or equipment to be drained has been depressurised.

6.7.14 Chemical Injection System

The following chemicals and associated injection systems will be bunkered, delivered, stored and ready for use, or in continuous use, throughout all activities (including periodic replacement) with approximate design tank or storage volumes (working and supply chain transition volumes may be different, and first fill totes may still be in storage or in use during the completions, hot commissioning, and start-up activity periods):

- Corrosion inhibitor for continuous injection into the condensate export stream to protect export pipeline (storage tank 15.6 m^3 with two refill tote tanks 4.2 m^3 each).
- MEG for well hydrate inhibition and for valve pressure equalisation during start-up (storage vessel 34.85 m^3 and four refill tote fill tanks 4.2 m^3 each).
- TEG make-up for TEG dehydration system (98.4 m^3 storage vessel).
- TEG pH adjuster for occasional batch dosing to control pH in the TEG system (4.05 m^3).
- TEG anti-foam for occasional batch dosing to control foaming in the TEG system (4.05 m^3).
- Diesel biocide to prevent micro-organism growth in diesel system (<1 m^3).
- Hypochlorite injection to prevent micro-organism growth in service water, grey water, and sewage system which may be in the form of sodium or calcium hypochlorite (<1 m^3).

In addition to the above, space, weight and tie-in piping allowances have been made for potential future injection of the following chemicals which are not expected to be required in the activity period, but which may be required, after surveillance of the relevant systems:

- Wax inhibitor or scale inhibitor may be required to inhibit wax or scale deposition in the export pipeline or at the wellhead (50 m^3 storage vessel with associated tote tanks as required).
- Demulsifier to assist oil and water separation in the produced water degasser by breaking emulsions (transportable tanks).
- Water clarifier to assist oil and water separation in the produced water degasser by clarifying particles (transportable tanks).
- Additional MEG storage capacity if required for future wells hydrate inhibition and valve pressure equalisation as required (storage vessel up to 100 m^3).

If these futures chemicals are required in the activity timeframe for the purposes of pipeline or process integrity, the necessary modifications will be made to install the remaining tanks in the allotted space and install pipework to connect to the tie-ins, prior to filling for operational use.

TEG is supplied by bunkering from a supply vessel into the permanent storage vessel using a dedicated bunkering hose reel. All other chemicals are supplied in transportable tanks. Hose couplings on transportable chemical re-supply tanks are dry-break type to avoid loss of containment in the event of lifting a transportable tank with the coupling unintentionally left disconnected. Hose couplings for connecting to transportable chemical re-supply tanks are unique and have colour-coding and labelling to avoid cross-contamination of the chemicals.

6.7.15 Service Water System

Service water is bunkered to the platform and stored in the service water tank. A pump delivers service water to the relevant users and for recirculation, which include:

- Helideck deck integrated fire-fighting system.
- Utility points such as wash stations, wash down, flushing, washing, and sand removal.
- HVAC system chilled water make-up.

- BSDG coolant make-up, and associated utilities including fire suppression.
- Gas turbine generator coolant make-up, water wash, and associated utilities including fire suppression.
- Ablution module, temporary refuge, and laboratory container (utility, sinks, showers and flush).

Service water may therefore be discharged periodically through the open drains and produced water system discharge points through all activity phases, in addition to the water flush line for the system which is routed overboard.

A hypochlorite injection package injects sodium hypochlorite downstream of the pump to manage bacterial growth with a chlorine analyser monitoring the chlorine level in the water return to the service water tank (which will normally be kept at with 0.5 to 3 parts per million (ppm) with occasional shock dosing up to 5 ppm, as required). Calcium hypochlorite tablets or granules may also be added via the tank hatch for bacterial control. Hypochlorite may also be injected and discharged into the sewage disposal caisson prevent bacterial growth.

An ultraviolet steriliser is also provided on the feed to the temporary refuge and future accommodation tie-in point to manage water quality requirements for future drinking water/potable water). The package includes cartridge filters to remove possible residuals (e.g., rust, scaling) in the service water system. Service water will be used for potable water if the future accommodation module is installed. Until this time, potable water for drinking will be sourced from accommodation vessels and, if required, stored in potable water containers in the temporary refuge.

6.7.16 Diesel System

Diesel fuel is required for the following consumers throughout the facility lifecycle and all activity phases:

- BSDG to provide power to start-up the topsides from a depressurised state when GTGs are unavailable through all activity phases (including regular testing).
- Temporary diesel fired equipment (diesel generators, completion spreads, air compressors, well completions, workover units, pumps, drilling facilities, maintenance spreads, etc.) through all activity phases.
- Hose dispensers for well temporary laydown area, temporary diesel generator and TEMPSC filling (survival craft), including the regular testing of all those components.

Diesel is supplied by bunkering from a supply vessel to the crane pedestal diesel storage tank (approximately 77.6 m^3) using a dedicated diesel bunkering hose reel. The BSDG utilises a day tank (approximately 2.1 m^3) and an additional diesel storage tote tank (approximately 14.7 m^3) is located on the upper main deck, which can be refilled by tote tank, to provide a redundant supply of diesel on the platform. Diesel is reticulated to the well laydown area for use when activities are occurring in that area. Although not a currently planned activity, diesel may also be used for vessel performance testing in the completions, hot commissioning and start-up activity period which would not result in any discharges. Some tasks through the activity period may require temporary diesel storage tanks to be mobilised on the platform. During all activity phases, the diesel fuel may be sourced from any of the tank storage locations on the facility to enable operational flexibility and redundancy in the event a pump or component is offline.

Level indication is provided on the crane pedestal diesel storage for monitoring the level inside the tank. Local level indication is also provided at the bunkering station via a level indicator, common alarm horn, common beacon light and common acknowledgement push button. Tank filling will be managed based on the required fill volume and using the bunkering pump flow meter. The tank filled volume is indicated on the DCS. Biocide dosing is injected into the diesel transfer pump suction line to prevent micro-organism growth in the crane pedestal tank. Note that the platform crane, whilst providing diesel storage in the pedestal structure, does not consume diesel as it uses an electric motor.

6.7.17 Utility Systems

Nitrogen as required during all activity phases for the purging of equipment containing flammable substances and to allow the flare headers to be swept immediately prior to hydrocarbons being introduced to the flare header during the restart process following a shutdown (and upon initial or subsequent start-ups). Nitrogen will be supplied by a combination of cylinders and a nitrogen generation system for use in manned operation mode. Nitrogen will also be used for MEG storage tank blanketing gas back up (fuel gas is normal blanket gas) and other utility stations.

An electrical distribution system (including transformers and cables) is installed to distribute power to the electrical users via high voltage and low voltage distribution switchgear, including an electrical equipment room, field auxiliary room and transformer area. Additional utilities include and instrument and service air

system that supplies dry compressed air for various users including tools, instruments, flare ignition package, air driven pumps and instrument air purges (motors, panels, junction boxes, etc, as required required). HVAC systems with refrigerants are installed to provide the environment (including temperature, humidity, air motion, air quality, noise, and cleanliness) to provide a safe (non-hazardous) working area for personnel and equipment.

6.7.18 Control and Monitoring Systems

The primary communication from Crux to Prelude FLNG is by subsea fibre optic link provided over the North-West Cable System, a subsea fibre network owned and operated by regional network telecommunication service provider. Should the primary fibre link fail, an alternative communication link using a VSAT satellite system will be utilised to enable continued monitoring and control of Crux from the host facility (Prelude FLNG). A CCTV system provides a visual feed back to the control room. Control systems on have been designed and built for a Not Normally Manned (NNM) platform that allow for extended periods of continuous operation with no human supervision on location. Therefore, a plug and play philosophy with high reliability and low maintenance requirements was applied to the systems design. Control, monitoring, reset and restart of equipment can be controlled locally or remotely from the control room and managed by an Integrated Control and Safeguarding System (ICSS), which consists of the following major subsystems for monitoring, controlling, safeguarding, maintaining, and managing the Crux facility which be available for use through all activity phases:

- Human Machine Interface (HMI) requires a management of change procedure to manage control of Crux platform between the control room and Crux. In degraded communications mode (i.e., primary communications link failure), the HMI provides sufficient information for the operator to make necessary decisions regarding continued safe operation and enable an orderly shutdown if required.
- DCS for implementation of non-safety related automation, control, and monitoring functions (including process and utilities), physically and functionally independent from the Instrumented Protective System (IPS) and Fire and Gas System (FGS). The DCS ensures plant operation within predetermined operational and design limits; uses automated controls minimising operator intervention; effective process control for all designed operational and transient scenarios; and alarm management and handling.
- IPS which continuously monitors for abnormal events (including loss of containment or fire/hazardous event); detects abnormal process parameters and initiates partial or full shutdown and/or isolation of process/utility/electrical equipment in an orderly and safe manner; depressurises (blowdown) the process inventory to make the facility safe; initiates alarms for mustering and evacuation of personnel; and provides levels of emergency shutdown, including:
    - Emergency Shutdown 0: Total offshore facility shutdown and electrical isolation while maintaining the battery power.
    - Emergency Shutdown 1: Shutdown level upon confirmed detection of fire or gas (at temporary refuge or intakes) or confirmed fire or gas in non-hazardous utility area.
    - Emergency Shutdown 2: Shutdown level with process system depressurization upon confirmed detection of fire or gas in process area.
    - Process Shutdown: Lower level of shutdown initiated by a process upset to prevent escalation to emergency level.
    - FGS which detects the loss of containment of hazardous inventory (gas and liquid), fires, raises alarms and interface with the emergency shutdown system for protective responses acting as a mitigation control in the event of a release, preventing a fire or explosion escalation. The system will monitor air spaces for hydrocarbon releases/accumulation, alert personnel by initiating alarms and finally initiating signals that enable necessary actions such as process or emergency shutdown for inventory isolation, blowdown, shutdown of ignition sources and HVAC intake dampers minimising the consequence of a potential fire or release.
    - Sequence of Events Recorder captures the status change of all ICSS input and outputs, system parameters, operator actions, equipment status, inhibit and override statuses and other nominated signals for high resolution audit trail in one common database.
    - Real Time Data Base is used for data storage and retrieval of all online data collected from Crux.

- Instrument Asset Management System is utilised for management and maintenance of Highway Addressable Remote Transducer type field instruments, Digital Valve Controllers etc.
- Alarm Management System manages all alarms generated in the DCS, IPS, FGS as well as alarms originated from third party system which are interfaced to ICSS.
- Electrical Network Monitoring and Control System which monitors and/or controls (where applicable) the Crux electrical network consisting of GTG, BSDG, power management system, switchgears, transformers, and UPS systems as part of platform DCS.

The following remotely operated functions are possible from the existing control room without the need for local operator support and/or intervention on Crux platform:

- Remote monitoring, control and diagnostics of all equipment and machinery.
- Remote start-up and control of main power generation (GTGs).
- Remote start-up (including BSDG), pressurisation, shutdown, and depressurisation of the facility.
- Maintain the process and utilities within predefined limits or tolerances.
- Remote monitoring and reporting of regulatory reservoir, process, and environmental parameters.
- Alarm management and handling.
- Remote modification, configuration, programming, maintenance, testing, troubleshooting and update the ICSS and its subsystems.
- Asset management, diagnostics and maintenance of some smart field instruments, valves, and detectors.
- Data archiving, recording, trending, and reporting etc.

The ICSS has the flexibility to expand for future facilities and is designed on a modular concept allowing additional equipment to be added into the system for future expansion.

A CCTV system has been incorporated into the design to allow remote operators to have ‘eyes on board’ the Crux platform. This system includes pan tilt zoom CCTV camera which have been placed on the northern, eastern, southern, and western external boundaries of the platform. This orientation allows the operator to observe the topsides equipment and the surrounding environment. There is also a fixed infrared CCTV camera (with automatic flame detection software) pointed at the flare flame, to provide backup confirmation that the flare tip is lit.

6.7.19 Protection Systems

The topsides have several mechanisms which help protect against loss of containment events, which include:

- Fire and explosion protection which includes blast walls to minimise the consequences of explosions and mitigate the impacts of explosions on equipment and areas of the platform. Blast resistance is also applied to structure and critical elements that may potentially be exposed to blast loads but are required to perform their function after an explosion event. Self-contained water mist suppression systems are provided for protection of GTG and BSDG enclosures.
- Passive fire protection coatings provided to process equipment (saddle/skirt and support), shutdown valves (riser ESDV), primary structures, and critical piping to maximise continued integrity of equipment under predicted fire conditions.
- Water in condensate analysers are installed to monitor and provide alarm if the water content in the condensate export and dew point in the TEG contactor outlet is exceeding limits, thereby providing warning for any situations that could impact the integrity of the export pipeline.
- Navigational aids to enable the facility to be visible to marine and aviation traffic, and to signal a safe line of approach or departure for helicopters, radar beacon and main navigation lights to alert marine vessels and aircraft of the position and prevent collision with the facility.
- Collision avoidance Automatic Identification System (AIS) is provided on the platform for collision avoidance to detect marine traffic and provide warning.

- Metocean data gathering system provides a Real Time Metocean Monitoring System to alert personnel to adverse weather by providing accurate, continuous, real-time metocean data for decision making when conducting weather sensitive activities to help prevent weather related incidents.

In addition to these protection mechanisms, the structural design intent of topsides and substructure (materials, corrosion protection, etc) is to maintain structural integrity under all expected actions through service life and provide sufficient robustness to maintain availability of critical systems during a major incident. Handling equipment on the topsides (e.g., underhung gantry crane, monorails, davit and pedestal crane) is designed to ensure that loads can be lifted and mechanically handled, without dropped object or swinging load risk. Process containment equipment (such as process vessels, heat exchangers, rotating equipment, piping and relief systems are designed to maintain integrity of the containment envelope through protection for mechanical failure (e.g., gas detectors, flame monitoring and dedicated suppression/water mist), materials corrosion and erosion allowances, vibration control, protective coatings, designing for transient pressure & temperature, environmental, mechanical, and dynamic (including slugging, flow pulsation, water hammer) loads (etc) with relief devices to prevent overpressure in pressurised hydrocarbon gas/condensate containment systems in the event of loss of process control, fire or any other credible overpressure scenarios. Ignition control systems are also designed to prevent the ingress or build-up of flammable hydrocarbon gas-air mixtures or dangerous atmospheres by ventilation systems, certified electrical equipment, earth bonding devices, and area classifications. Helicopter facilities include a passive fire retarding helideck, helideck perimeter lights, self-contained deck integrated firefighting system (DIFFS), safety perimeter net and helicopter crash / rescue equipment.

6.7.20 Other Facilities

6.7.20.1 Living Quarters

The platform designed to allow a future accommodation module to be installed above the temporary refuge, if required, without extending the current platform deck footprint. Future accommodation allowance is designed to allow additional people to stay on the facility (approximately 15-20 Persons On Board [POB] subject to change) instead of the Accommodation Support Vessel (ASV). Space and weight allowances have been included so that the future living quarters module and sewage treatment system can be safely installed during a turnaround. Space and weight allowances have also been made for the supporting tie-in utilities of the module such as HVAC, sewage, and potable water.

6.7.20.2 Ablutions

The following systems will discharge grey water from basins/showers and/or macerated sewage in separate headers to the sewage caisson which discharges approximately 15 metres below the sea surface:

- Ablution module (grey water and macerated sewage) for up to approximately 80 POB.
- Temporary refuge (grey water and macerated sewage) for up to 2 toilets, 2 basins, and integrated shower (approximately).
- Laboratory (grey water from basins), contaminated water is self-contained for onshore disposal.
- Future accommodation module (grey water and macerate sewage) for up to approximately 15 POB.

Each toilet has its own integrated macerator to convert solids and fluids into fine slurry before being expelled into the sewage line. Sodium hypochlorite will be injected into the disposal caisson on a regular basis. Temporary, self-contained toilet/ablution modules that are not discharged to the sewage or grey water header may also be utilised during hot commissioning, start-up and any subsequent planned or unplanned campaign depending on scope requirements. These temporary units, or their waste contents, will be shipped onshore for disposal. No food waste is discharged from the platform.

6.7.20.3 Laboratory

The premise for laboratory testing in not-normally manned operational modes is that Prelude FLNG and/or mainland laboratories will be utilised for testing requirements delivered by helicopter or support vessel depending. Temporary laboratory module facilities will be located on the main deck to support completions, hot commissioning, start-up phases and will be retained/mobilised as required during the remainder of operations phase activities.

6.7.20.4 Chemical Storage

During the activity lifecycle, non-injected process, and other miscellaneous chemicals such as hydraulic fluid, lube oil / seal oil, coolants, instrument air dryer beds, radioactive sources/nucleonics, TEG activated charcoal

filters, biocide treatment, well annulus fluid and generic cleaning fluids (as examples) will be utilised for specific tasks, maintenance, and operational requirements.

6.7.20.5 Lighting System

The lighting system on the Crux platform is limited to the illumination required for safety, navigational and emergency lighting. Portable lighting may be needed for short durations if night activities are required for works through all activity periods. Normal operational lighting can be remotely turned off and on where required.

6.7.20.6 Bird Deterrent System

An acoustic bird deterrent system has been included in the Crux platform helideck for operation when facility is in unmanned mode. The system basis is to discourage bird nesting and habitat creation on the helideck, and therefore minimise the potential for bird strike during helicopter operations when facility is manned. Speakers are included in the helideck, and will both intermittently and on demand (e.g., prior to helicopter landing) play the acoustic bird deterrent distress call. The system will be turned off when the platform is manned, given the presence of personnel is a deterrence to birds.

6.7.20.7 Fire and Suppression Systems

The Crux topsides DIFFS is a passive system and contains no chemical foam (water only) pressurized via nitrogen cylinders. If it needs to be tested offshore (or used in emergency situations) it would discharge approximately 1.2 m^3 of water per minute and the water tank working volume is approximately 6.5 m^3. The water within the water tank may be dosed to control water quality (e.g., prevent bacteria or marine growth). Self-contained water mist suppression systems are provided for protection of GTG and BSDG enclosures. During periodic testing or actual emergency use, suppression water may be discharged overboard through grated decking.

6.7.20.8 Metocean Monitoring

A real-time metocean monitoring system is installed on the platform to support helicopter and vessel operations at the platform. There may also be deployment of metocean monitoring equipment (such as waverider buoys) throughout the Activity Area for any of the activity phases to provide a comprehensive understanding of meteorological, oceanographic, or biological conditions for monitoring and surveillance purposes, planning activities, and informing inspection, repair or major maintenance activities.

6.8 Project Vessels and Other Supporting Operations

A range of vessel types will be needed to carry out the activities associated with the Activity. Table 6-6 lists these vessel types and summarises the associated indicative activities, presence within the Activity Area and estimated duration. Note: Specific vessel types and activities may change due to project scheduling, vessel availability, or unforeseen circumstances.

Table 6-6: Potential Vessel Types for Various Activities and Estimated Duration

Vessels and Other Supporting Operations	Indicative Activities	Presence within the Activity Area			Estimated Duration[9]
		Prelude FLNG /Prelude–end	Export Pipeline	Crux–end	
Vessel Type					
Pipelay	install PLETs and export pipeline bunkering undertake IMR and contingency activities, if required	×	✓	×	~2 months
Construction	undertake surveys install foundations, supporting structures, static umbilical, EFL, SFL, mattresses, spool, fibre-optic jumper and other installation aids transport equipment and infrastructure transfer materials undertake support activities (touchdown / ROV monitoring, subsea positioning) undertake cold commissioning activities provide bunkering transfer personnel seabed preparation or remediation, if required undertake IMR and contingency activities, if required	✓	✓	✓	Required for the duration of each work package (refer to Table 6-2).
Substructure transportation barge	provide substructure transport and launch	×	×	✓	~1 week

[9] Timing, duration and vessel selection for indicative activities is subject to change due to project schedule requirements, vessel availability, unforeseen circumstances, and weather.

Vessels and Other Supporting Operations	Indicative Activities	Presence within the Activity Area			Estimated Duration[9]
		Prelude FLNG /Prelude–end	Export Pipeline	Crux–end	
Topsides heavy transport vessel (HTV)	provide topsides transport, floatover and installation	×	×	✓	~2 weeks
Flexible pipelay	supply and install the flexible risers (and UCON), umbilicals (and UTH), installation aids and riser heel anchor tie-in UCON, UTH and EFL/SFL pull-in flexible riser and umbilicals undertake cold commissioning support and testing undertake IMR and contingency activities, if required	✓	×	×	~6 weeks
Survey	undertake surveys undertake support activities	✓	✓	✓	~4 months
Accommodation support vessel (ASV)	provide accommodation transfer crew/personnel support cold commissioning activities provides supplies and equipment	×	×	✓	Required for the duration of this EP following topsides installation.
Support and supply	provide emergency support and response handle, wet–tow and position vessels and infrastructure undertake preservation and IMR activities, if required support and monitor installation and cold commissioning activities undertake surveys, IMR and contingency activities, if required	✓	✓	✓	Required for the duration of each work package (refer to Table 6-2).

Vessels and Other Supporting Operations	Indicative Activities	Presence within the Activity Area			Estimated Duration[9]
		Prelude FLNG /Prelude–end	Export Pipeline	Crux–end	
	transport and store materials, supplies equipment, infrastructure, fuel and chemicals transport crew/personnel transport vessel waste and debris (if required) from vessels to mainland for disposal				
Other Supporting Operations					
Existing Prelude FLNG	undertake Prelude-end flexible riser and umbilical pull-in undertake cold commissioning activities (limited to the flexible riser and umbilical leak test [Section 6.10.1.3] and topsides to Prelude FLNG dewatering, vacuum and nitrogen packing [Section 6.10.1.5]) undertake Prelude FLNG modifications for Crux Tie-in scopes (Section 6.9.10) Note: this EP excludes other activities covered under the Prelude FLNG EP (Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002)	✓	×	×	Intermittent across ~24 months.
Remotely operated vehicles (ROVs)	Monitor or support: installation activities including placement, tie-ins, scour protection, span rectification and seabed remediation cold commissioning activities surveys IMR and contingency activities (if required) unplanned incidents, including retrieving equipment, installation aids or infrastructure	✓	✓	✓	Intermittent, as required for the duration of this EP.

Vessels and Other Supporting Operations	Indicative Activities	Presence within the Activity Area			Estimated Duration[9]
		Prelude FLNG /Prelude–end	Export Pipeline	Crux–end	
Autonomous underwater vehicles (AUVs)	Monitor or support: surveys IMR and contingency activities (if required)	✓	✓	✓	Intermittent, as required for the duration of this EP.
Aviation	transfer crews undertake medevac, if required provide offshore helicopter refuelling provide supplies	✓	✓	✓	Refer to Section 6.8.9.2.

6.8.1 Pipelay Vessel

A specialised pipelay vessel, like the *Audacia* (Figure 6-4), will be used for the activities outlined in Table 6-6. Table 6-7 lists the indicative pipelay vessel specifications.

The pipelay vessel will be typically equipped with:

- enclosed firing line
- a lay system
- cranes
- ROVs (see Section 6.8.9.1 for typical ROV specifications)
- helideck and helicopter refuelling system

Figure 6-4: Indicative Pipelay Vessel (*Audacia*)

Table 6-7: Typical Pipelay Vessel Details (based on the* Audacia*)

Detail	Example General Specifications
Main engine capacity	39,800 kW
Engine configuration	Diesel electric
POB	Up to 270
Length overall	327 m
Weight	56,172 t
Operating draft	9–10 m
Dynamic positioning	DP3
Tank Capacities	
Ballast	Ballast systems can vary in size with total volumes from 20,000–32,000 m³
Cooling system	Sea water used to cool main engines, refrigerators and service cooling; sea water is circulated by pumps
Fresh water	Evaporators/distillation units on board. Freshwater tank sizes vary from 1,000–1,500 m³
Total fuel oil	Multiple isolatable fuel tanks with a total capacity of 5,547 m³. The largest single tank is 1,118 m³ with double-hull equivalent protection and is the largest single Marine Diesel Oil (MDO) fuel tank[10] within the project vessel fleet.

[10] MDO and Marine Gas Oil (MGO) are collectively referred to as MDO for the purposes of this EP.

6.8.2 Construction Vessels

Specialised construction vessels, like the *Fortitude* (Figure 6-5) and Derrick Lay Vessel 2000 (DLV2000) (Figure 6-6), may be used for the activities outlined in Table 6-6. Table 6-8 lists the indicative specifications for the largest proposed construction vessel in the vessel spread.

Construction vessels will be typically equipped with:

- cranes
- ROVs (see Section 6.8.9.1 for typical ROV specifications)
- helideck and helicopter refuelling system

Figure 6-5: Indicative Construction Vessel (*Fortitude*)

Figure 6-6: Indicative Construction Vessel (*DLV2000*)

Table 6-8: Typical Construction Vessel Details (based on the* DLV2000*)

Detail	Example General Specifications
Main engine capacity	25,500 kW

Detail	Example General Specifications
Engine configuration	Diesel electric
POB	Up to 401
Length overall	184 m
Weight	45247 t
Operating draft	5.5–7.9 m
Dynamic positioning	DP3
Tank Capacities	
Ballast	Ballast systems can vary in size with total volumes from 20,000–32,000 m³
Cooling system	Sea water used to cool main engines, refrigerators and service cooling; sea water is circulated by pumps
Incinerators	MARPOL-compliant incinerators
Total fuel oil	A single tank will be less than 1,118 m³ with double-hull equivalent protection based on the largest Marine Diesel Oil (MDO) fuel tank within the project vessel fleet
Putrescible waste system	MARPOL-compliant comminuting (grinding) system
Sewage system	IMO/MARPOL-compliant sewage treatment plants

6.8.3 Substructure Transportation Barge

A specialised substructure transportation barge, like the *Intermac 650* (*I-650*) (Figure 6-7), will be used for the activities outlined in Table 6-6 and described in Section 6.9.6. Table 6-9 lists the indicative specifications for the substructure transportation barge.

The substructure transportation barge will be typically equipped with:

- rocker arms
- hydraulic jacking units
- rapid flood ballast system
- ballast water treatment system

Figure 6-7: Indicative Substructure Transportation Barge (I650)

Table 6-9: Typical Substructure Transportation Barge Details (based on the* I650*)

Detail	Example General Specifications
Length overall	198 m
Weight (gross)	30,796 t
Deadweight	55,678 t
Substructure launch capacity	25,000 t
Tank Capacities	
Ballast	Ballast capacity is 93,008 t with a 90,850 L/min total pumping capacity.
Total fuel oil	38 m^3

6.8.4 Topsides HTV

A specialised topsides HTV, like the *Hai Yang Shi You 278* (*HYSY 278*) (Figure 6-8), will be used for the activities outlined in Table 6-6. Table 6-10 lists the specifications for an indicative topsides HTV. The topsides HTV will be typically equipped with a helideck and rapid flood ballast system.

Figure 6-8: Indicative Topsides HTV (*HYSY278*)

Table 6-10: Typical Topsides HTV Details (based on the* HYSY278*)

Detail	Example General Specifications
Main engine capacity	11,000 kW
Engine configuration	Diesel electric
POB	55
Length overall	221.6 m
Weight	52,500 t
Draft (loaded)	10.15 m
Dynamic positioning	DP2
Allowable load on main deck	27.5 tonnes/m^2

Detail	Example General Specifications
Tank Capacities	
Ballast	Ballast system has four 6,750 m^3 air compressors and 84 ballast tanks. Ballast speed is ~10,000 m^3/h.
Total fuel oil	Multiple isolatable fuel tanks with total a capacity of 3,285 m^3. Largest single tank is 1309.8 m^3 with double-hull equivalent protection. This vessel is the only vessel in the fleet that uses Intermediate Fuel Oil (IFO).

6.8.5 Flexible Pipelay Vessel

Specialised flexible pipelay vessels, like the *Deep Orient* (Figure 6-9), will be used for the activities outlined in Table 6-6. Table 6-11 lists the specifications for an indicative flexible pipelay vessel.

Flexible pipelay vessel vessels will be typically equipped with:

- cranes
- ROVs (see Section 6.8.9.1 for typical ROV specifications)
- helideck and helicopter refuelling system
- a vertical lay system

Figure 6-9: Indicative Flexible Pipelay Vessel (*Deep Orient*)

Table 6-11: Typical Flexible Pipelay Vessel Details (based on the* Deep Orient*)

Detail	Example General Specifications
Main engine capacity	15,360 kW
Engine configuration	Diesel electric
POB	Up to 120
Length overall	136 m
Weight (gross)	12,127 t
Operating draft	6.85 m
Dynamic positioning	DP2

Detail	Example General Specifications
Tank Capacities	
Ballast	7,600 m^3
Total fuel oil	2,200 m^3 (largest single tank is 336 m^3)
Fresh water	25,000 m^3

6.8.6 Survey Vessels

Survey, construction or other support vessels may be used for the activities outlined in Table 6-6. Survey vessels are typically 60–90 m long with a crew capacity of up to 50. ROVs may be used to support surveys, using visual or geophysical techniques (such as side scan sonar) (see Section 6.8.9.1).

6.8.7 Accommodation Support Vessel

An ASV, like the *Triumph* (Figure 6-9), will provide lodging for the additional workforce required at the Crux topsides location. The ASV will use DP to maintain its position. Personnel will walk between the ASV and topsides using a gangway system.

Figure 6-10: Indicative ASV (*Triumph*)

Table 6-12: Typical ASV Details (based on the* Triumph*)

Detail	Example General Specifications
Main engine capacity	22,470 kW
Engine configuration	Diesel electric
POB	Up to 500 (base case 300 but other ASVs may have up to 750)
Length overall	125 m
Weight (gross)	27,211 t
Operating draft	22 m
Dynamic positioning	DP3

Detail	Example General Specifications
Tank Capacities	
Ballast	11397 m^3
Total fuel oil	1,893 m^3 (largest single tank is 359 m^3)
Fresh water	1,000 m^3

6.8.8 Supply and Support Vessels

Supply and support vessels provide resources, storage, external heading control and logistical support and may be used for the activities outlined in Table 6-6. These vessels may transit between the Activity Area, port or mooring locations. Supply and support vessels include:

- tugboats and anchor handling tugs
- barges
- cargo vessels
- offshore supply vessels
- crew transfer vessels
- pipe/pile supply vessels.

6.8.9 Other Supporting Operations

6.8.9.1 Remotely Operated Vehicles and Autonomous underwater vehicle

ROVs and AUVs may be deployed from project vessels and used for the activities outlined in Table 6-6.

Hydraulic control fluids are used to operate ROVs—negligible amounts of these fluids may be released to sea during some operations such as opening and closing valves. Typically, work class ROVs will be used.

6.8.9.2 Aviation Operations

Helicopters will provide aviation support (e.g. medevac [if required], crew changes). Aviation operations may include offshore helicopter refuelling on vessel helidecks (including the ASV) within the Activity Area (see Section 6.12), subject to flight distances and the weight of helicopter loads. Helicopter flights will occur about seven times per week at peak usage. Helicopter transfers via the Crux helideck and contingency DIFFS testing (Section 6.11.3) will only occur in the event of an emergency (e.g. stranded personnel).

Personnel will travel from Broome International Airport via North Kimberley Airport for the duration of this EP using both Fixed Wing and Rotary Wing aircraft. Alternative landing sites may be required under certain weather conditions. These activities are outside the scope of this EP.

6.8.10 Summary of Typical Discharges and Emissions

Table 6-13 summarises typical emissions and discharges across the spread of project vessels and other supporting operations.

Table 6-13: Summary of Typical Discharges and Emissions: Project Vessel and Other Supporting Operations

Type	Description
Discharges	
Ballast water	Ballast water will comply with the Australian Ballast Water Management Requirements (DAWE 2020), which implements the requirements of the *Biosecurity Act 2015* (Cth) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (of appropriate class).
Rapid flood ballast system	The substructure transportation barge is likely to discharge ~2,600 m^3 during the substructure launch. The topsides HTV is likely to discharge ~12,000 m^3 during the topsides floatover.

Type	Description
	Corrective ballasting may also be required to reposition the substructure or topsides or if disconnection between the structures does not occur.
Sewage and greywater	The volume of sewage and greywater is proportional to the POB number. Up to 40 L of sewage/greywater may be generated per person per day.
Deck drainage/run-off	Drainage water from project vessels may comprise rainwater, sea water and washdown water, which may contain trace quantities of oil, grease and detergents. During an unforeseen fire event, firefighting foam may also be present.
Cooling water	Excess or unused heat in cooling water will be carried away from vessel and equipment components using sea water and returned to the sea with residual sodium hypochlorite.
Bilge water	Oily bilge water will be treated via an oily water filter system to achieve 15 mg/L after treatment, then discharged.
Brine (if a reverse osmosis unit is used for water treatment)	Brine generated from the water supply systems on the vessels will be discharged to the ocean at a salinity ~10% higher than sea water.
Putrescible food waste effluent	The volume of putrescible food waste effluent is proportional to the POB number. Putrescible waste discharge to sea will be ~1 L of food waste per person per day.
Exhaust gas cleaning system (EGCS) wash water (if required)	MARPOL Annex VI allows ships to use EGCS to comply with the 0.5% mass by mass (m/m) sulfur fuel oil limit. The EGCS wash water will comply with discharge water quality criteria set out in the 2021 Guidelines for exhaust gas cleaning systems (EGCS Guidelines) (IMO 2021).
Emissions	
Atmospheric emissions (hydrocarbon combustion)	Atmospheric emissions resulting from hydrocarbon combustion are produced by project vessel (and supporting operations) engines and associated equipment, and from operating vessel incinerators.
Light emissions	Light emissions occur from various sources, including ROV underwater lighting, spot (task) lighting as needed, and vessel navigation and safety lighting.
Noise emissions	Noise emissions are generated by acoustic positioning systems and project vessel and supporting operations, such as engines, dynamic positioning (DP) thrusters, and other machinery.

6.9 Installation Activities

6.9.1 Surveys and Inspections

Surveys and inspections will be done at various stages throughout the Activity. Survey methods may use acoustic pulses such as multibeam echo sounder (MBES), side-scan sonar (SSS), magnetometer and sub-bottom profiler (SBP). Other survey methods that may be used include magnetic induction, cone penetration test (CPT) and electric sensors.

Inspections are required to confirm the condition of equipment and infrastructure, including infrastructure installed outside the scope of this EP (e.g. the drilling template and development well heads). Inspections will likely use MBES to achieve high resolution bathymetric information and ROVs for visual inspections.

Some or all of these surveys and inspections will be conducted:

- Engineering and soil assessments: Engineering surveys determine the optimal location for the initiation structure and the soil assessment will provide subsurface conditions information. CPTs will be performed by pushing a rod into the seabed to a depth of 10 m, and a vibrocore samples will be taken to a depth of 6 m. Some box core sampling will also be performed.
- Pre-lay, post-lay, as-built and as-found: These surveys will be conducted before, during, and after installation.
    - The pre-lay survey aims to identify any potential obstacles or hazards, the seabed slope, map morphological and other features (such as cultural features and marine archaeology) along the intended route and substructure location.

- The post-lay, as-built and as-found surveys to:
  - verify the infrastructure placement, as-built water depth, inform span rectification and identify deviations from straightness.
  - determine the condition of the seabed including the extent of the drill cuttings and cement prior to infrastructure installation (e.g. levelling survey)
  - assess the installed infrastructure for potential scour formation, marine growth, condition and damage.
- Acoustic metrology: Acoustic metrology techniques will be used to determine the dimensions of the tie-in spool. Acoustic signals measure distances accurately and ensure precise alignment during tie-in.
- Drill hole: Drill hole surveys monitor and verify the internal dimensions and condition of the hole.
- Magnetometer: Magnetometer surveys use magnetic induction to detect the presence of iron objects such as unexploded ordnance or wrecks.
- Unforeseen events (such as cyclones) surveys: non-routine surveys to confirm the integrity of the infrastructure after an unforeseen event (if required).

6.9.2 Underwater Acoustic Positioning

Accurately positioning subsea infrastructure on the seabed is crucial and may require ultra-short baseline (USBL) and long baseline (LBL) acoustic positioning systems. Typically, USBL transponders are attached to subsea equipment, and LBL transponders are fixed to seabed frames, which are deployed and then fully recovered once the infrastructure is correctly positioned. These systems can provide accuracy up to one metre.

LBL and USBL systems emit short non-continuous pulses ('chirps') of medium- to high-frequency sound that typically last 3–40 milliseconds at a frequency of 19–33 kHz. The units will be retrieved after use. Table 9-33 lists the total temporary footprint from acoustic positioning.

6.9.3 Metocean Monitoring

Metocean monitoring will be conducted throughout the Activity to ensure a comprehensive understanding of meteorological and oceanographic (metocean) conditions. Temporary metocean monitoring equipment will be deployed, such as waverider buoys (connected to a clump weight,) and recovered once the monitoring is finished. Table 9-33 details the temporary seabed disturbance footprint associated with metocean monitoring as a contingency.

6.9.4 Scour Protection and Span Rectification

Scour protection and span rectification may be required to support the infrastructure associated with the Activity. Scour protection may also be required around the substructure drilling template (outside the scope of this EP and covered under the Crux Development Drilling Template Installation EP [2200-010-HE-5880-00004]). Scour protection and span rectification may use mattresses, mudmats, skirts and grout bags (pre- and post-filled). Localised seabed remediation, such as jetting or soil removal using an ROV, may be required:

- before positioning scour protection or span rectification
- before positioning infrastructure
- for sediment clearance to support well management (wellhead installation is outside the scope of this EP), including the redirection of development well and insert pile drill cuttings, and grout/cement away from wellheads and other infrastructure
- to facilitate debris clearance.

Table 9-33 lists the footprint (including a contingency allowance), associated with scour protection, span rectification and sediment clearance activities.

6.9.5 Export Pipeline Installation

The export pipeline's lay direction is from Prelude towards Crux. PLET foundations, which will be installed using a construction vessel, are steel structures with pre-installed scour protection. The construction vessel will use a crane to lift the infrastructure foundations from the vessel deck onto the seabed. During installation, an ROV will position and orientate the supporting structures. A construction vessel will install a temporary initiation structure at the Prelude-end of the export pipeline to allow it to be tensioned for initial lay-away. The

initiation structure is typically a suction pile, drag anchor or dead-man anchor and is installed before the pipeline is installed. This temporary initiation structure is disconnected and will be retrieved and removed from the Activity Area after the export pipeline is installed. Table 9-33 lists the temporary seabed footprint associated with the pipeline initiation structure.

The pipelay vessel will install the PLETs and export pipeline using a traditional s-lay installation method. The PLET will be lowered from the pipelay vessel deck into the firing line where it is then welded into the pipeline. The PLET and pipeline are progressively lowered until the PLET/pipeline assembly lands onto the pre-installed PLET foundation. PLET installation will occur during pipeline initiation (Prelude-end) and laydown operations (Crux-end).

Pipe will be transferred from a support vessel to the pipelay vessel. After the pipe is transferred to the pipelay vessel, it will be stored on deck or below deck (in deck holds). Before being used, each piece of pipe will be inspected to ensure it has not been damaged during transportation and is clean of debris. The pipeline will be laid using a continuous assembly pipe-welding installation method, which involves the horizontal assembly of single pipe joints on the pipelay vessel's working plane. The joints are welded together, tested, and then coated before departing the firing line and entering the stinger. A stinger—a steel structure with rollers extending from the end of the firing line/vessel—supports the upper section of the pipeline catenary to control the curvature during installation. Tension is applied to the pipeline by the vessel's tensioners and forward DP thrust to maintain the catenary and prevent buckling as the pipeline is lowered to the seabed. As the welding process continues, the constructed pipeline is continuously lowered from the vessel to the seabed as the vessel moves along the predetermined route. Typically, the pipelay vessel will cover ~2–3 km per day.

If span rectification is required, some localised seabed rectification (e.g. jetting span shoulders; removing soil for grout bag installation) may be required before either pre-lay mattresses or post-lay grout bags are positioned. Concrete mattresses or grout-filled bags are typically used for scour protection and lateral buckling mitigation:

- Concrete mattresses are usually concrete blocks bound together by flexible cables.
- Grout bags are typically made of flexible material, such as woven polypropylene, and are filled with granular material like sand, which is stabilised with a binder (e.g. cement) or with rock without a binding material.

A crane on the pipelay or construction vessel will lift concrete mattresses from the vessel deck and lower them above the seabed. An ROV will orientate and position the mattresses before they land on the seabed. For small spans, pre-filled grout bags may be installed individually by ROV or lowered to the seabed by the pipelay or construction vessel crane for individual placement. For higher spans, post-filled grout bags may be installed, although unlikely to be required. The empty grout bags are positioned under the pipe by an ROV and are filled from the surface using a liquid slurry of grout via a downline. After each operation, the downline is flushed (approximately 4 m^3) to the subsea to prevent the grout from setting in the downline between filling operations.

6.9.6 Prelude-end Flexible Riser and Umbilical Installation

The flexible pipelay vessel will install the Prelude-end umbilical and flexible risers. This installation will require the vessel to work close to the Prelude FLNG (i.e. within the FLNG's swing circle of ~500 m), with a minimum standoff of ~10 m for a very short duration (up to several days).

6.9.6.1 Flexible Riser Installation

One flexible riser (Table 6-1) will be installed during the riser laydown operations. The prefabricated riser will be flooded with treated freshwater (see Section 6.9.10 for chemical composition) and then stored on two large-diameter reels on the flexible pipelay vessel deck.

The lay direction will likely start from the Prelude FLNG and move towards the Prelude-end PLET. To facilitate installation, the flexible riser may need to be wet parked prior to installation or installed directly from the flexible pipelay vessel.

The flexible pipelay vessel will then use the whipline and deck winch to recover the long-term protection cap and winch wire from the Prelude FLNG and then connect the FLNG pull-in wire to the riser pulling head (Figure 6-11). The bend stiffener latching mechanism connection and flexible riser hang-off will be completed at the Prelude FLNG turret (Figure 6-12). The flexible riser is pulled in and installed with a permanent hang-off collar.

Ancillary equipment (if required) including ballast modules (see Figure 6-13), installation clamps, clump weights and buoyancy modules will be installed onto the flexible riser using an inline method at the flexible

pipelay vessel vertical work table and then continually lowered from the vessel; an ROV will monitor the sag bend. Once all the buoyancy modules (see Figure 6-14) have been deployed, the riser will be laid in a lazy wave formation, monitored by ROVs (Figure 6-15), and then normal lay operations will continue. The riser comes in two sections, so at the end of the 1st section a "midline connection" will be made connecting the 1st and 2nd sections of flexible on deck, after which normal lay will resume.

The flexible riser will be terminated with the UCON at the Prelude-end PLET. The flexible riser UCON is a steel structure (see Figure 6-16 for an example). At the end of the flexible riser line, the UCON will be connected and then lowered by the flexible pipelay vessel crane, with ROV assistance, onto a pre-installed UCON guidepost. Once in place, the UCON will be connected (subsea tie-in) to the flexible riser and the Prelude-end PLET; some inconsequential discharges may occur.

The seabed footprint associated with installing the flexible riser is listed in Table 9-33.

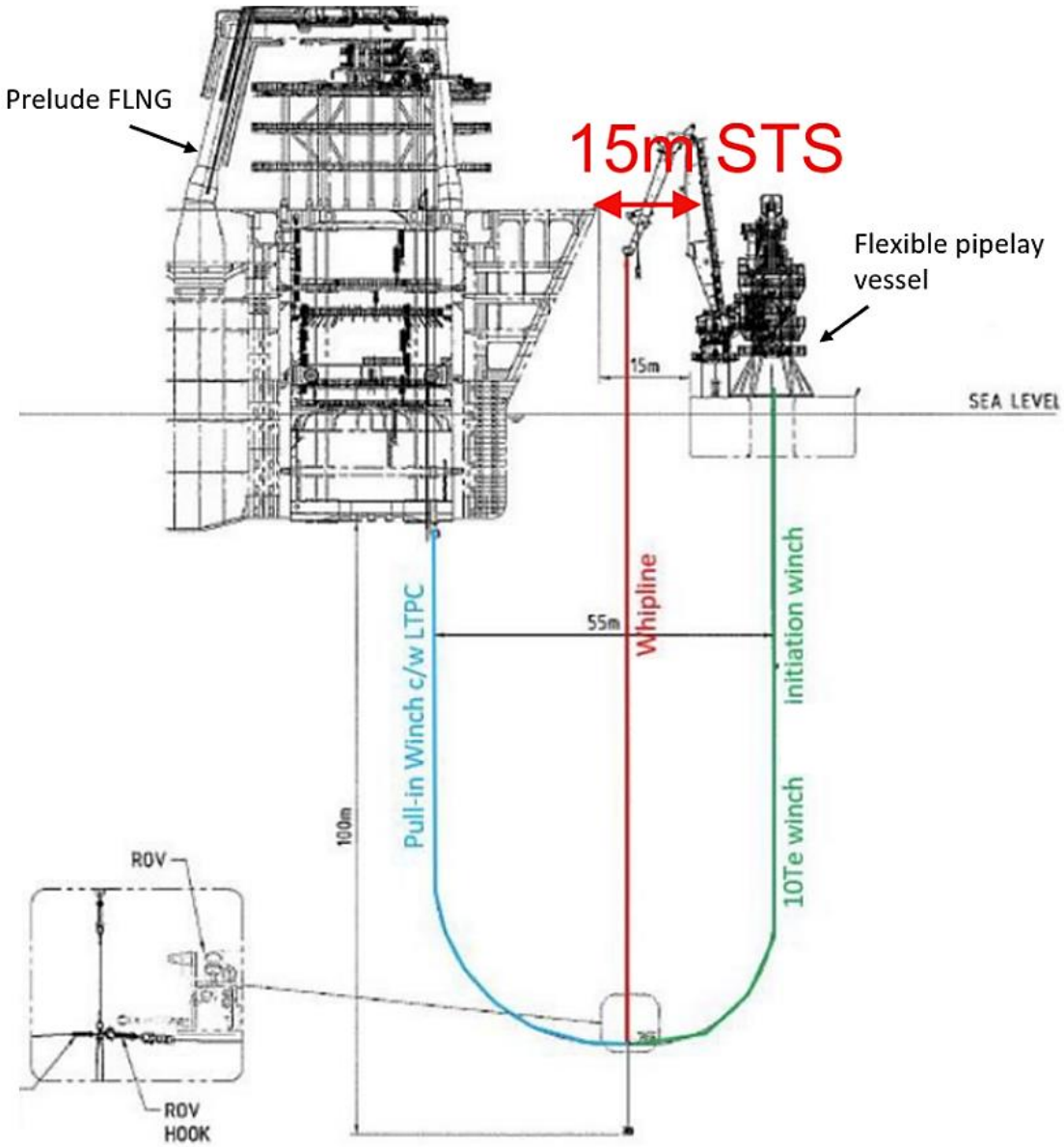


Figure 6-11: Flexible Riser Initiation

LTPC = Long-term Protection Cap; STS = Ship-to-ship

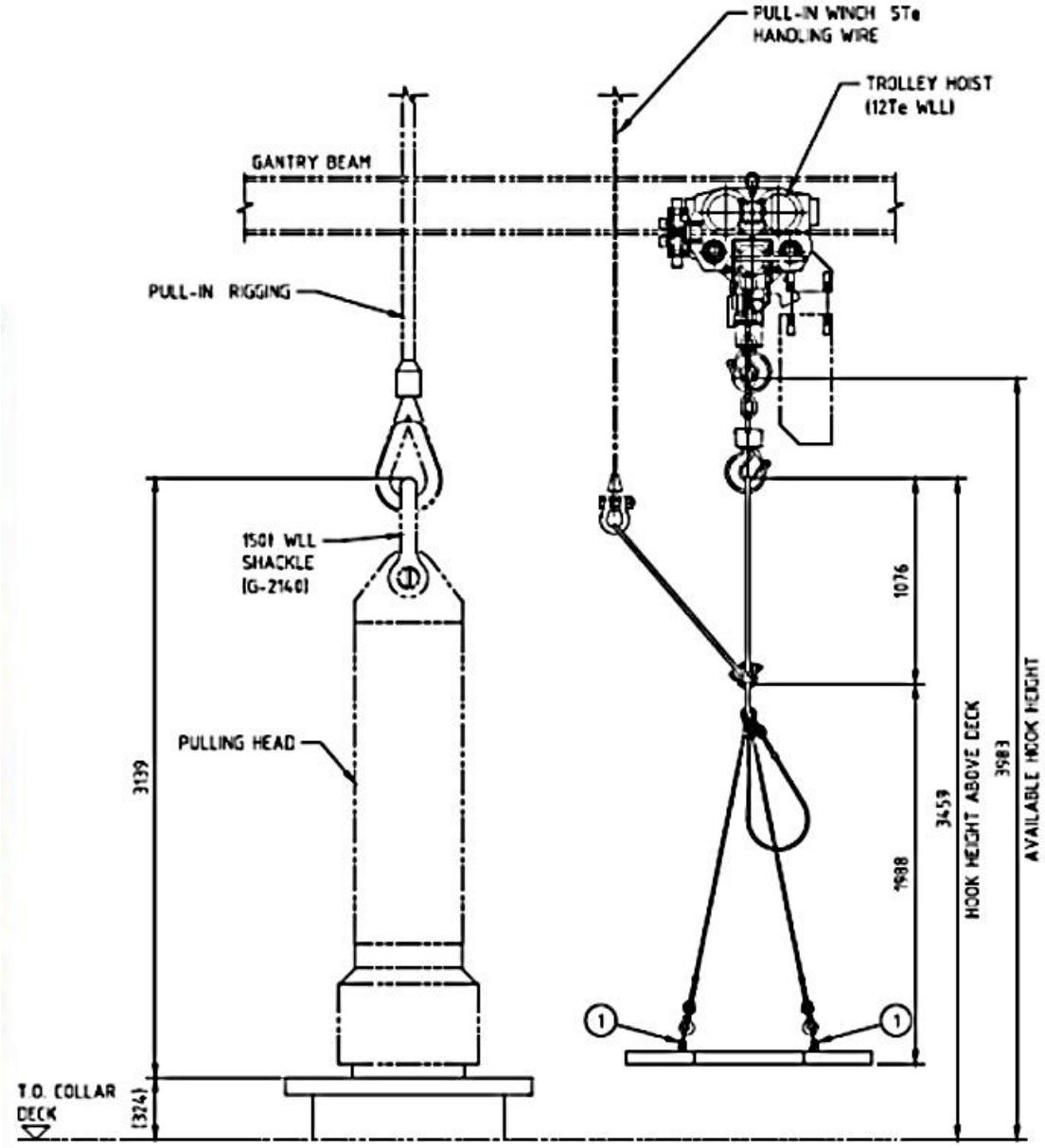


Figure 6-12: Flexible Riser First End Pull-in within the Prelude FLNG Turret

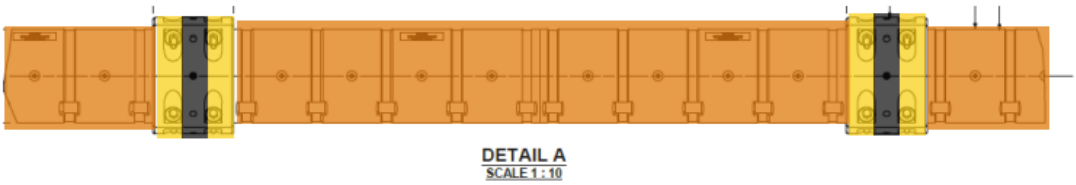


Figure 6-13: Indicative Ballast Configuration

Figure 6-14: Example of a Buoyancy Module

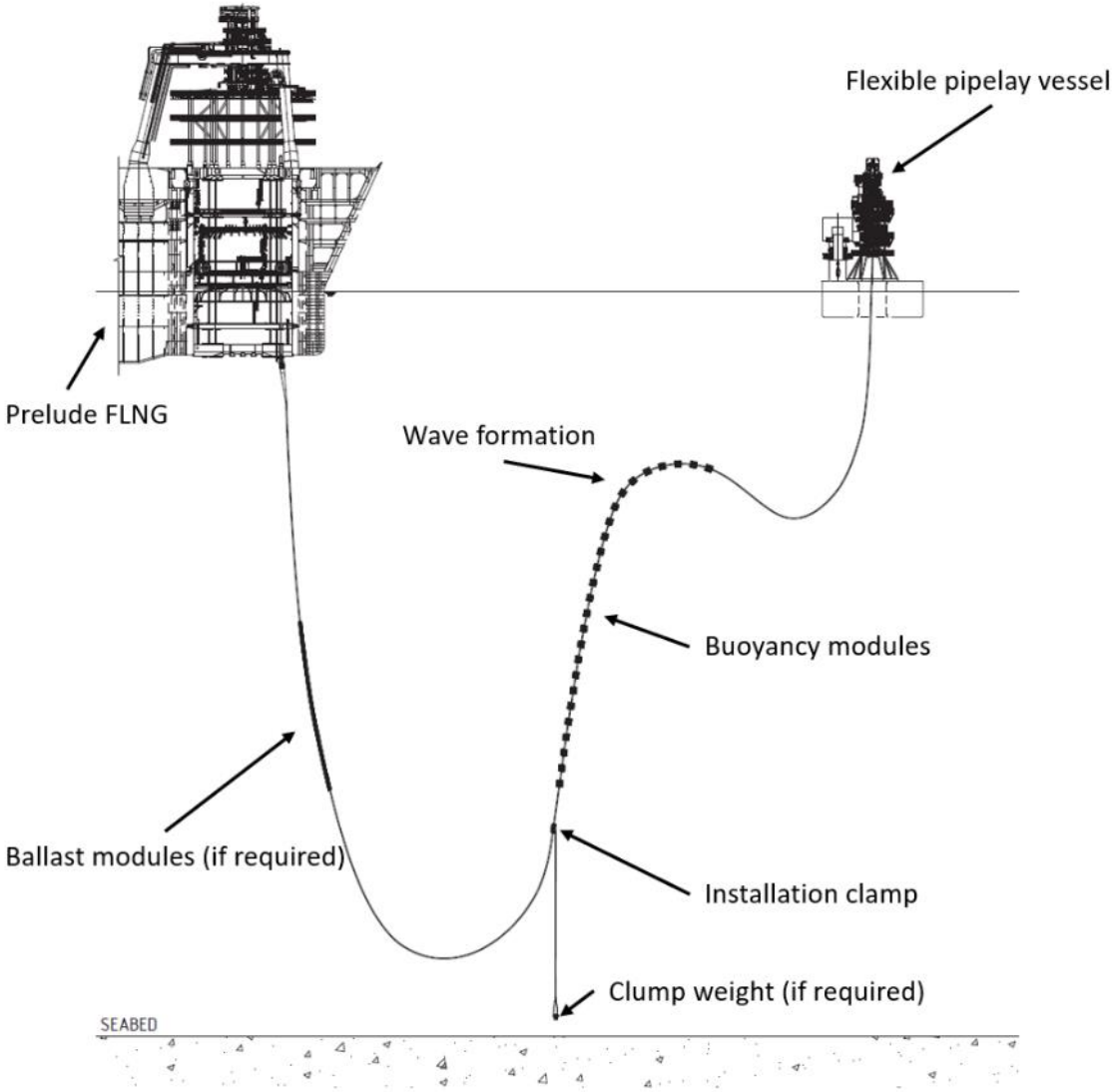


Figure 6-15: Riser Installation

Figure 6-16: Example of UCON

6.9.6.2 Prelude Dynamic Umbilical Installation

A manufactured dynamic umbilical will be filled with hydraulic control fluid and stored on a large-diameter reel on the flexible pipelay vessel deck. The lay direction is likely to start from the Prelude FLNG and move towards the Prelude PLET.

Preparatory works for umbilical installation will start after the flexible riser is installed. These preparations include post-load out umbilical testing, wet-parking of the umbilicals (if required), as-found survey of the previously installed subsea structures and preparing the flexible pipelay vessel for the umbilical pull-in (including setting up tensioners and the umbilical reel).

The process of umbilical lay is very similar to the flexible riser lay. The lay direction is likely to start from the Prelude FLNG and move towards the Prelude-end PLET. The flexible pipelay vessel will then use the whipline and deck winch to recover the long-term protection cap and winch wire from the Prelude FLNG and then connect the FLNG pull-in wire to the riser pulling head. The bend stiffener latching mechanism connection and umbilical hang-off will be completed at the Prelude FLNG turret. The umbilical is pulled in and installed with a permanent hang-off collar.

Ancillary equipment (if required) including ballast modules, installation clamps, clump weights and buoyancy modules will be installed onto the umbilical using an inline method at the flexible pipelay vessel vertical worktable and then continually lowered from the vessel; an ROV will monitor the sag bend. Once all the buoyancy modules have been deployed, the umbilical will be laid in a lazy wave formation, monitored by ROVs.

The umbilical will be terminated with a UTH (as shown in Figure 6-17) which will be connected onto the Prelude PLET using vessel crane and ROV to assist. The seabed footprint associated with the dynamic umbilical is listed in Table 9-33.

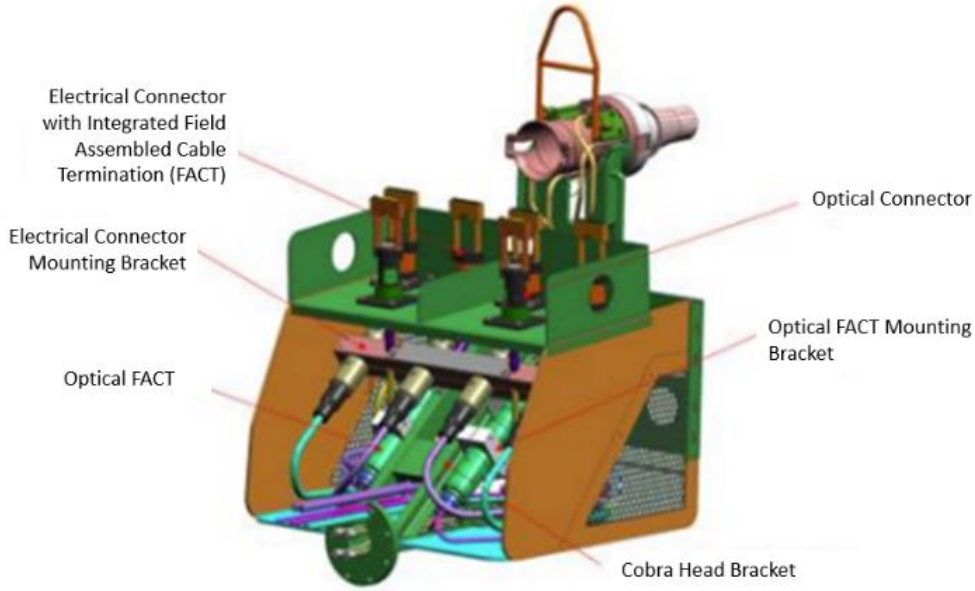


Figure 6-17: Example of UTH

6.9.6.3 Prelude-end UTH and EFL/SFL Tie-In

The Prelude-end UTH will be repositioned once the Prelude-end umbilical is installed. The turning bollards that were placed near the Prelude-end umbilical initiation location to allow a 5 m overlength are to be recovered (bulka bags are cut and recovered empty). ROVs will help reposition and connect the Prelude UTH to the Prelude-end PLET. The Prelude-end umbilical will be tested for leaks (as per Section 6.10.1.3) before the final Prelude EFL/SFL (including hydraulic jumper) tie-in (the EFL/SFL will connect the UTH and the Prelude-end PLET).

6.9.7 Crux Substructure Installation

The Crux substructure is a fixed steel lattice-type jacket (see Figure 6-18) with drilled and grouted piled foundations that will be installed over the pre-drilled wells and the substructure drilling template (outside the scope of this EP). For clarity, piling and drilling will not occur at the same time.

Figure 6-18: Example of Substructure

6.9.7.1 Substructure Launch, Wet Tow and Positioning

The substructure will be launched from the substructure transportation barge ~5 km from the installation location. The substructure transportation barge will use a system of double-action hydraulic jacks to initiate the substructure launch before launching. Up to three support vessels will be rigged to the wet tow connection points located on the substructure. The two support vessels rigged to the substructure transportation barge will be reset for the wet tow activities. The substructure will then be launched and upended using the substructure transportation barge rapid flood ballast system (see Table 6-13 for ballast volumes). If required, corrective ballasting may be required to reposition the substructure. The substructure will then be wet towed to the installation location. Once in position, the construction vessel will lift the substructure ~3 m to gain positive control and then lower it to the seabed with the assistance of controlled ballasting of the substructure's compartments, and Auxiliary-Buoyancy Tanks (ABT) via actuated valves controlled from the construction vessel. The substructure will be positioned over the docking piles located on the previously installed substructure drilling template (installation outside the scope of this EP) (see Figure 6-19). The substructure will then be lowered onto the primary docking pile for initial engagement then continue to be lowered onto the secondary docking pile until it reaches the seabed (see Figure 6-20).

The remaining substructure compartments will be flooded to provide additional stability and counteract the buoyant forces acting on the substructure. Once set down, the ABTs will be retrieved (via deballasting with air) and recovered to the vessel deck or configured for wet tow for transportation from the Activity Area. The ABT deballasting will result in the release of approximately 8,100 m^3 of locally sourced sea water. The internal lifting tools and pile sleeve diaphragms will also be retrieved and recovered to the construction vessel or supporting vessel for removal from the Activity Area. Once completed, an as-built survey will be conducted (see Section 6.9.1).

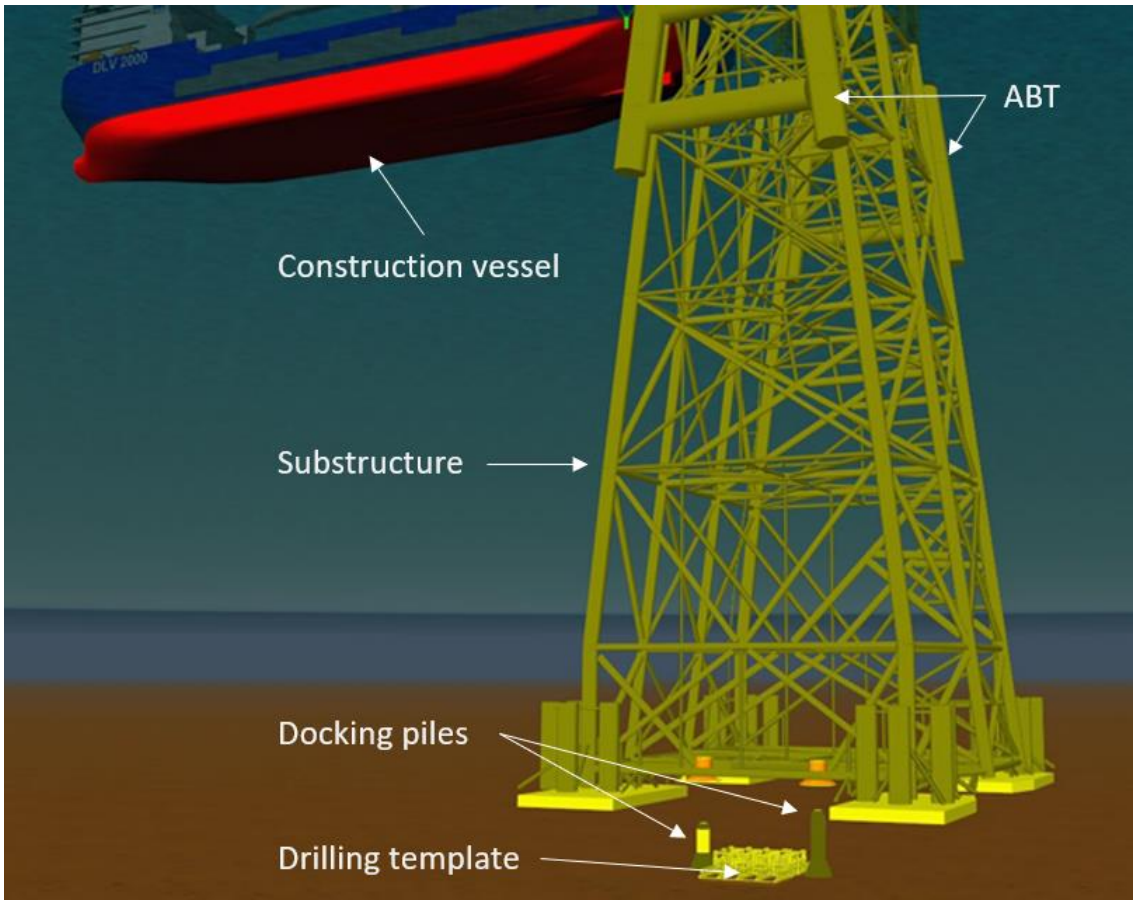


Figure 6-19: Example of Substructure Positioning and Set-Down

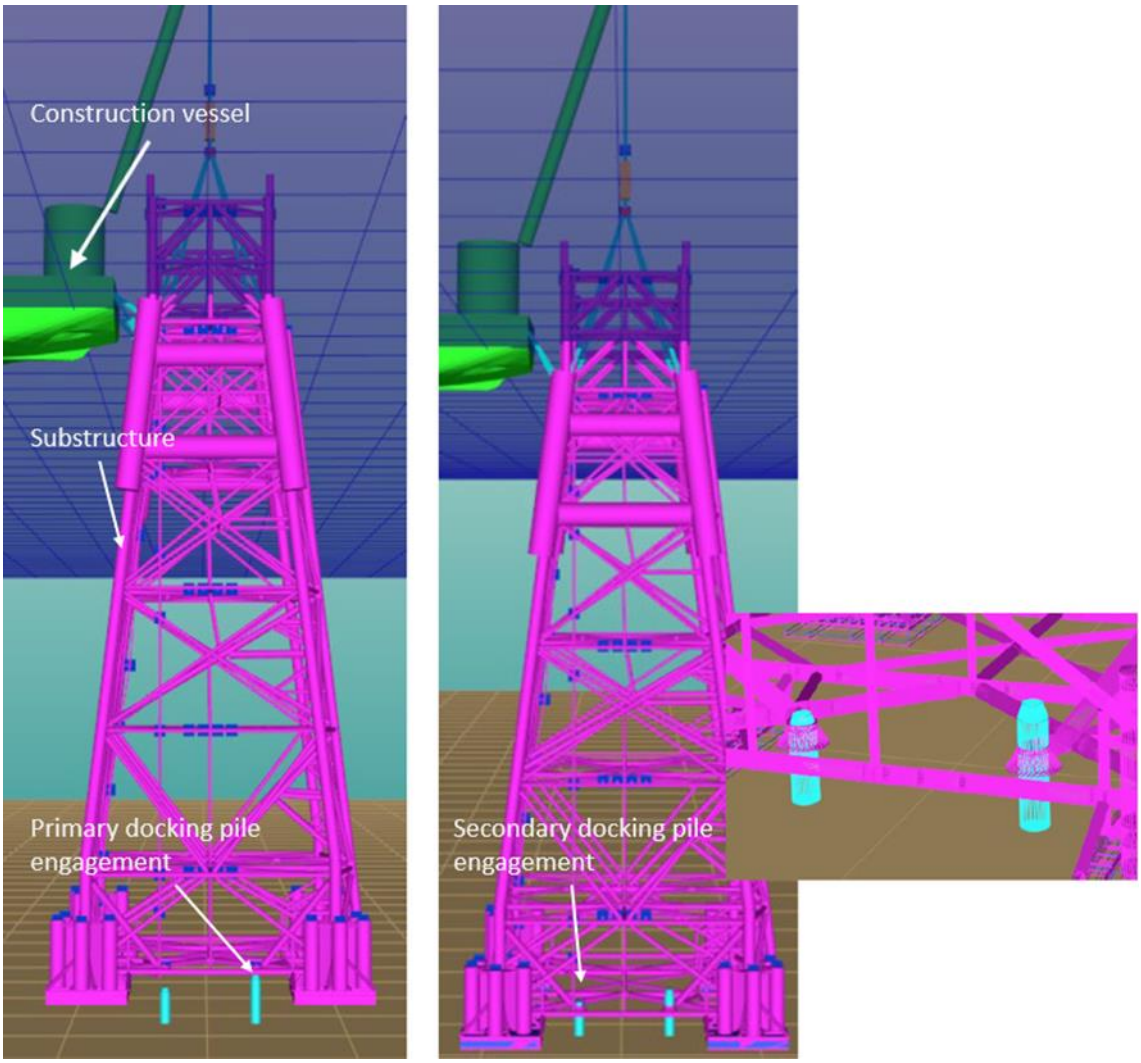


Figure 6-20: Example of the Substructure Docking Pile Engagement

6.9.7.2 Primary Pile Installation

The primary pile installation activities will commence after the substructure set-down activities have finished.

Each of the 16 primary piles will be lifted horizontally from the supply vessel to the upending station by the construction vessel. A pin and collar method will be used to transition each primary pile from a horizontal to a vertical position, as shown in Figure 6-21 and Figure 6-22. Once vertical, each primary pile will be stabbed and lowered into the pile sleeves with the assistance of ROVs. The nature of the soil at the Crux substructure location means that the primary piles are likely to penetrate through most of the soil profile under their own weight (Fugro 2019). Each primary pile will be driven, one at a time, into the seabed using a hydraulic hammer (likely options include the Menck MHU 500T [MHU 500T], Menck MHU 800S [MHU 800S] or Merwede IHC 800S [IHC 800S]).

Once the target depth is reached, each primary pile will be grouted to the pile sleeves. The grout downlines and clump weight will be deployed from the construction vessel to the seabed. An ROV will be used to position the grout downlines and inspect them after flushing to confirm their structural integrity before commencing grouting operations. Once the integrity is confirmed, a liquid cement slurry will be pumped from the vessel via the downlines. After each grouting operation, the grout downline will be flushed (~21 m^3 per line), subsea (approximately 170 m below waterline) to ensure the grout does not set in the downline between filling operation. Figure 6-24 shows an indicative cross-section of the arrangement and positioning of the installed primary piles.

The internal lifting tools will be recovered to the construction or supply vessel.

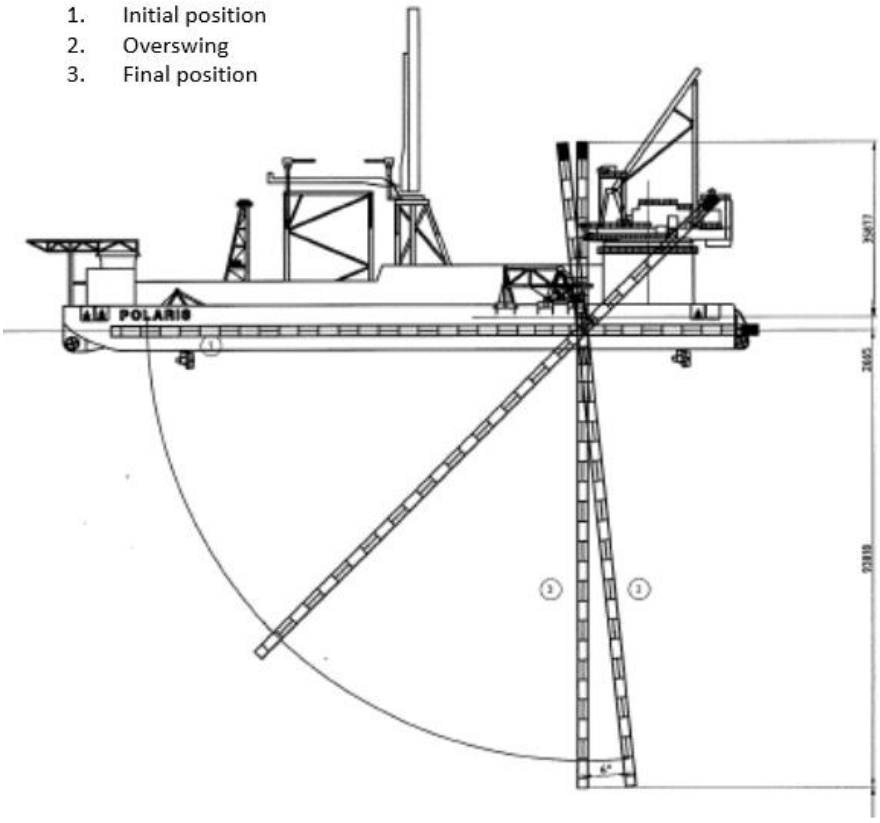


Figure 6-21: Schematic of Primary Pile Upending (Pin and Collar Method)

Figure 6-22: Example of Primary Pile Upending (Pin and Collar Method)

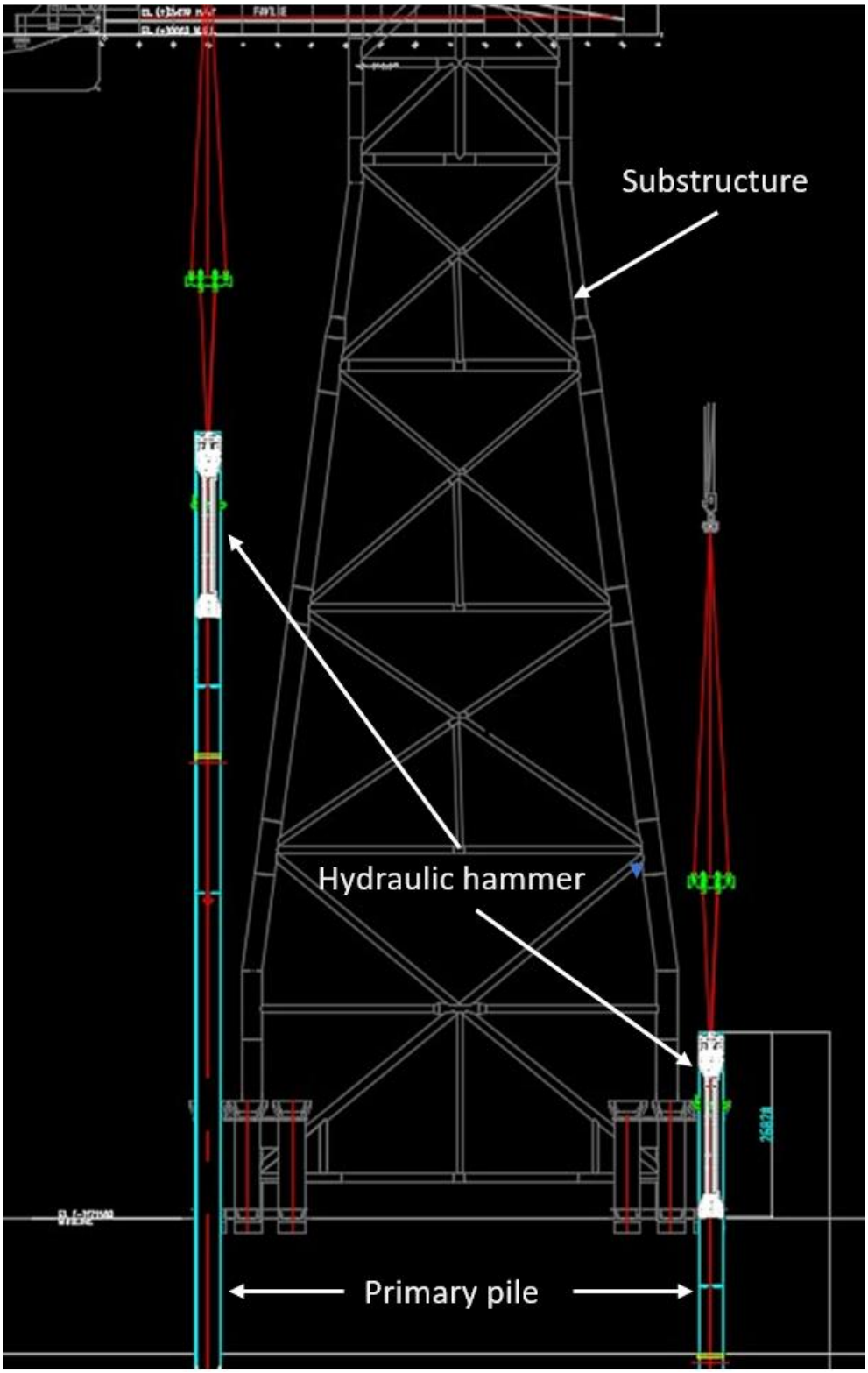


Figure 6-23: Example of Pile Driving Process, noting that only a single hydraulic hammer will be used during the piling activity.

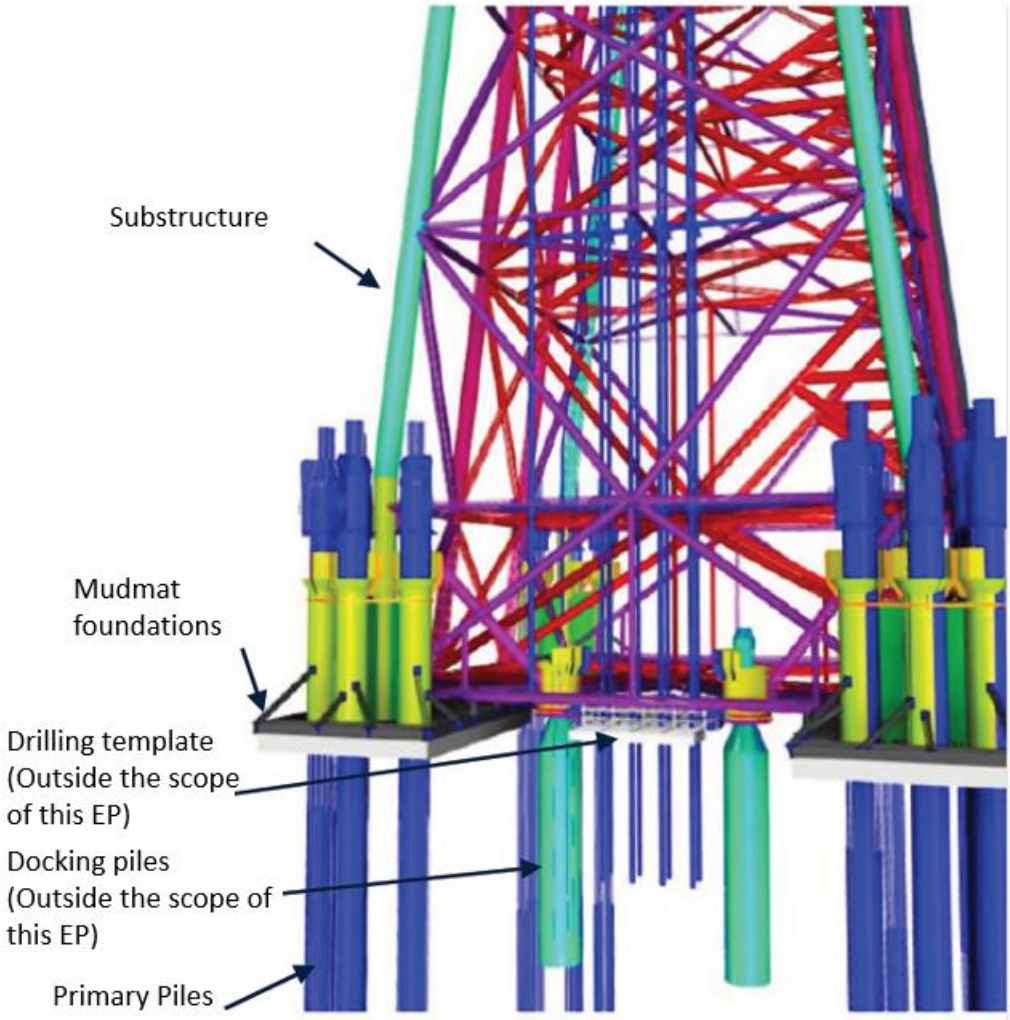


Figure 6-24: Cross-section of Indicative Installed Primary Piles

6.9.7.3 Insert Pile Installation

An insert pile is a component used to extend the length and enhance the load-bearing capacity of primary piles. Once all the primary piles have been installed, a temporary pile drilling spread will be set up on top of the substructure (see Figure 6-25 for an indicative pile drilling spread). A construction vessel will be used to lift the required pile drilling components from the supply vessel and position them on the substructure. After the components are in place, the caisson, which serves as a foundation for the two temporary drilling rigs, will be lifted horizontally to the upending station, then upended to a vertical position and placed over the relevant primary pile. The construction vessel then lifts the temporary drilling rig onto the caisson. Once in place, services are established to support the drilling operation. This includes providing power, communication and utilities to facilitate insert pile drilling activities. The pile drilling spread will be dynamically configured and adjusted based on the specific activity being carried out.

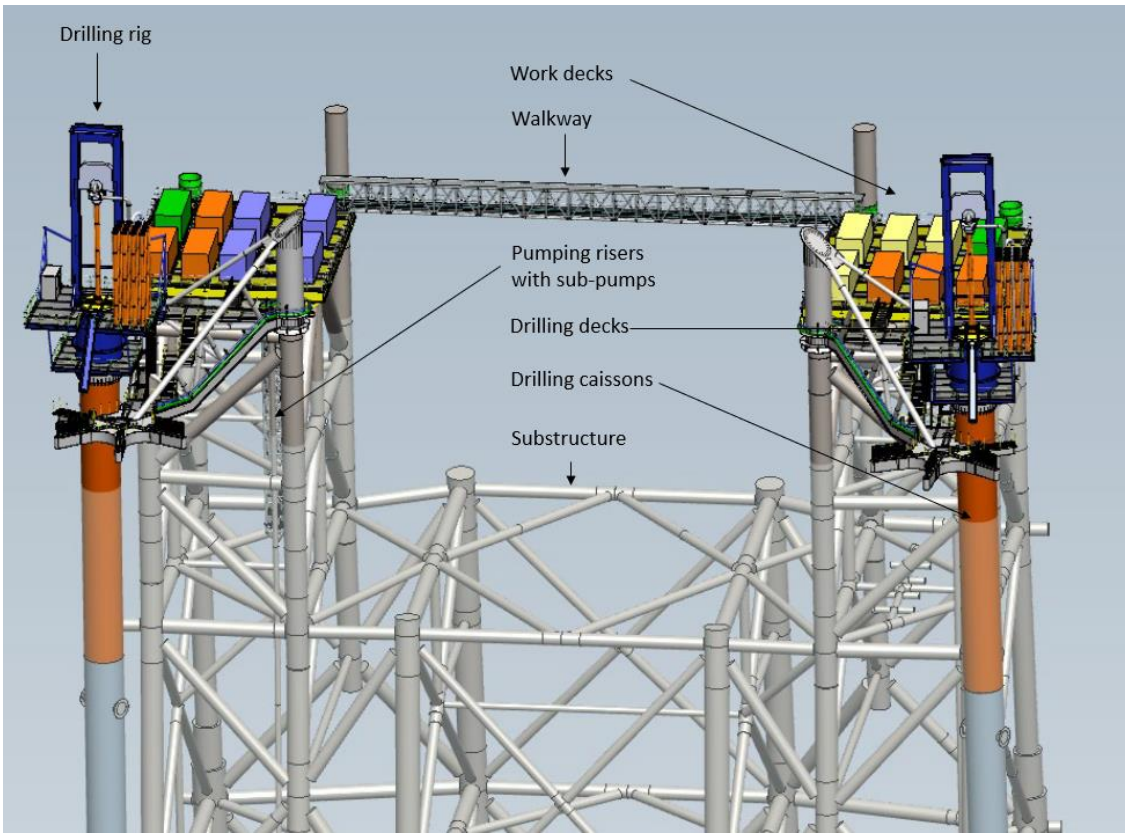


Figure 6-25: Indicative Temporary Pile Drilling Spread, noting that only a single drill rig will be operated during the drilling activity.

Each insert pile location will be drilled using a conventional Down The Hole (DTH) drilling rig, one at a time, which uses untreated sea water instead of drilling fluid/mud. Up to 14 holes (12 nominal and 2 contingency) will be drilled to a target depth of ~155–165 m below the mudline. The drill hole diameter will be ~2.9 m. The holes will be sequentially drilled one at a time, with a marine riser in-place which will enable the drill cuttings and untreated sea water to be circulated back to the temporary pile drilling deck. The drill cuttings and untreated sea water (~1400 m^3 per hole) will then be discharged to the marine environment from the drilling deck discharge point (~18 m above the waterline). The duration of the DTH drilling activity is likely to be conducted over ~30-35 days with an estimated duration of ~16 hours per hole.

Following the drilling (and verified by a drill hole survey [see Section 6.9.1]), grouting operations, which provide a structural base for the insert pile, will start. During grouting operations, equipment and lines will undergo initial testing using water and an inert dye. Once grouting is complete, the equipment and lines will be flushed, washed and cleaned with sea water to prevent hard setting. The residual grout and wash water will be discharged to the environment after each pile (~21 m^3 per line; ~14 flushes). Then the caisson will be removed and relocated to the next pile location using a supply vessel. The construction vessel will lift the insert pile from the supply vessel, vertically orientate and align it with the caisson. Once positioned, the construction vessel will lower the insert pile into position. The internal lifting tools will be retrieved using the construction vessel after the insert pile has been installed. A similar process will be used for the remaining 13 insert piles.

6.9.7.4 Topsides Preparation

The Leg Mating Units (LMUs) are vital components for aligning the substructure and the topsides deck and reducing impact loads between the topsides deck and substructure during the floatover (see Figure 6-26). Each LMU is installed on the substructure and comprises a receptor, vertical and circumferential elastomer pads, and outer sleeves. The receptor is a unit with a cone that matches the stabbing cone located beneath the topsides deck leg. It is designed to securely house the stabbing cone during load transfer. The elastomer pads and rings are specifically designed to attenuate shock and dynamic loads between the stabbing cone and receptor in both lateral and vertical directions.

The LMU installation process involves conducting a level survey of the substructure and preparing the substructure legs (e.g. cutting, welding, sand blasting, if required). The LMUs are then positioned and welded into place, ensuring readiness for the subsequent topsides installation activities, as described in Section 6.9.8.

Once the final insert pile and LMUs (including weather cover) are installed, the temporary pile drilling spread will be backloaded, unless the equipment is required for the floatover of the topsides (see Section 6.9.8). The hammer hose hydraulic lines will be cut by an ROV and recovered using the construction vessel. This will result in a negligible volume (~0.5 m^3) released to the environment (approximately 170 m below the water line). The hydraulic fluid used, such as Shell Tellus T46™ or similar, will be selected using the chemical selection process (see Section 10.1.6).

6.9.8 Topsides Installation

The floatover topsides installation method uses a topsides HTV to transport the topsides as a single integrated unit to the substructure location. Once the topsides HTV is in position over the substructure, the topsides are lowered by ballasting until the topsides is landed onto the substructure. During this operation it is critical that the position of the topsides HTV is maintained and controlled over the substructure.

6.9.8.1 Floatover Preparation

After the substructure is installed, it will be prepared to receive the topsides—preparation activities will include installing survey equipment (e.g. tide gauges), initiating the equipment on the topsides HTV (e.g. CyScan™ reflectors, RadaScan™ transponders), and installing welding housing and scaffolding materials onto the substructure. The previously installed substructure (see Section 6.9.6) and LMUs (see Section 6.9.8.3) will be inspected using a combination of in–person and ROVs. If required, maintenance and repair activities may occur, such as the removal of debris and marine growth. The topsides HTV will also prepare for the floatover outside of the PSZ—these preparations test various functions, including the DP, entry/exit simulations, ballast control system (to the required standards), environmental condition, and vessel motion monitoring system. The topsides HTV will discharge ~12,000 t of ballast water to achieve the desired floatover draft. Before starting the floatover activities, the sea fastenings that secured the topside structures during transportation will be prepared, and the upper sea fastening will be partially cut (the cut-off stubs will be lowered to the deck and secured).

6.9.8.2 Floatover

Once the floatover preparation is complete and the testing requirements have been met (see Section 6.9.8.1), the topsides HTV will move into position to commence the floatover activities, which involve docking (entry) operations. The topsides HTV will be moved (under DP) into the substructure slot with a contingency support vessel within the vicinity. Once at the mating position, the mating mooring lines will be connected between the topsides HTV and the substructure to ensure precise alignment and accurate placement over the LMUs. The topsides HTV will be positioned with an initial clearance between the LMUs on the topsides and substructure of ~1.5 m (see Figure 6-26). The topsides HTV will rapidly ballast (using locally sourced water) once initial contact is made between the topsides and LMUs the remaining sea fastenings will be cut. Ballasting will continue until the LMUs are fully engaged and all the weight has transferred to the substructure. When there is adequate clearance (nominally 1.25 m) from the Deck Support Unit (DSU) to the topsides cellar deck (see Figure 6-27). The topsides HTV will start the undocking (exit) operation by exiting (under DP) from the substructure slot. A support vessel will remain within the vicinity to assist if required, during the floatover activities.

6.9.8.3 Post-floatover Activities

After completing the topsides installation, the welded connection between the topsides and substructure legs will be completed and tested. Painting (and selective sand blasting if required) of the weld lines and any areas of coating damage caused by the floatover operation and temporary attachments will occur. This process will require temporary scaffolding, enclosed areas and welding housing.

All utility and process systems necessary to enable other contractors to commence work on the topsides will be reinstated, including all essential services and utilities. During this time, temporary power will be established using diesel generators.

Other post-floatover activities include decommissioning, removing and recovering temporary equipment and structures from the topsides and substructure (where no longer required to support subsequent activities), including piping for the diesel connections to GTG, mooring lines (if applicable), scaffolding, welding housing,

rigging, removable installation aids, the environmental monitoring system, temporary navigation system (if used), and temporary access and walkways.

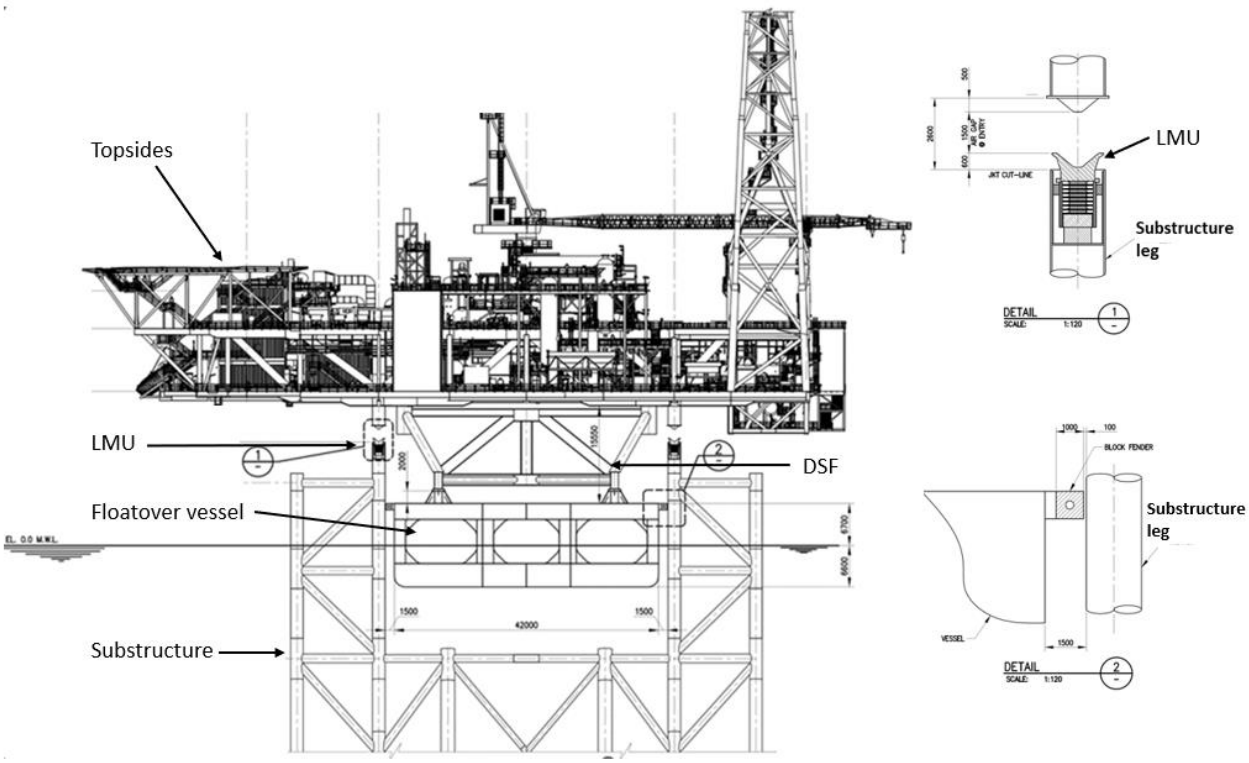


Figure 6-26: Cross-section of the Indicative Topsides Mating Operation (1st Phase)

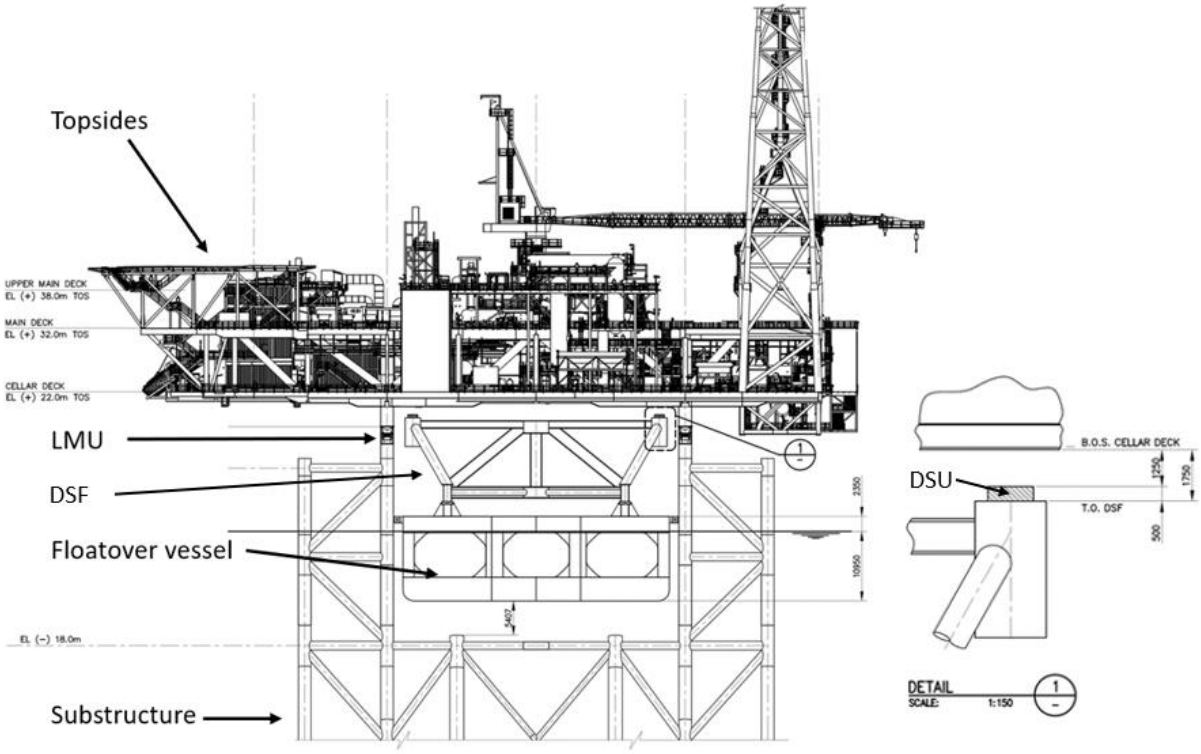


Figure 6-27: Cross-section of the Indicative Topsides Mating Operation (Final Phase)

6.9.9 Crux Topsides Tie-Ins

6.9.9.1 Crux-end Rigid Riser Tie-in Spool and Subsea Tie-in Spool

Two rigid spools will be installed at Crux–end—one is a topsides spool which will connect the topsides piping to the export riser within the substructure and the second is a subsea spool which will connect the substructure riser to the subsea pipeline (via the Crux PLET).

Figure 6-28 illustrates the subsea Crux riser subsea tie-in spool and mattresses. The prefabricated rigid riser spool will be altered (via welding and based on the precise dimensions confirmed using acoustic metrology (see Section 6.9.1). The construction vessel will install mattresses from a supply vessel onto the seabed using the construction vessel crane, followed by the subsea spool. During installation, an ROV will position and orient the supporting structures. The subsea spool connections will then be tested (refer to Section 6.10.1.4).

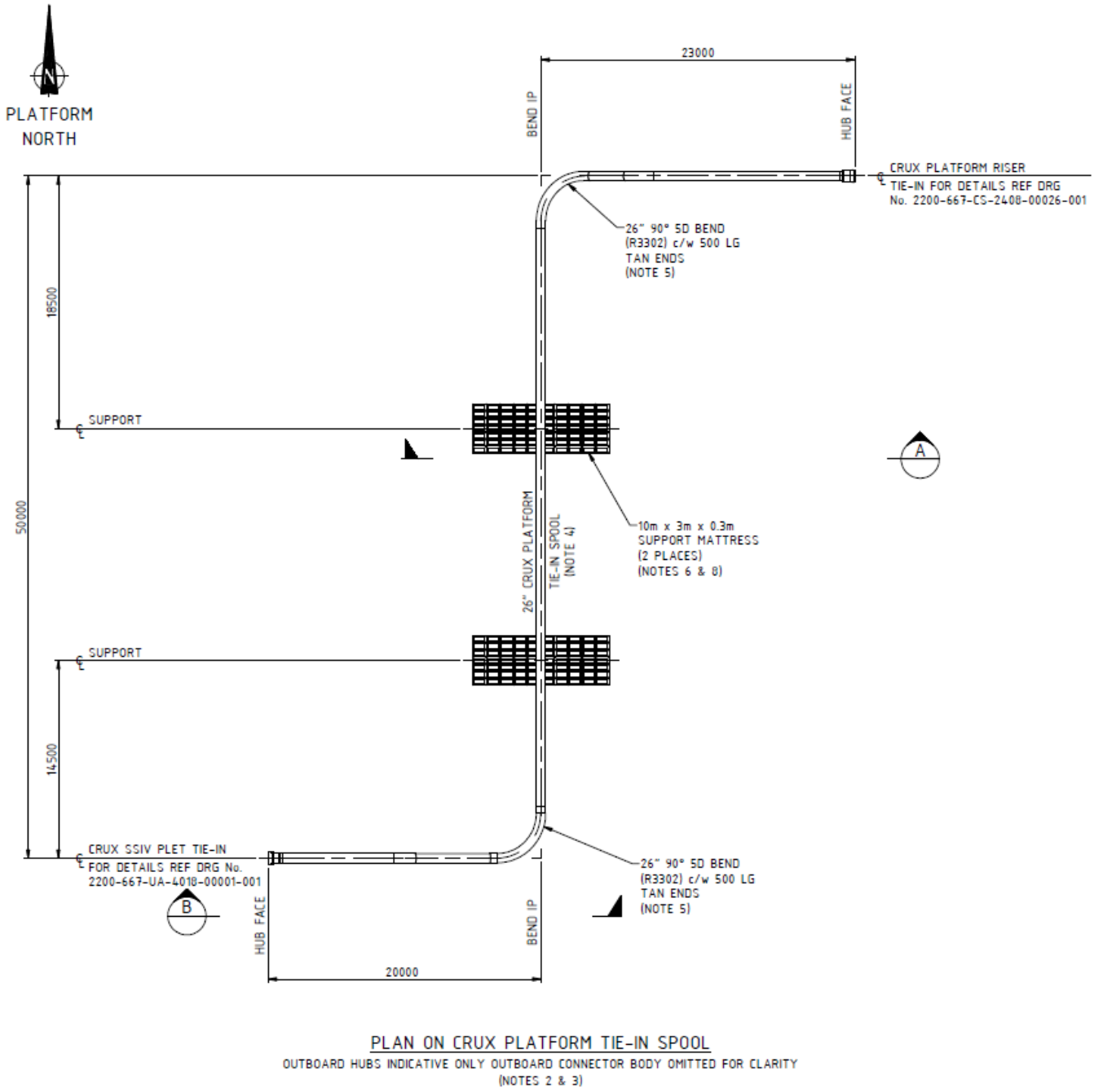


Figure 6-28: Preliminary Crux Riser Subsea Tie-in Spool

6.9.9.2 Crux-end Umbilical Installation

The umbilical J-tube will be pre-installed onto the substructure. After topsides has been installed (see Section 6.9.8), the umbilical j-tube will be connected to the topsides via a j-tube spool. The j-tube spool will be positioned and installed (bolted connection) using a temporary hoist system on the topsides cellar deck. Subsequently, the umbilical installation will occur. One Crux-end static umbilical will be pull-in via the umbilical J-tube with a temporary winch on the topsides cellar deck. The subsea-end of the umbilical will be connected to the Crux-end PLET foundation multi-quick connect (MQC) panel and the topsides-end of the umbilical will be hung-off at the topsides cellar deck, ready for termination. The prefabricated umbilical hydraulic tubes will be pre-filled with water-based hydraulic control fluid and stored on a large diameter reel on a pipelay or reel-lay vessel deck.

To commence the umbilical laydown, a messenger wire located in the umbilical J-tube, is recovered to the vessel then connected to the umbilical pull-in hang off assembly. The vessel will deploy the umbilical and the umbilical is pulled-in through the J-tube using umbilical winch and hang-off (see Figure 6-29). Once the umbilical has been hang-off, ROV's will help reposition and connect the Crux-end UTH to the Crux-end PLET foundation MQC panel.

The Crux-end umbilical will be tested for leaks (as per Section 6.10.1.3) before the final Crux-end EFL/SFL tie-in (the Crux-end EFL/SFL will connect the UTH and the Crux-end PLET).

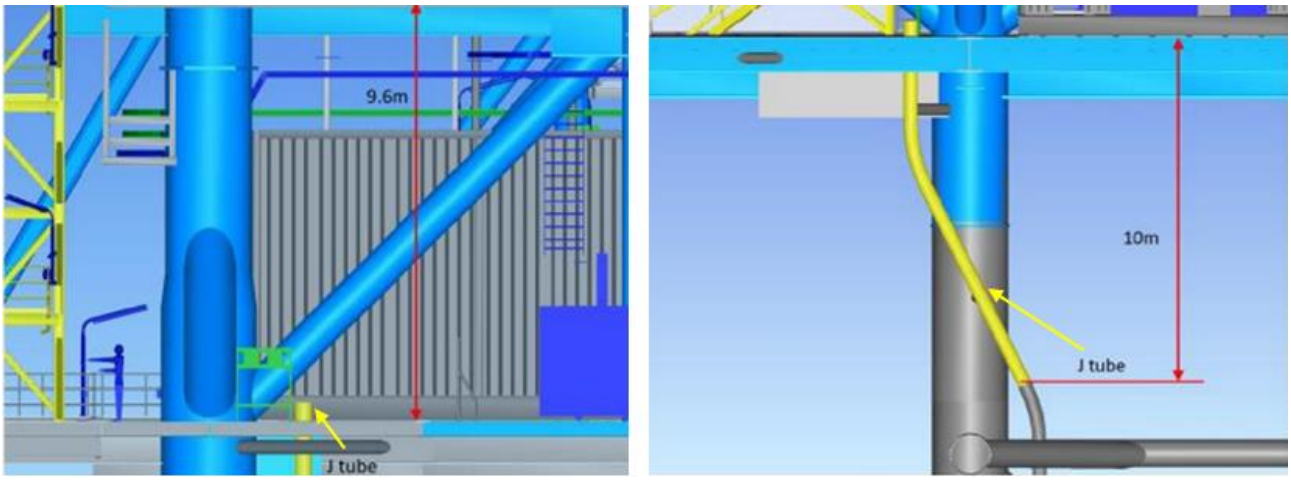


Figure 6-29: J-Tube (left image: umbilical pulling location on the topsides; right image: J-Tube example)

6.9.9.3 Fibre-optic Jumper

The fibre-optic jumper will be installed by lowering a flying lead deployment frame (see Figure 6-30) to the seabed in between the Crux-end PLET and Fibre-optic Cable Termination (FOCT). An ROV will unspool the fibre-optic jumper then connect it to the Crux-end PLET and FOCT. The Subsea insolation valve (SSIV) hydraulic lines will be routed and terminated at the hydraulic wellhead control unit. After installation, the flying lead deployment frame is recovered.

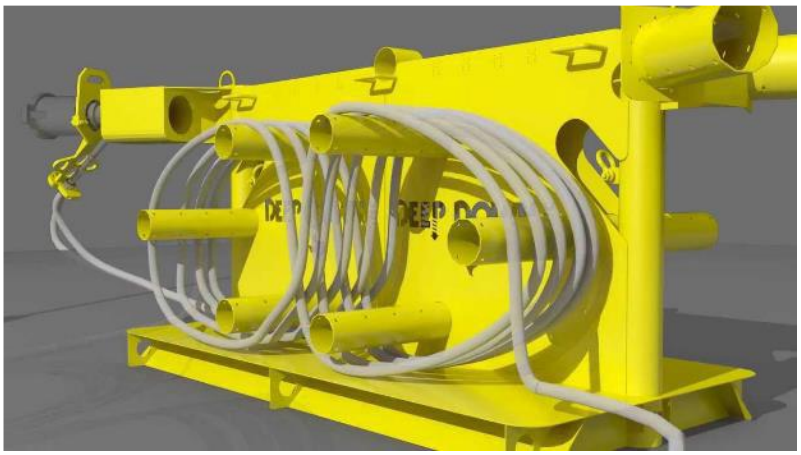


Figure 6-30: Typical Flying Lead Deployment Frame

6.9.9.4 Well Tie-Back, Upper Completions and Dry Xmas Tree Installation

After the topsides has been installed, the well tie-back and upper completion activities will occur. The well perforation, lower completions and clean-up activities are out of scope for this EP and covered under the Crux Completions, Hot Commissioning, Start-up and Operations EP/s. Removal of the two verified barriers located in the intermediate and lower completions is out of scope for this EP, hence no access to reservoir sands is credible during this phase.

A Hydraulic Workover Unit (HWU) or similar (see Figure 6-31) will be temporarily installed on the topsides platform using approximately two vessels supported by ROV operations. The HWU will be used to prepare the subsea wellhead, tie-back (see Figure 6-32), run an upper completion and install a dry (surface) Xmas tree (See Figure 6-33) for each well. Section 6.10.1.4 describes the pressure test requirements for this activity.

After all the dry Xmas trees are installed, the temporary equipment if no longer required will be removed and the HWU will be demobilised and backloaded onto the project vessel(s). The well tie-back, upper completions and dry Xmas tree installation activity is likely to take approximately 120 days. Note: Shell's Well Operation Management Plan – Crux Development, Well Construction Phase 1 (Shell document number: 2200-010-ZW-5880-00007) describes these activities in detail.

Figure 6-31: Indicative Hydraulic Workover Unit

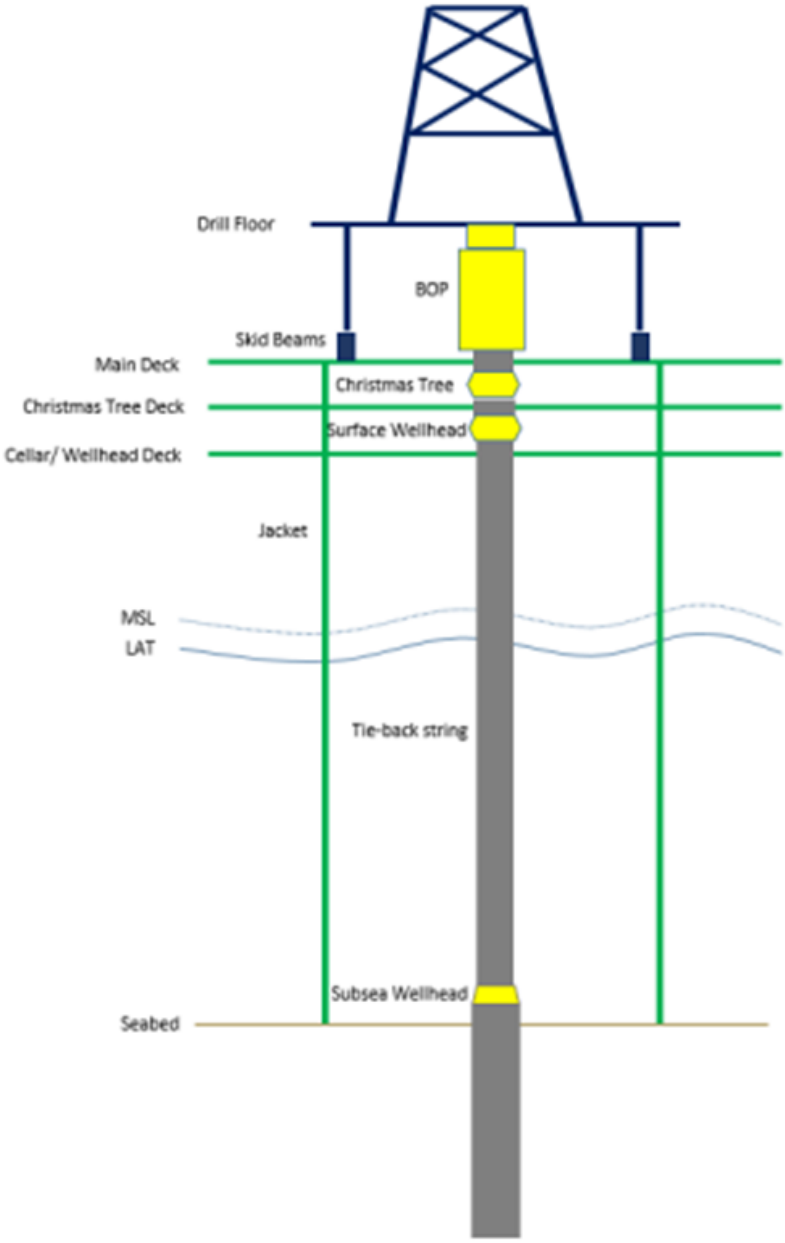


Figure 6-32: Indicative Schematic of Tie-back and Completion of Well

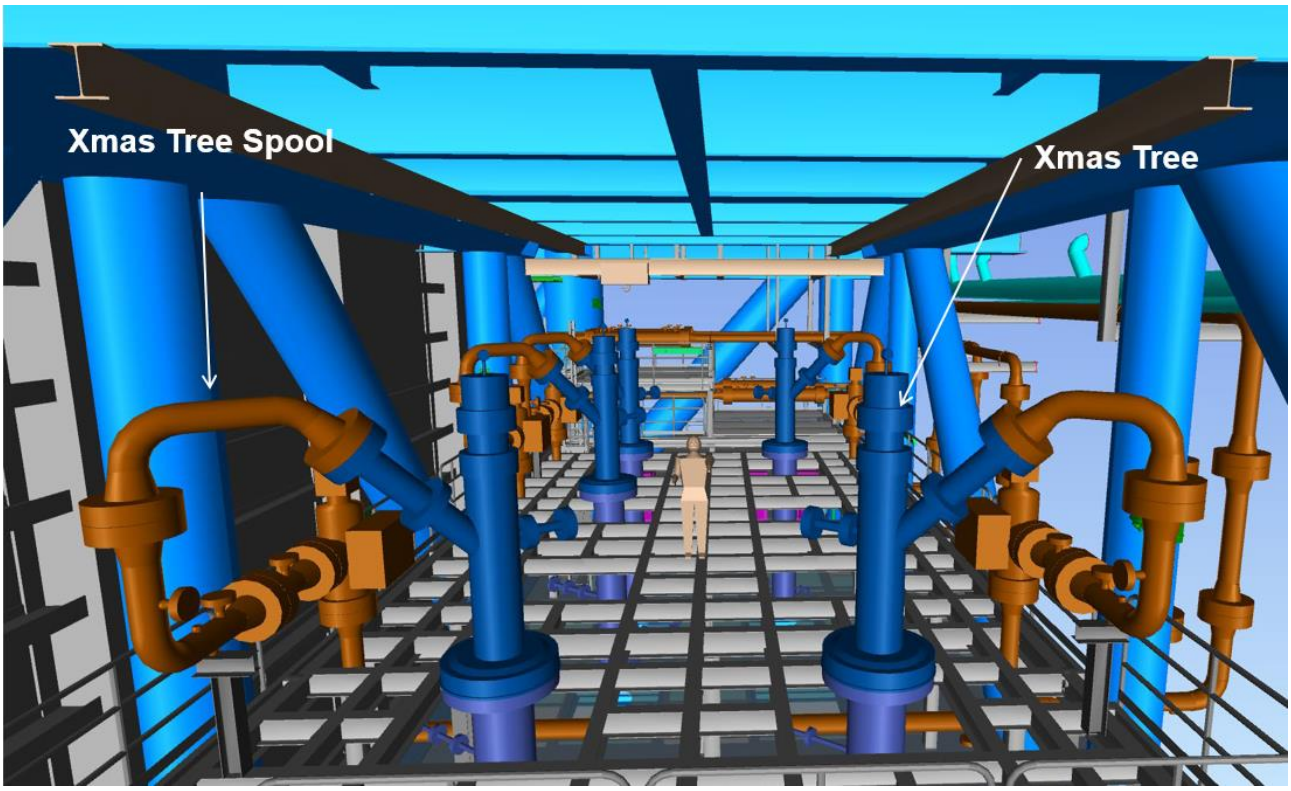


Figure 6-33: Dry Xmas Tree and Tie-in Spool Example

6.9.10 Prelude FLNG Modifications for Crux Tie-in

The Prelude FLNG Modification for Crux Tie-in (PMCT) activities shall provide the Prelude FLNG facility the functionality to process the Crux production fluids. The modifications will also enable the future remote operation, communication with the Crux facility and commissioning of the Crux pipeline, including disposal of fluids produced during Crux pipeline pre-commissioning (Refer Section 6.10.1.5).

The Crux production must remain within Prelude FLNG integrity limits for all operating modes, therefore these modifications do not change Prelude's FLNG production capability. Turret modifications shall be performed to allow the tie-in of the 16-inch Crux flexible riser through the existing guide-tube slot. This includes the installation of the riser bend stiffener connector and a riser emergency shutdown valve to provide emergency isolation on the Prelude FLNG.

The installation of a vertical pig receiver will allow receipt of pigs from the Crux facility. The pig receiver shall be designed to accommodate all operational pigging requirements, including initial pipeline pre-commissioning activities (such as de-watering) and periodic inspection or intelligent pig running.

Due to the requirements to separately meter the Crux fluids and the incompatibility of Crux fluids with Prelude fluids until they are heated (due to hydrates), the Crux fluids require their own upstream processing train. Figure 6-34 below illustrates the planned process flow for the modifications to enable a separate Crux train.

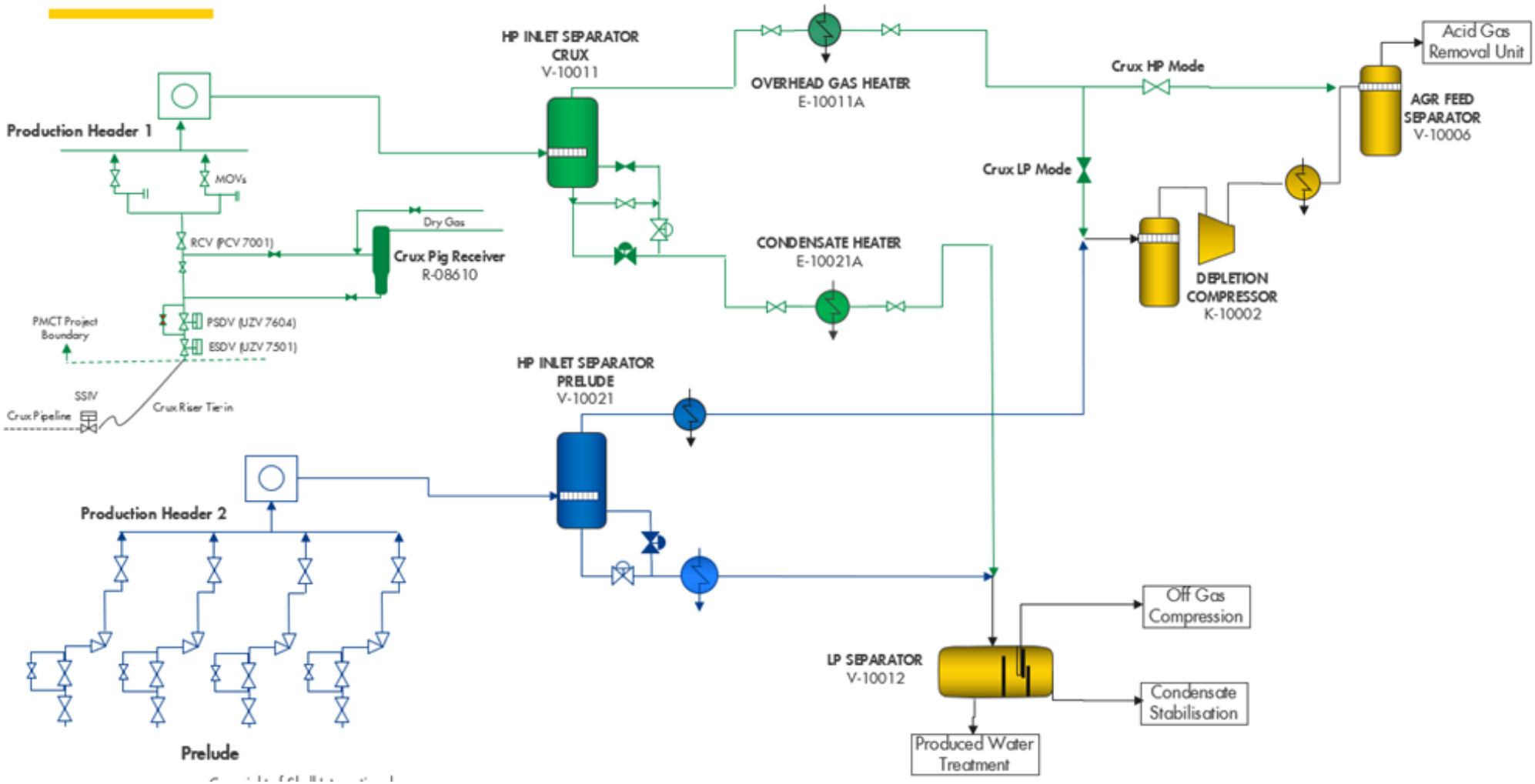


Figure 6-34: Process Diagram showing Crux Upstream Processing Train (green) and the Prelude Upstream Processing Train (blue)

6.9.10.1 Physical Modifications

The physical modifications to Prelude FLNG include the following activities:

1. Verification and modifications of the processing facilities such as equipment, piping, valving instrumentation etc., downstream of the receipt point. The receipt point is the point where the production riser in the Crux facilities physically connects to the upstream flange of the emergency shutdown valve on the Prelude FLNG facility.
2. Any topsides equipment required on the Prelude FLNG to terminate and interface the Crux subsea equipment including a pig receiver for the Crux pipeline.
3. Instruments Control and Telcom modifications to allow remote operation and communication with the Crux facility.

These PMCT Activities can be broadly broken down into three main scopes including:

1. Turret Modifications;
2. Inlet Facilities (U10000) Modifications; and
3. Instrument Control and Telecom (ICT) Scope.

6.9.10.2 Turret Modifications

During design and fabrication of the Prelude FLNG Turret, provisions were made for tie-in of future developments. Blinded off interfaces were prepared on all piping systems; including Production, Dry Gas, HP Flare Gas, MEG Injection, Chemical Distribution, Closed and Open Drain and Instrument Air. Similarly, foundations and supports were prepared for future installation of mechanical equipment, valves and piping.

The scope of work in the Turret is shown in Figure 6-35 and includes:

- New piping to tie the riser into the existing production header including emergency and process shutdown valves, choke valve, isolation valves, control and safeguarding systems.
- New pig receiver and associated control, safeguards and utility systems.
- Certification of existing production header, swivel and piping for Crux operating envelope.
- Installing two bend stiffener connectors

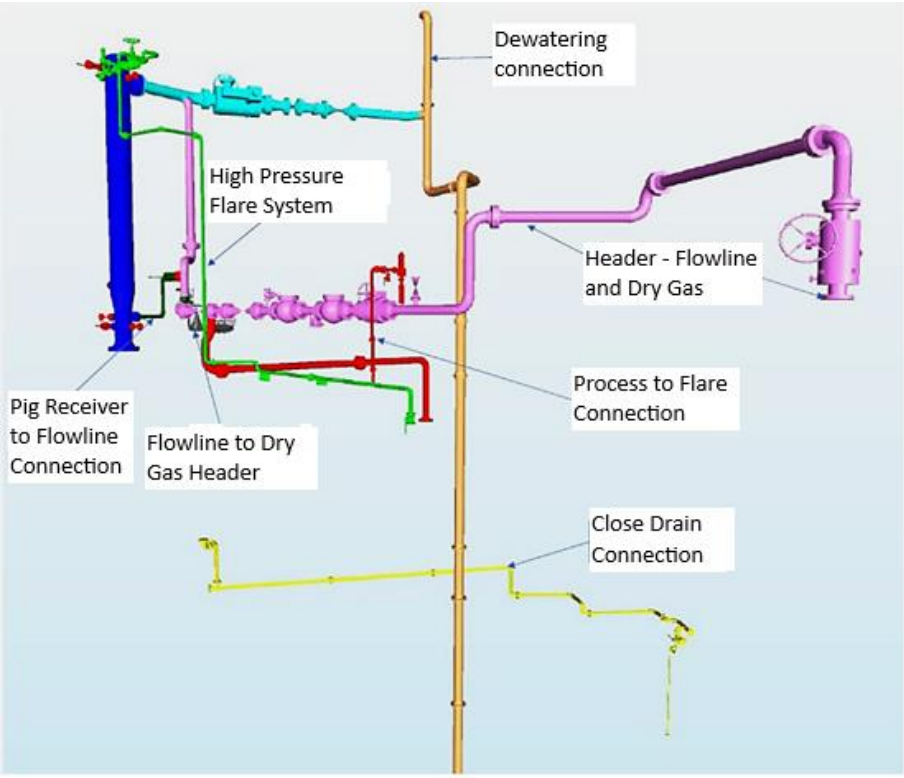


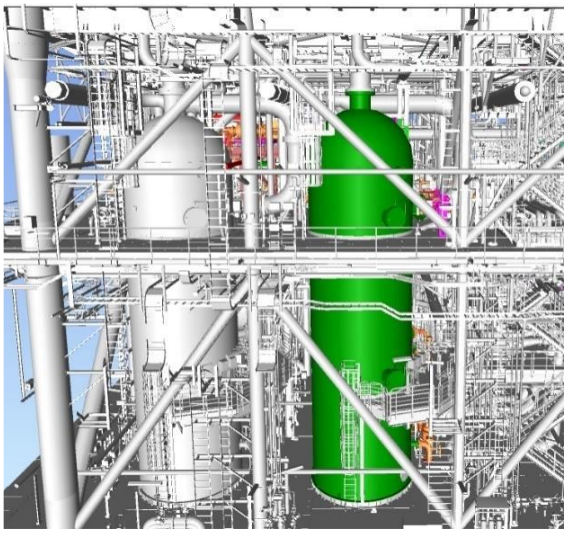
Figure 6-35: Schematic of the prelude turret modifications indicated by highlights.

6.9.10.3 Inlet Facilities U10000 Modifications

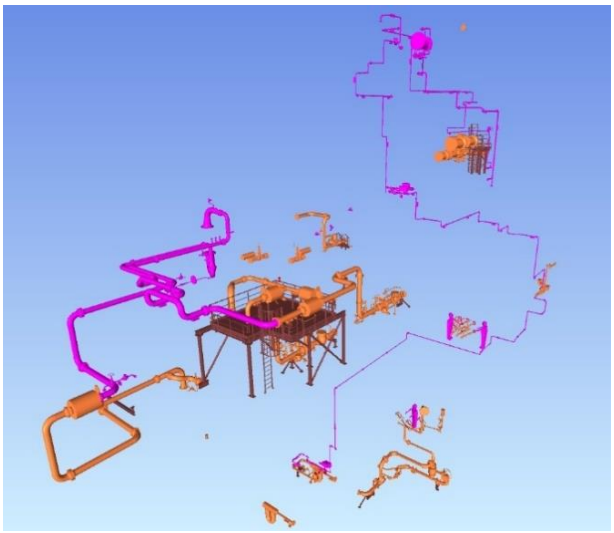
The Crux fluids arrive cold at the Prelude FLNG and require heating before mixing with wet Prelude fluids to avoid hydrate formation. The Crux liquids line will therefore be routed to an existing redundant gas heater in the Prelude inlet facilities. This will require piping modifications to the inlet system. Modifications to the Prelude FLNG HP Separator and liquid piping systems are required to increase surge volume to allow for faster ramp ups and more controller response time during start-ups.

The Scope of work in the Inlet facilities (U10000) includes:

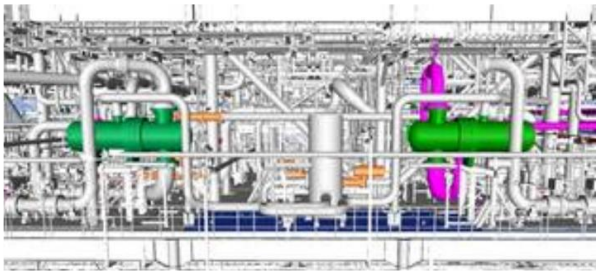
- Modification of the control system to manage Crux and Prelude Production. Including management of Crux low temperatures, Pressure and liquid surge from the Crux multiphase pipeline.
- Verification of existing piping and equipment for Crux operating envelope.
- Line up HP Separator to allow it to be re-purposed as a 2-phase separator with a larger liquid handling capacity (from Prelude 3-phase Separator).
- Certify the Prelude Gas GFLNG heater E10011A is suitable for the Crux operating envelope.
- Re-purpose the Prelude Gas GFLNG heater E10021A from a gas heater to a Crux condensate heater.
- Introduce MEG injection to manage hydrate risk.
- Allow valving and isolations to allow the Crux separator to be re-lined up to process Prelude fluids.
- Subsea Umbilical Control, Terminations and supply.
- Riser Monitoring System (Riser Vent Gas Monitoring System – RVGMS)



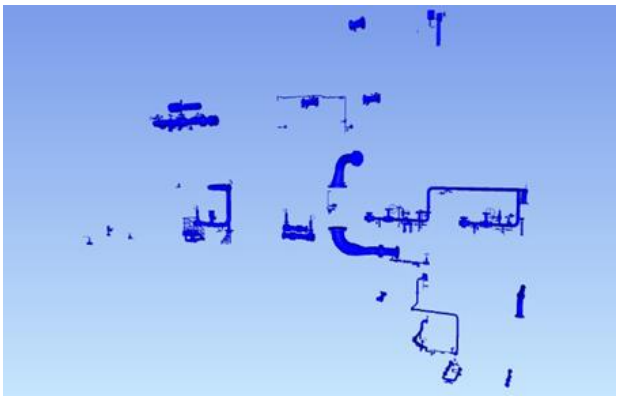
Re-purpose V-10011 as 2-phase separator



Construction Scope



Re-Purpose E10021A, Certify E10011A



Deconstruct Scope

Figure 6-36: Inlet separator PMCT scope overview.

6.9.10.4 Instrument Control and Telecom (ICT) Modifications

The Instrument Control and Telecom (ICT) scope is any scope required for the remote control, monitoring and communication with the Crux facility.

The scope includes integration of Crux into the following Prelude Systems:

- Telephony
- Public Access General Alarm (PAGA)
- UHF Radio
- VHF Marine / Airband Radio
- CCTV Process
- CCTV Security
- Weather (RTMMS)
- Access Control System & E-Mustering
- Network Management System (NMS)
- Communication Control Interface Radio System (CCIRS)
- Process Control Domain – Information Technology (PCD-IT)
- VSAT

- Critical Alarm Integration
- Instrumentation & Controls
- LAN WAN
- LTE (4G) Network

6.9.10.5 Phased Installation of PMCT works

The PMCT works will be executed in a phased manner as follows:

- **Pre Tie-in phase**: Installation of piping spools, equipment and structural supports in the Prelude Turret and U10000 (Inlet Facilities). This installation will not be connected to the existing Prelude processing systems and will remain unpressurised until the tie-in phase.
- **Tie-in**: During the next Prelude turn around, the pre-installed PMCT modifications will be tied into the Prelude FLNG processing and utility systems. No Crux production fluids will be introduced into the tie-ins under the scope of this EP. This will be addressed in a future revision of the Prelude FLNG EP. After the PMCT modifications have been commissioned the facility will be ready for start-up and to enable processing of Crux fluids on the Prelude FLNG facility.

6.10 Cold Commissioning Activities

After the key infrastructure (as listed in Table 6-1) is installed, cold commissioning activities for relevant infrastructure will be undertaken using a staged approach to ensure the integrity of the infrastructure and its connections. Cold commissioning activities also covers the operational use of the topsides permanent (e.g. reinstated utility and process systems) and temporary systems and equipment which do not involve processing or use of production fluids (which only become available once the wells are completed, which is out the scope of this EP).

The cold commissioning activities will be done in accordance with contractor's cold commissioning philosophy and project-specific procedures, which will be developed by the successful cold commissioning subcontractor and approved by Shell. The cold commissioning activities may include Flood, Clean, Gauge and Testing (FCGT), dewatering, nitrogen packing, flushing, cleaning and hydrostatic leak testing (leak testing).

Sections 6.10.1 to 6.10.2 describe the cold commissioning activities. Although unlikely, Section 6.11.1 describes the contingency cold commissioning activities that may be required that may result in additional discharge volumes.

6.10.1 Pipework Cold Commissioning

6.10.1.1 Pipework Cold Commissioning Fluids and Gases

The chemical selection process for the cold commissioning fluids is described in Section 10.1.6. The fluids to be discharged to the marine environment from this process include treated freshwater and treated sea water. Negligible volumes of other cold commissioning fluids may include but not limited to, hydraulic control fluids, cleaning products and chemical sticks.

Treated freshwater or treated sea water is water conditioned with a hydrotest mixture—similar to Hydrosure 0-3670R™ or Roemex Hydro 3—that is typically a mixture of biocides (to prevent biofouling on the internal surfaces), an oxygen scavenger and corrosion inhibitor (to control corrosion of the pipeline) and a dye (allows leaks to be detected through visual inspections). Treated sea water and freshwater will be dosed with the hydrotest mixture at a rate based on a defined preservation period (up to 500 mg/L).

Hydraulic control fluids will likely use water-based products that include a leak detection tracer such as Castrol Transaqua HT2™ or similar. Chemical sticks (biocide, oxygen scavenger and dye) may also be added during subsea tie-in activities and usually contain approximately 400 mL of fluid. Base oil completion fluid used for the wells will likely use a benign base oil such as Saraline 185V or similar.

6.10.1.2 Export Pipeline FCGT

After the export pipeline is installed, its internal surface will be cleaned and inspected to ensure there are no obstructions.

The export pipeline will initially be flooded with treated sea water before a series of pigs (a pig is a pipeline inspection gauge) are launched into it. The pig launcher is located on the Crux-end PLET and the pig receiver on the Prelude-end PLET. The pigs are pushed through the pipe using treated sea water sourced from a

construction vessel from the Crux-end PLET. During the flooding process, treated sea water will separate each pig in the train and this water will be discharged at the Prelude-end PLET as each pig completes a run. A slug of treated sea water will be injected ahead of the first pig to lubricate the sealing discs on the pig and to control pig speed. Some debris from the pipeline's installation activities may be discharged with this treated sea water.

The pig receiver located at the Prelude-end PLET will be recovered to a support vessel, and the gauging information will be gathered to confirm there are no unacceptable obstructions in the pipeline. One or more high-pressure caps will then be placed on the PLETs (if required).

Once the condition of the gauge plates has been confirmed, hydrostatic pressure testing (hydrotest) using treated sea water will occur. Subsea temperature loggers will be deployed along the export pipeline route; these are capable of transmitting data without being recovered to deck. These data are used to prove a correlation between the pressure and temperature changes.

The temperature loggers will inform the hydrotest duration (as per the relevant standard) to test the export pipeline integrity. Small, localised discharges may occur around PLETs as the export pipeline is depressurised. Once the hydrotest has been completed, the export pipeline (with treated sea water) will be left in place until the dewatering activities commence (see Section 6.10.1.4).

The export pipeline FCGT discharge will occur at the Prelude-end PLET resulting in ~52,800 m^3 of treated sea water discharged over 4 to 8 days.

6.10.1.3 Prelude-end Flexible Riser and Umbilical Leak Test

Leak, conductor/insulation resistance and system pressure tests will be done to confirm the integrity of the subsea connection for the flexible riser and umbilical.

After-installation, the flexible riser and umbilical leak test will be done by connecting the test spread through the topsides pull-head on the Prelude FLNG. The leak test pressure will be held for a period (as per the relevant standard). Small, localised discharges may occur as the infrastructure is tested. As the flexible riser and umbilical are depressurised to subsea ambient pressures, the nominal volume of cold commissioning fluids (treated sea water or hydraulic control fluid) are discharged. Once the leak test has been completed, the flexible riser and umbilical will be left full of the cold commissioning fluids until the dewatering activities commence (see Section 6.10.1.5).

6.10.1.4 Crux-end Piping System Leak Testing

A construction vessel, support vessel or ASV will be used to pressurise (via a hose connection) the pipework (e.g. Crux-end rigid riser, umbilical, spools etc).

The leak test pressure will be held for a period (as per the relevant standard) and inspected—an ROV will be used to inspect the subsea connections. The various cold commissioning fluids are described in Section 6.10.1.1. Small, localised discharges may occur as the pipework is tested. Once all connections have been inspected and the pressure profile indicates no leaks, the pipe component (e.g. riser) or system will be depressurised. The pipework will be left in situ until the dewatering activities commence (see Section 6.10.1.5).

The wells will be pressure tested from the topsides platform using temporary equipment. The leak test pressure will be held for a period (as per the relevant standard) and inspected—an ROV will be used to inspect the subsea connections. Negligible localised discharges of benign base oil may occur as the wells are tested.

6.10.1.5 Topsides to Prelude FLNG Dewatering, Vacuum Drying and Nitrogen Packing

Topsides to Prelude FLNG dewatering, vacuum drying and nitrogen packing involves dewatering the relevant infrastructure and replacing the water with nitrogen gas.

A baseline inspection—using a baseline inspection tool with treated sea water—will be carried out before the dewatering pig train is launched. The piping system will be dewatered using a train of pigs separated by freshwater slugs, followed by a train of pigs separated by air slugs and if required a MEG slug. The air slugs and MEG slug will be used to gather the water from the offtake pipework and accelerate the drying process.

The dewatering discharge will occur at the Prelude FLNG (~12 m below the waterline) resulting in ~48,000 m^3 of treated sea water, ~900 m^3 of treated freshwater and if required ~250 m^3 of MEG discharged over ~4 to 8 days.

The remaining air and moisture will be removed via a vacuum spread at the Crux topside. Nitrogen will then be introduced for preservation to ensure the integrity of the infrastructure is maintained until the commencement of activities under the Crux Completions, Hot Commissioning, Start-up and Operations EP/s. An unplanned nominal amount of nitrogen may be released during this process.

6.10.1.6 High Pressure Leak Testing

High Pressure Leak Testing (HPLT) of the process systems and HPLT revalidation of selected systems post installation may occur using a nitrogen/helium gas mixture to confirm the integrity of the flanges (e.g. each spool). The HPLT will be held for a period (as per the relevant standard) and inspected. Once all connections have been inspected and no leaks confirmed, the system will be depressurised and vented to the atmosphere with negligible emissions expected. The HLPT test is likely to be repeated two to three times; however, if leaks are detected, this could result in additional testing.

6.10.2 Topsides Utility and Process Cold Commissioning

Once the topsides have been installed, cold commissioning of the topsides utility and process systems will occur.

6.10.2.1 Chemical Fill

Diesel, service water and chemical storage tanks will be filled. In addition, utility systems and equipment may require a range of chemicals (e.g. hydraulic fluids, coolant etc) to be added prior to operation. Table 6-14 lists the first fill of process chemicals and estimated volumes. No planned discharges will result from this activity.

The following utility equipment and systems will be commissioned prior to operation:

- Chemical injection pumps
- Communications
- Compressed air
- Critical system pressure relief valves
- Diesel supply system
- Distributed Control System / Emergency Shutdown / Fire and Gas Detectors
- Hydraulic Power Unit
- HPLT (see Section 6.10.1.6)
- Hydraulic Power Unit
- Lighting and temporary power
- Pedestal crane
- SSIV system
- Temporary diesel generators (~1500 kW combined capacity)

Table 6-14: Topsides First Fill Process Chemicals

Chemical Type	Purpose	First Fill Volume (~m^3)
Corrosion inhibitor	Mitigate against corrosion risk in pipeline	14
Triethylene glycol (TEG)	Gas dehydration circuit / system	Up to 260
TEG pH adjuster	Batch dosing to control pH in the gas dehydration circuit	4
TEG antifoam	Hydrate control during cold-well start-up	4
Monoethylene Glycol (MEG)	Hydrate control during cold-well start-up	34

6.10.2.2 Service Water System

The topsides service water system will be used to provide all water consumers, except for drinking water and safety showers / eyewash stations. Service water will be supplied to the platform via bunkering at a potable quality. A water treatment system will be installed on Crux topsides to ensure that water meets health-related potable quality for supply to showers / toilets located in the Temporary Refuge. Drinking water will be available on the ASV, brought to the topsides platform in bottles on every visit and stored in a temporary refuge.

6.10.2.3 Sanitary and Water Discharge System

The topsides will not include permanent toilets for normal use (two toilets in the Temporary Refuge for emergency use). Urinals will be included along with showers and basins. The grey water drainage from the showers and basins will be discharged directly overboard. Any discharge from toilets that is required to be sent overboard will be macerated.

6.10.2.4 Utility Open Drain System

The open drains system will collect rainwater, washdown water and any leakage or spillage within the plated or bunded areas and direct this water to either treatment through the open drains system, disposal via the waste oil tank, or overboard, depending on the potential for contamination of the water. The first flush of stormwater from potentially contaminated areas will be captured for treatment; drainage water above the first flush, or from non-contaminated areas, will be considered clean and discharged directly overboard. The open drains oily water separator is designed to meet ≤30 mg/l dispersed oil in water concentration.

6.11 Contingencies

Although unlikely, contingency measures may be required during the Activity. Sections 6.11.1 and 6.11.3 describe the contingencies that may result in a release or discharge.

6.11.1 Cold Commissioning Contingencies

Cold commissioning contingency activities may occur due to project optimisation, schedule changes, delivery sequence adjustments or unplanned events. The cold commissioning activities described in Section 6.9.10 are based on the most likely method and optimal delivery schedule. However, Sections 6.11.1.3 to 6.11.1.3 describe the contingency measures to accommodate and adapt to unforeseen circumstances.

6.11.1.1 Wet Buckle

A wet buckle is a failure in the pipeline installation process that results in the ingress of untreated sea water into the export pipeline. If this occurs, an assessment will be done to address any issues identified, ensure that pipelay can safely recommence, and determine the recovery pipeline location. The pipeline will be flushed with freshwater and potentially a pig to remove debris, then flushed with treated sea water using the same chemicals described in Section 6.9.10. The pipeline will then be dewatered using a pig, with discharge occurring at the pipeline recovery tool (~1 km from the open end of the pipeline). The pipeline will be reflooded in line with the FCGT process described in Section 6.10.1.2.

6.11.1.2 Stuck Pig

If a pig gets stuck or damaged in the export pipeline during cold commissioning, it will be forced out using a high seal pig, or a train of high seal pigs, resulting in a discharge at the Prelude-end PLET. The high seal pig(s) will be propelled with cold commissioning fluids to the same specification as the flooding or dewatering train. The process for propelling the high seal pigs and the associated discharges at the Prelude-end PLET or Prelude FLNG facility will be similar to the processes and discharges outlined in Sections 6.10.1.2 and 6.10.1.5 respectively. In the unlikely event of a stuck pig, the timing between discharges associated with the planned cold commissioning activity and the contingency stuck pig activities will be greater than one week, as such there are no cumulative impacts as a result of these unplanned discharges.

6.11.1.3 Onshore Pipework Cold Commissioning Contingency

To maintain the project schedule, planned onshore cold commissioning activities for pipework, such as the rigid riser and spool), may be transferred to the Activity Area. The cold commissioning fluids (e.g. treated sea water or freshwater) will use the same chemicals described in Section 6.9.10, and the discharge volumes will be a maximum of up to 1,000 m^3, based on project-specific considerations and requirements.

6.11.1.4 Onshore Equipment and Systems Cold Commissioning Contingency

To maintain the project schedule, planned onshore cold commissioning activities that test and verify equipment and systems may be transferred to the Activity Area. Onshore equipment and systems cold commissioning contingencies include hydraulic power unit hot oil flushing, generator testing (e.g. GTGs and BSDG) and nitrogen EDP testing. This contingency activity may use diesel fuel, lubricants and hydraulic fluids; however, will not result in any discharges to the marine environment.

6.11.1.5 TEG System Cleaning Contingency

Although unlikely, the topsides TEG system (noting the TEG system is not operational under this EP) may require re-cleaning after the topsides is installed to maintain the integrity of the system. The non-hazardous cleaning product (such as ash soda or similar) will be selected in accordance with Shell's chemical selection process as described in Section 10.1.6. If required, this will result in approximately 160 m^3 of freshwater/cleaning product mixture released to the environment.

6.11.1.6 Re-dosing of Pipework

If the preservation period extends beyond two years or meets pre-determined water quality trigger values, pipework re-dosing may be required. If required, this will result in approximately 48,000 m^3 of treated seawater. The dosage rate of the hydrotest mixture will be based on the revised preservation period (up to 500 mg/L). The pipework will be dewatered as described in Section 6.10.1.5.

6.11.2 Flooding Compartment Ballast Contingency

A small volume of treated sea water (approximately 340 m^3) may be released if the substructure requires elevation or manoeuvring within the water column before reaching the seabed using controlled ballasting of the substructure compartments and ABT through actuated valves controlled from the construction vessel.

6.11.3 Deck Integrated Fire Fighting System Testing Contingency

The Crux topsides DIFFS is a passive system and contains no chemical foam (potable water only) pressurized via nitrogen cylinders. If it needs to be tested offshore it would discharge approximately 1285 L/min of water and the water tank working volume is approximately 6.5 m^3. The potable water within the water tank may be dosed to control water quality (e.g. prevent bacteria or marine growth).

6.11.4 Well Re-Entry Contingency

With two tested barriers deep in the well (outside the scope of this EP), the presence of gas below the environmental plug during re-entry is not expected. Nevertheless, if pressure is detected below the environmental plug during re-entry activities, as outlined in Section 6.9.9.4, a negligible amount of gas may be released into the atmosphere. The response activities are detailed in the Shell's Well Operation Management Plan – Crux Development, Well Construction Phase 1 (Shell document number: 2200-010-ZW-5880-00007) and include activities such as bleeding off pressure, flow checking and implementing contingency re-entry plans.

6.12 Bunkering, Refuelling and Chemical Transfers

Bunkering (refuelling) and chemical transfers may be required for project vessels. Fuel will be supplied from a supply or support vessel and the fuel type and amount will depend on the operational criteria.

Bunkering from a supply vessel will be required for the temporary drilling rig set-up and topsides platform. Diesel is supplied by bunkering to the topsides crane pedestal diesel storage tank using a dedicated diesel bunkering hose reel. Additionally, a diesel storage tote tank is included on the upper main deck, which can be refilled by tote tank, to provide a redundant supply of diesel on the platform. The fuel requirement of the temporary drilling rig is anticipated to be ~9 m^3 each time (likely to occur every second day), while the topsides requirement is anticipated to be ~81 m^3 each time (likely to occur every three to four days).

The topsides will require the chemical transfer of ad-hoc (see Section 6.10.2) and the first fill chemicals (refer to Table 6-14 for a list of the first fill process chemicals and estimated volumes). TEG is supplied by bunkering from a supply vessel into the permanent storage vessel using a dedicated bunkering hose reel. All other chemicals, including MEG, are supplied in transportable 'tote' tanks which are placed in a dedicated, bunded chemical storage area. Hose couplings on transportable chemical re-supply tanks are dry-break type to avoid loss of containment in the event of lifting a transportable tank with the coupling unintentionally left disconnected. Hose couplings for connecting to transportable chemical re-supply tanks are unique and have colour-coding and labelling to avoid cross-contamination of the chemicals. The total duration of the first fill chemical transfer is expected to be nominally one day.

Service water is supplied by bunkering from a supply vessel and stored for use; on each visit, the service water tank will be flushed and refilled with potable water to ensure the quality of the service water, and reduce the risk of contamination of the system.

Helicopter operations may include offshore helicopter refuelling on project vessel helidecks (and topsides helideck contingency), subject to flight distances and the weight of the loads the helicopter will carry.

6.13 Inspection, Maintenance and Repairs

The Crux philosophy for IMR is to inspect and maintain the installed portfolio of infrastructure and equipment such that its mechanical condition remains fit for the purposes specified in its original design requirements. These include but are not limited to integrity, availability, service life and decommissioning requirements. IMR activities under this EP are not planned to occur, however may be required to:

- maintain the continued integrity of the Crux infrastructure (not covered under this EP) to enable installation activities covered under this EP to be conducted (e.g. the drilling template—installation is outside the scope of this EP—is free from damage and marine growth prior to installing the substructure)
- maintain the continued integrity of the Crux infrastructure installed under this EP
- respond to unplanned events, such as cyclones or dropped objects.

IMR activities are typically carried out using an IMR vessel equipped with ROVs. IMR activities may include cathodic protection surveys and visual inspections, as well as maintenance and repair work such as servicing and replacing damaged infrastructure components, cathodic protection system maintenance, restabilisation, marine growth removal and debris removal.

6.14 Preservation Period Activities

The preservation period ensures the integrity of the infrastructure is maintained once installed (and cold commissioning, if applicable) (see Sections 6.9 and 6.9.10) for the duration of this EP (refer to Section 6.3). Hence the preservation period will be staged as the Activity progresses and the estimated duration is outlined in Table 6-2.

The preservation period activities include:

- leaving the infrastructure (cover under this EP) in a preserved in-situ state
- IMR activities, if required (see Section 6.13)
- re-dosing of pipework (if required) (Section 6.11.1.6).

7 Description of the Receiving Environment

This section describes the Planning Area, including details of the particular values and sensitivities within that environment that could be affected by the Activity (planned and unplanned), as required by sections 21(2) and 21(3) of the OPGGS(E) Regulations. The Planning Area has been defined as an area where a change to ambient environmental conditions may potentially occur, but it should be noted that a change does not necessarily imply an adverse impact (see Table 7-1). The planned activities have been subdivided into specific subcategories to delineate the maximum extent of ecological and social impacts, as described in Table 7-1.

The spatial extent of the receiving environment encompasses the physical, biological, cultural and socio-economic receptors that may be affected by planned and unplanned activities. The majority of the impacts and risks from the Activity occur within or in close proximity to the Activity Area, however some impacts and risks may extend further. The credible worst-case hydrocarbon release scenarios determined by modelling studies are predicted to present the greatest spatial extent of all the impacts and risks identified. The outer boundary of the area that may be influenced by the Activity, identified by the modelling and referred to as the Planning Area, has been used as the outer boundary for the description of the receiving environment. The worst-case hydrocarbon releases during the Activity have a remote likelihood of occurring, and Shell implements a range of controls to ensure such incidents are prevented, and risks reduced to ALARP and Acceptable Levels. The Planning Area for the combined worst-case credible hydrocarbon spill from the Activity is shown in Figure 7-1 and represents the low exposure thresholds (see Table 7-1). Refer to Section 9.14 or additional information on hydrocarbon spill modelling and risk management and associated impact thresholds applied for the assessment.

In accordance with section 56(1) of the OPGGS(E) Regulations, reference to the Master Existing Environment (Section 6) of the accepted Crux OPP (referred to as the Master Existing Environment) is made throughout this EP. The accepted OPP (NOPSEMA ID: A742335) is available on NOPSEMA's website. In addition, contemporary sources, including information shared during consultation for this EP and during consultation/engagement relevant to other Crux EPs, were also used to inform and describe the values and sensitivities.

The description of the receiving environment considers environmental receptors that are protected under the EPBC Act, including:

- World heritage and national heritage values
- Ramsar wetlands
- Biologically Important Area and Habitat Critical to the survival of species
- listed threatened species, migratory species and threatened ecological communities
- values and sensitivities within the Commonwealth marine environment.

The EPBC protected matters reports for the Planning Area and subcategories (Appendix F) were used to identify environmental receptors protected under the EPBC Act.

This information was used to inform the assessment of environmental impacts and risks presented in Section 8.3.

Table 7-1: Description of the Planning Area and Subcategories

Areas	Description
Description of the Environment	
Planning Area	The Planning Area refers to the zone where ambient environmental and socioeconomic conditions may alter based on planned or emergency events. The spatial extent of the Planning Area was determined by combining 300 stochastic oil spill simulations based on the worst-case vessel collision scenario, using low exposure thresholds for each oil phase (1 g/m^2 floating, 10 g/m^2 shoreline, 10 parts per billion [ppb] entrained, and 6 ppb dissolved). At low exposure thresholds, a sheen may be visible on the sea surface or shoreline (at ~2 teaspoons of oil per m^2), potentially affecting visual amenity; however, it does not necessarily imply an adverse ecological impact.

Areas	Description
Planned Activities	
Activity Area	The Activity Area is defined in Section 6.2 and Section 12.
Light Assessment Area	The Light Assessment Area is defined as 20 km[11] around the Activity Area. This area encompasses the maximum extent of predicted measurable light (up to 9 km) and is used to identify sensitive receptors and inform the lighting impact assessment (Section 9.4).
Noise Assessment Area	The Noise Assessment Area is defined as 20 km[12] around the Activity Area with an additional 56.4 km radius surrounding the proposed substructure location. The worst-case extent of the predicted noise impact criteria (based on SEL_{24h} Temporary Threshold Shift [TTS] for low-frequency cetaceans) is expected to be met within 56.4 km from the substructure location during pile driving operations. The Noise Assessment Area is used to identify sensitive receptors and inform the noise impact assessment (Section 9.5).

[11] The predicted worst-case light impacts are within 9 km; however, a precautionary limit of 20 km was applied to align with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023b).

[12] The 20 km noise assessment area was assigned to align with the light assessment area and with consideration of the noise modelling results for project vessel noise.

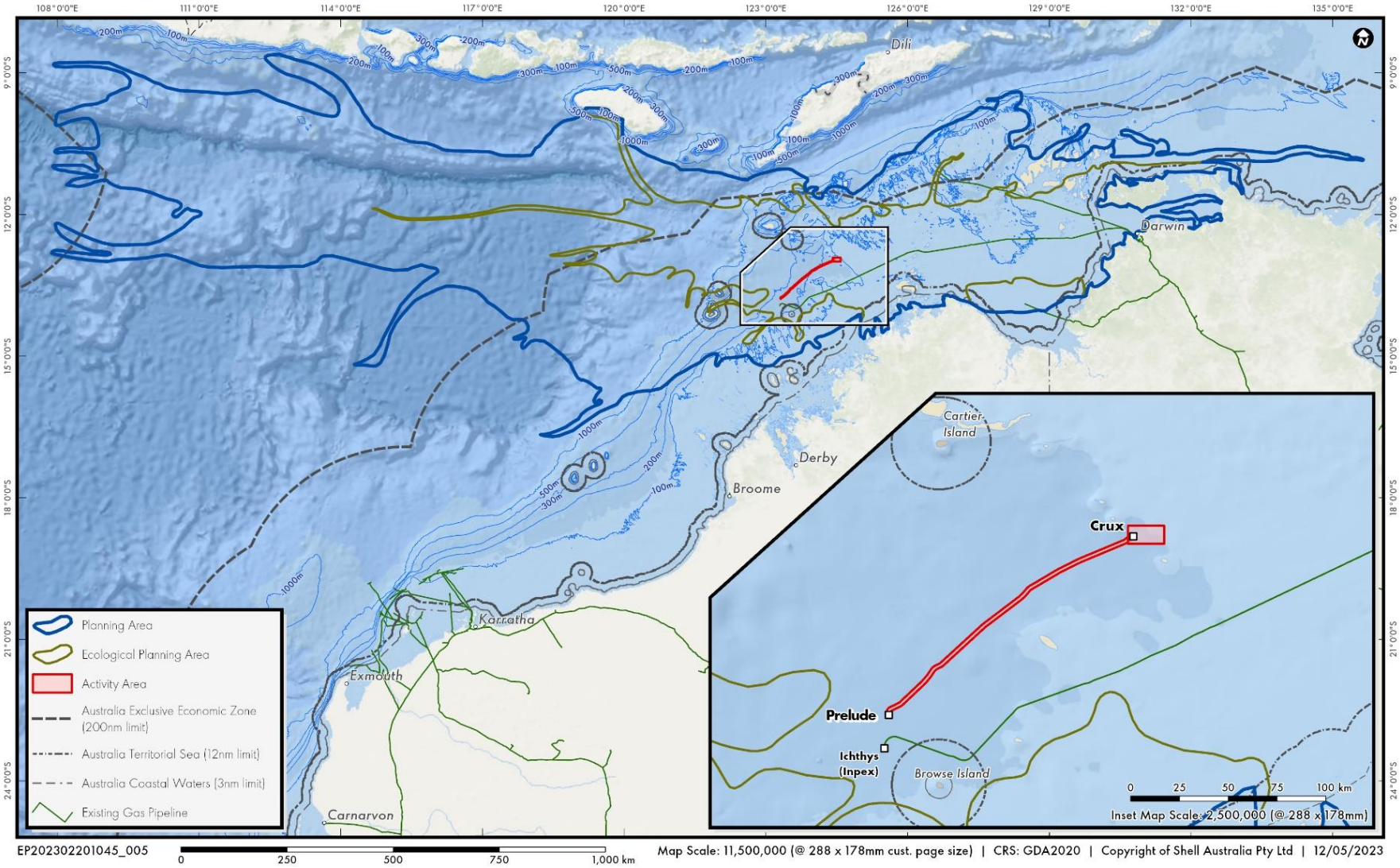


Figure 7-1: Activity and Planning Area

7.1 Regional Context

The Activity Area (defined in Section 6.2) is situated in the North-West Marine Region (NWMR), a marine bioregion encompassing Commonwealth waters extending from the WA–NT border to Kalbarri, WA (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2008a). The region is characterised by shallow-water tropical marine ecosystems and home to globally significant populations of internationally threatened species (DEWHA 2008a). The NWMR is further divided into provincial bioregions—the Activity Area is situated within the Timor Province (Integrated Marine and Coastal Regionalisation of Australia [IMCRA] v4.0). The Planning Area overlaps additional provincial bioregions of the NWMR and the North Marine Region (NMR), including the Central Western Transition, Northwest Province, Northwest Shelf Province, Northwest Transition, Northwest Shelf Transition, Timor Transition, Northern Shelf Province, Christmas Island Province, and Cocos (Keeling) Island Province. Further descriptions of the marine regions and bioregions are detailed in Section 6.4 of the Master Existing Environment.

7.2 Physical Environment

Table 7-2 summarises the key features of the physical environment; refer to Section 6.3 of the Master Existing Environment for a detailed description.

Table 7-2: Summary of the Characteristics of the Physical Environment Relevant to the Activity and Planning Area

Physical characteristic	Relevance to the Activity and Planning Areas
Bathymetry and geomorphology	Installation activities on the seabed will occur in waters exceeding 160 m deep. Baseline seabed surveys of the Activity Area (Shell 2009; Fugro 2017a; Fugro 2017b), indicate the seabed is relatively flat and featureless with a gentle gradient and seabed morphology is typically smooth and bare of hard substrates, with predominantly sandy sediments observed. Sediments within the Activity Area are typically smooth and bare, with sediment particle size distribution characterised by sand particles (muddy sands at the western [Prelude] end of the pipeline corridor, transitioning to gravelly sands at the proposed location of the Crux platform). Seabed features observed throughout the Activity Area include clusters of pockmarks, sand waves, megaripples and some anchor drag scars (Fugro 2017a). Given the water depth and location of the Activity Area, it is reasonable to infer that significant changes to seabed bathymetry and geomorphology will not have occurred over the period between when the referenced seabed surveys were undertaken) and the present day. No reefs or extensive areas of rocky substrate have been observed. Notable seabed features within the Planning Area include the coral reefs and islands that occur throughout the region. There are numerous reefs, banks and shoals throughout the Timor Sea, which host diverse biological communities. Refer to Section 7.3.1 for further discussion of the biological communities associated with these seabed features.
Climate	The Activity Area is situated in the tropics and experiences a monsoonal climate with two seasons. The Australian northern monsoon generally occurs between December and March (Figure 7-2). It is associated with the inflow of moist west to north-westerly winds into the monsoon trough, producing convective cloud and heavy rainfall over northern Australia. During the cooler months (June - September), the sub-tropical ridge that lies over continental Australia drives stable and persistent easterly winds over the region. The Australian cyclone season officially runs from November to April, although very few storms have occurred in November. The chance of experiencing an intense category 4 or 5 cyclone is highest in March and April. At the start of the cyclone season, the most likely areas to be affected are the Kimberley and Pilbara coastlines and offshore areas including the Activity Area; later in the season, the area threatened extends further south.
Oceanography	The NWMR is relatively shallow (<200 m deep over >40% of the region) and strongly influenced by surface currents, notably the Indonesian Throughflow, which brings warm, low-nutrient (oligotrophic), low-salinity water from the western Pacific Ocean through the Indonesian archipelago to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region. The strong seasonality in wind direction and rainfall is another important factor driving ecological processes. The region experiences monsoonal climate patterns with highly variable tidal regimes and a pronounced cyclone season between December and March. The weakening of the Indonesian Throughflow and Leeuwin Current in the dry season (April to September and

Physical characteristic	Relevance to the Activity and Planning Areas
	particularly during El Niño years), along with the seasonal reversal in wind and cyclones, enhances biological productivity through increased mixing of the deeper, cold, nutrient-rich waters with surface waters. In addition to synoptic-scale and tidal currents, locally generated wind-driven currents also influence water movement within the Activity and Planning Areas. These are more variable and are superimposed over large-scale flows.
Water quality	Temperature, salinity, pH and dissolved oxygen were investigated across the Activity Area (AECOM 2016, 2017) and determined to be relatively consistent and comparable to previous studies in the region, such as Prelude (Shell 2009), Ichthys (INPEX 2010) and Barossa (ConocoPhillips 2018). Minor seasonal variation exists. Water quality in the immediate vicinity of the Prelude FLNG facility is slightly lower due to routine discharges from the facility (e.g. greywater, sewage, produced formation water [PFW]). The area impacted by these discharge streams is localised.
Sediment quality	A sediment survey was conducted within the Project Area (defined as the in-field development area [30 km radius around the proposed Crux platform]) and export pipeline corridor (1 km buffer either side of the route with a 2 km radius around the Prelude end) encompassing approximately 314,000 ha; refer to Section 8.2 for further description) in October/November 2016 (AECOM 2017). Twenty sample sites were chosen within the in-field development area—16 were aligned with, or were perpendicular to, the prevailing tidal current axis, and four reference sites were located at each corner of AC/RL9. Eleven sample sites were selected at 10–15 km intervals along the export pipeline corridor to account for existing sediment variability. Shell recognises that the survey data reported by AECOM (2017) are more representative of a broad characterisation of sediment quality within the Crux Activity Area, rather than being suitable for robust statistical comparison with data collected during subsequent operations and decommissioning phases of the overall Crux Project. A summary of the scope of works and associated objectives for establishing a robust supplementary pre-operations baseline dataset is described further in Section 10.4.2. In summary, AECOM (2017) indicated that concentrations of metals, hydrocarbons and radionucleotides were generally consistent across all sites, typically indicating a lack of obvious existing anthropogenic impacts on sediment quality in the area. The exception to this is where barium concentrations in some of the sediment samples in the vicinity of previous exploratory well sites, in the Activity Area, were elevated relative to samples collected at greater distances from these well locations and reference sites. This suggests some localised elevations of barium from past exploration drilling given barium concentrations can be indicative of the presence of water-based mud residues (Barite) from drilling activities (AECOM 2017). Barium from drilling related activities remains in marine sediments as relatively inert barite and because of its low aqueous solubility, is not readily accumulated in the soft or hard tissues of marine organisms (Neff 2002). Therefore, barium is considered to have very low bioavailability and bioaccumulation potential when associated with drilling muds (Swan, Neff & Young 1994) and would be anticipated to attenuate naturally over time (AECOM 2017). In addition, studies have shown that, due to the low solubility of barite in seawater, the concentration of barium in solution in seawater cannot rise high enough to represent a toxicity risk to marine organisms (Neff 2002).
Air quality	No specific information concerning air quality in the Project Area is available. However, the Activity Area is ~190 km from the Kimberley coastline, which is a remote and unindustrialised area. Therefore, the air quality is unlikely to be subject to considerable anthropogenic effects, with the exception of the Prelude FLNG facility. Emissions from commercial shipping are likely to represent the main source of localised and temporary impacts on air quality. Production facilities in the broader region, such as the Montara Floating Production Storage and Offloading (FPSO) facility (~30 km from the Activity Area) and the Ichthys FPSO (~20 km from the Activity Area) are also expected to incrementally influence local and regional air quality. In a regional context, the main contributors to particulate levels are ambient wind-borne dust and smoke from seasonal bushfires that are characteristic across the Kimberley region. International contributors to reduced air quality in the Project Area may also include 'slash-and-burn' agricultural methods and other large forest fires in Southeast Asian countries (Vadrevu et al. 2014; Kim Oanh et al. 2018).

Physical characteristic	Relevance to the Activity and Planning Areas
Ambient noise	Previous underwater monitoring programs in the northern Browse Basin and the Ichthys field (164 km south-west of the Activity Area), recorded fish chorus, whale calls (pygmy blue, humpback), persistent vessel and some seismic survey signals as part of the underwater soundscape (INPEX 2010, ConocoPhillips 2018).

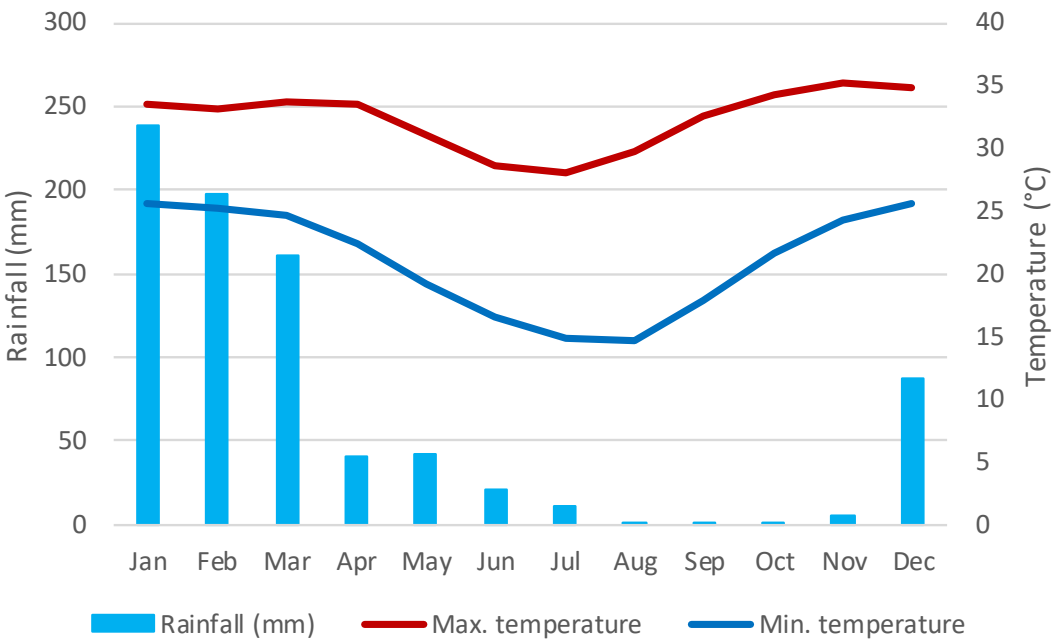


Figure 7-2: Long-term Maximum and Minimum Temperatures and Mean Rainfall from Cygnet Bay

Source: Bureau of Meteorology (BOM n.d.); Cygnet Bay is the closest BOM climate station to the Activity Area.

7.3 Biological Environment

7.3.1 Habitats and Communities

Surveys undertaken in 2017 by Fugro (2017) and AECOM (2017) indicated a very low abundance of macrobenthic fauna present in the Activity Area. This is broadly consistent with surveys from other developments in the immediate region, such as the Montara Development, Ichthys Gas Field Development Project and Prelude. The benthic habitats in the Montara development area, ~36 km north-east of the Crux platform, were characterised by homogenous, flat, featureless soft sediments supporting patchy, low abundance macrobenthic faunal assemblages dominated by polychaete bristleworms (abundance of ~40 to 60%) and crustaceans (e.g. shrimps, crabs) (~13 to 19%) (PTTEP 2017). The sparsely distributed epifauna assemblage supported hydroids, octocorals (soft corals, gorgonians and seapens), black corals and ascidians. The seabed within the Ichthys field (235 m to 275 m), ~20km south of the Activity Area, was characterised by bare substrates supporting an infauna dominated by polychaete worms and crustaceans, and few epibenthic organisms. Areas of hard substrate exhibited a low cover of epibenthic fauna, comprising filter feeding communities including sponges, gorgonians, soft corals (INPEX 2010). Macrobenthos in the Prelude development area was also recorded as having consistently low abundance and similar composition across the area surveyed (Shell 2009). While individuals were identified from nine different Phyla (Annelida, Chordata, Cnidaria, Crustacea, Echinodermata, Mollusca, Nematoda and Sipuncula), approximately 80% of individuals across the survey area were identified as Annelid worms (Shell 2009). Species from three classes of polychaete worm and mud shrimps (Crustacea) were also dominant.

However, it is recognised that the AECOM (2017) survey sampled a limited number of locations within the Activity Area, with limited sediment sampling depths and volumes, and patches of the seafloor with higher

abundances of infauna may not have been sampled. Therefore, Shell considers that the survey data reported by AECOM (2017) are more representative of a broad characterisation of infaunal assemblage within the Crux Activity Area, rather than being suitable for robust statistical comparison with data collected during subsequent operations and decommissioning phases of the overall Crux Project. A summary of the scope of works and associated objectives for establishing a robust supplementary pre-operations baseline dataset is described further in Section 10.4.2.

Habitat types observed by surveys in the Activity Area generally comprised unconsolidated substrates (sand, gravel, mud etc.) interspersed with patches of hard substrate, which provide attachment points for sponges and molluscs. Soft (unconsolidated) seabed substrates are widely distributed in the region (Baker et al 2008). The patchiness of benthic fauna distribution (at scales from centimetres up to hundreds of metres) within unconsolidated seabed substrates has been well documented through numerous studies (e.g. Sandulli & Pinckney 1999, Rogers *et al.* 2008, Zajac 2008, Kraan *et al.* 2009, Ramey *et al.* 2009, Meadows *et al.* 2012, Somerfield *et al.* 2019, Stark *et al.* 2024 and references therein). It is reasonable to expect that, for any benthic fauna that may be impacted during field activities, there will be species of equivalent ecological function that are present within the broader region. The demersal and pelagic fish communities of the Activity and Planning Areas are expected to include small pelagic fishes, such as sardines and anchovies, which form an important trophic link between microscopic planktonic communities (e.g. zooplankton feeding on phytoplankton) and larger consumers (e.g. tunas). Also present may be migratory larger pelagic fish such as tuna, bonito and blue sharks. Pelagic fish are expected to be broadly distributed throughout the tropical pelagic environment, given the relatively homogeneous nature of the open sea, with food availability and predation also influencing the distribution and abundance of these species. The demersal fish communities of the Activity Area are likely to reflect those of the wider Timor Province in which a high level of endemicity exists (DEWHA 2008a).The environment of the Activity Area reflects the wider region and does not support the highly diverse benthic communities found on banks and shoals in the region. Table 7-3 summarises the key habitats and communities and these are further described in the Master Existing Environment.

Table 7-3: Habitats and Communities

Habitat/Community	Key locations within the Activity and Planning Areas		
Benthic communities			
Bare/unconsolidated sediments	Most common habitat type of the Activity and Planning Areas. Inhabitants largely comprise polychaete worms, molluscs and sponges and are consistent with the wider region.		
Epifauna and infauna	Characterisation studies (AECOM, 2017) show that areas sampled within the Activity Area comprise polychaete worms, nemerteans, molluscs and arthropods. Epifauna comprise sponges, branching soft coral, hydroids, sea anemones, and echinoderms (such as crinoids). In the Planning Area, deep water communities feature soft corals (such as sea whips), hydroids, etc. Shallower water communities include molluscs, hard corals, branching soft corals, echinoderms and crustaceans. The Planning Area is dominated by widespread soft sediment habitat that is unlikely to support significant epifauna. Low-density epifauna communities are associated with sparser hard substrate in deeper waters.		
Corals	Soft branching coral (Alcyonacea) is associated with consolidated rock and unconsolidated gravel within the Activity Area (Fugro 2017a). This taxon is widespread throughout the Planning Area and is associated with banks and shoals that are characteristic of the region, and the regionally significant Ashmore Reef and Cartier Island.		
Macroalgae and seagrass	Important feature of seabed communities at several offshore banks and shoals in the Planning Area, particularly calcareous green algae in the genus *Halimeda.* Seagrass is less common, displaying temporal and spatial variability.		
Banks and shoals	No banks or shoals exist within the Activity Area. The distances to the nearest banks and shoals within the Planning Area from the Activity Area are listed below:		
	Feature	**Water Depth(~m)**	**~Distance / direction from Activity Area**
	Goeree Shoal	20	8 km NNW

Habitat/Community	Key locations within the Activity and Planning Areas		
	Eugene McDermott Shoal	15	8 km ESE
	Vulcan Shoal	10	17 km NNW
	Barracouta Shoals	15	57 km NNW
	Heywood Shoals	15	20 km ESE
	Echuca Shoals	10	52 km ESE
Offshore reefs and islands	No known offshore reefs and islands occur within the Activity Area. The key reefs and islands within the Planning Area are listed below:		
	Feature	**~Distance / direction from Activity Area**	
	Ashmore Reef	130 km NW	
	Cartier Island	83 km NNW	
	Hibernia Reef	152 km NNW	
	Browse Island	42 km SSE	
	Seringapatam Reef	135 km W	
	Scott Reef	147 km WSW	
	Tiwi Islands	605 km ENE	
WA and NT mainland coastline communities	Mainland coastlines of WA and the NT occur within the Planning Area. The nearshore and coastal environments of the Kimberley (WA coastline) are ~200 km from the Activity Area. Communities include coral reefs, seagrass and macroalgae beds, mangroves, sandy beaches, rocky shores, estuaries, wetlands, creeks and rivers. The NT coastline is ~539 km from the Activity Area. Communities include coral reefs, seagrass meadows, mangroves and sand or mudflats.		
Other habitats and communities			
Plankton	Surface waters within the Activity Area are typical of clear open water environments with little seasonal variation. In the Planning Area, phytoplankton is diverse but low in abundance, typical of low-nutrient open ocean environments (Shell 2009, AECOM 2016, AECOM 2017). Plankton distribution is linked to localised and seasonal productivity; i.e. areas of upwelling and fluctuations in plankton abundance and distribution occurs in response to tidal cycles, seasonal variation and cyclonic events.		
Pelagic and demersal fish communities	Free-swimming pelagic fish within the Activity and Planning Areas are expected to include small pelagic fish (e.g. sardines, anchovies) that are broadly distributed throughout the tropical pelagic environment. Larger pelagic fish typically include migratory species (e.g. tuna, bonito, blue shark) as well as commercially important species (e.g. marlin, swordfish, mackerel). There is a high level of endemicity associated with separate demersal fish communities of the upper and mid continental slope, particularly in areas of complex geomorphology (DSEWPaC 2012a). Species include trout, snapper and shark.		

7.3.2 Key Ecological Features

KEFs are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity.

The Activity Area intersects one KEF—Continental slope demersal fish communities (see Figure 7-3). This KEF is partially overlapped by 7 km of the export pipeline corridor, with the corridor covering ~14 km^2 of the KEF, which represents <0.05% of the total KEF area. The value associated with this KEF is the biodiversity, including high levels of endemism, of demersal fish that occupy two distinct demersal community types associated with the upper slope (water depth of 225–500 m) and the mid–slope (water depth of 700–1000 m)

(DSEWPaC 2012a; DCCEEW 2022). The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish on the continental slope (DCCEEW 2022), with more than 500 species of demersal fish (Last et al 2005). Brewer et al. (2007) suggested that the demersal-slope communities rely on bacteria and detritus-based systems comprised of infauna and epifauna as the basis of the food web. No relevant pressures of concern have been identified for this KEF for the activities (DCCEEW 2022).

The pipeline footprint is expected to directly overlap ~0.7 ha (0.000043%) of the total KEF area in the water depths associated with the upper-slope fish communities and is more than 100 km from the nearest mid-slope communities. Environmental surveys along the pipeline route recorded isolated areas of hard substrates and associated communities (Fugro 2017a). Fugro (2017) anecdotally noted the absence of highly abundant or diverse fish assemblages. The presence of pipelines has been positively correlated with the diversity and abundance of fish (McLean et al. 2017); over time, the export pipeline is expected to host an artificial reef community with relatively high fish diversity and abundance compared to the surrounding seabed.

Table 7-4 lists the KEFs within the Activity and Planning Areas and these are illustrated in Figure 7-3. The values of each KEF are further described in Section 6.4.7 of the Master Existing Environment.

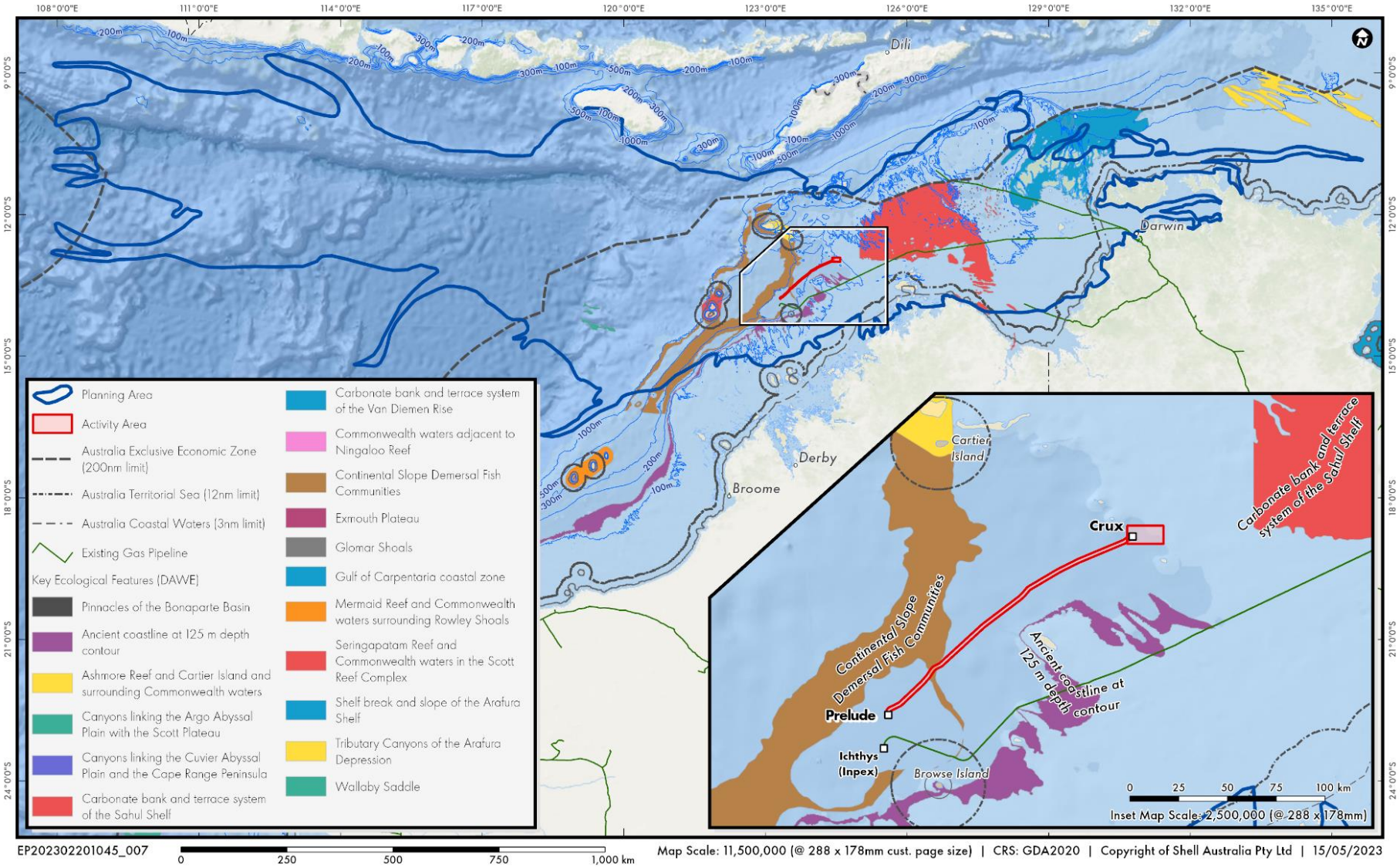


Figure 7-3: Locations of KEFs within the Area

Table 7-4: KEFs within the Planning Area, including distance from Activity Area

KEF	Marine Region	Distance from the Activity Area (~km)
Ancient coastline at 125 m depth contour	NWMR	12.5
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	NWMR	95
Canyons linking the Argo Abyssal Plain with the Scott Plateau	NWMR	384
Carbonate bank and terrace system of the Sahul Shelf	NMR	46
Carbonate bank and terrace system of the Van Diemen Rise	NWMR	433
Continental slope demersal fish communities	NWMR	Intersects
Pinnacles of the Bonaparte Basin	NWMR / NMR	292
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	NMR	130
Shelf break and slope of the Arafura Shelf	NWMR	413

7.3.3 Threatened and Migratory Species

The EPBC Act listed species (or species habitat) that may occur within the Planning Area and subcategories are listed in Table 7-5, Table 7-7, Table 7-10 and Table 7-11; the protected matters reports are provided in Appendix F. The full list of marine species identified from the protected matters search is provided in Appendix F. Most species within the Activity Area are expected to be transitory only; only the whale shark is identified as having important behaviours (e.g. foraging BIA) within the Activity Area (see Figure 7-17). Figure 7-4 to Figure 7-18 show the BIAs or habitat critical to the survival of the species within the Planning Area. Further descriptions of identified species can be found in Section 6.5 of the Master Existing Environment.

Note: Several MNES receptors (e.g. terrestrial species) identified in the protected matters reports for the Planning Area will not credibly be impacted by the petroleum activities. The Protected Matters Search Tool (PMST) results are an artefact of the method used to generate the area; this method occasionally overlaps small areas of the terrestrial environment that will not credibly be impacted by the petroleum activity and are excluded from further consideration.

7.3.3.1 Marine Mammals

Table 7-5 lists the EPBC Act listed threatened and migratory marine mammals that may occur within the Activity Area, Noise Assessment Area and Planning Area. No additional species were identified within the Light or Noise Assessment Area compared to the Activity Area. However, the inclusion of the dugong within the Activity Area and Noise Assessment Area has been incorporated based on anecdotal sightings within or in close proximity to the Activity Area (per comms Craig McPherson [JASCO] 2023).

The Activity Area does not intersect any marine mammal BIAs. The marine mammal BIAs that may occur within the Planning Area are listed in Table 7-6 and shown in Figure 7-4 to Figure 7-9. In addition to the description of marine mammals provided in the Master Existing Environment (Section 6.5), pygmy blue whale tagging studies by Thums et al. (2022) and Ferreira et al. (2024) found that pygmy blue whales demonstrate extensive use of slope habitat off the coastline of WA and limited use of WA shelf waters. These studies indicate that pygmy blue whales are predominantly present in water depths >250 m. During their migratory period along the coast of WA, the pygmy blue whales travel predominantly fast, with directed travel interspersed with relatively short periods of low movement persistence in 3 main areas—Perth Canyon, Cape Range Canyon and Cloates Canyon. The low movement persistence could indicate foraging, resting or breeding behaviours (Thums et al. 2022), supporting the 'possible' foraging areas identified in the Blue Whale Recovery Plan (CoA 2015a).

Table 7-5: EPBC Act Listed Threatened and Migratory Mammals that may Occur within the Planning Area

Species Name	Common Name	EPBC Act Listing Status		EPBC Management Publications	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Balaenoptera borealis	Sei whale	Vulnerable	✓	✓	Species or species habitat likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni	Bryde's whale	×	✓	×	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Balaenoptera musculus	Blue whale	Endangered	✓	✓	Species or species habitat likely to occur within area	Migration route known to occur within area
Balaenoptera physalus	Fin whale	Vulnerable	✓	✓	Species or species habitat likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Megaptera novaeangliae	Humpback whale	×	✓	×	Species or species habitat known to occur within area	Breeding known to occur within area
Physeter macrocephalus	Sperm whale	×	✓	×	Species or species habitat may occur within area	Species or species habitat may occur within area
Orcinus orca	Killer whale, orca	×	✓	×	Species or species habitat may occur within area	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted bottlenose dolphin (Arafura/Timor Sea populations)	×	✓	×	Species or species habitat may occur within area	Species or species habitat known to occur within area
Dugong dugon[13]	Dugong	×	✓	×	Anecdotally mentioned that species may transit within the area.	Breeding known to occur within area
Orcaella heinsohni[13]	Australian snubfin dolphin	×	✓	×	×	Breeding known to occur within area
Sousa sahulensis[13]	Australian humpback dolphin	×	✓	×	×	Breeding known to occur within area

[13] Identified species or species habitat may occur within the Noise Assessment Area, in addition to the species identified within the Activity Area.

Species Name	Common Name	EPBC Act Listing Status		EPBC Management Publications	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Xeromys myoides	Water mouse	Vulnerable	×	✓	×	Species or species habitat known to occur within area

Table 7-6: BIAs of Marine Mammals within the Planning Area

Common Name	BIA Behaviour	Distance from Activity Area (~km)
Blue and pygmy blue whales	Distribution	68
	Foraging	132
	Migration	77
Humpback whale	Calving	145
	Migration	145
	Nursing	145
	Resting	145
Dugong	Breeding	150
	Calving	150
	Foraging	150
	Foraging (high density seagrass beds)	135
	Nursing	150
Australian snubfin dolphin	Breeding	150
	Calving	150
	Foraging	155
	Foraging (high density prey)	150
	Resting	150
	Breeding	150
Indo-Pacific humpback dolphin	Breeding	190

Common Name	BIA Behaviour	Distance from Activity Area (~km)
	Calving	155
	Foraging	150
	Foraging (high density prey)	190
	Significant habitat	150
Indo-Pacific spotted bottlenose dolphin	Breeding	240

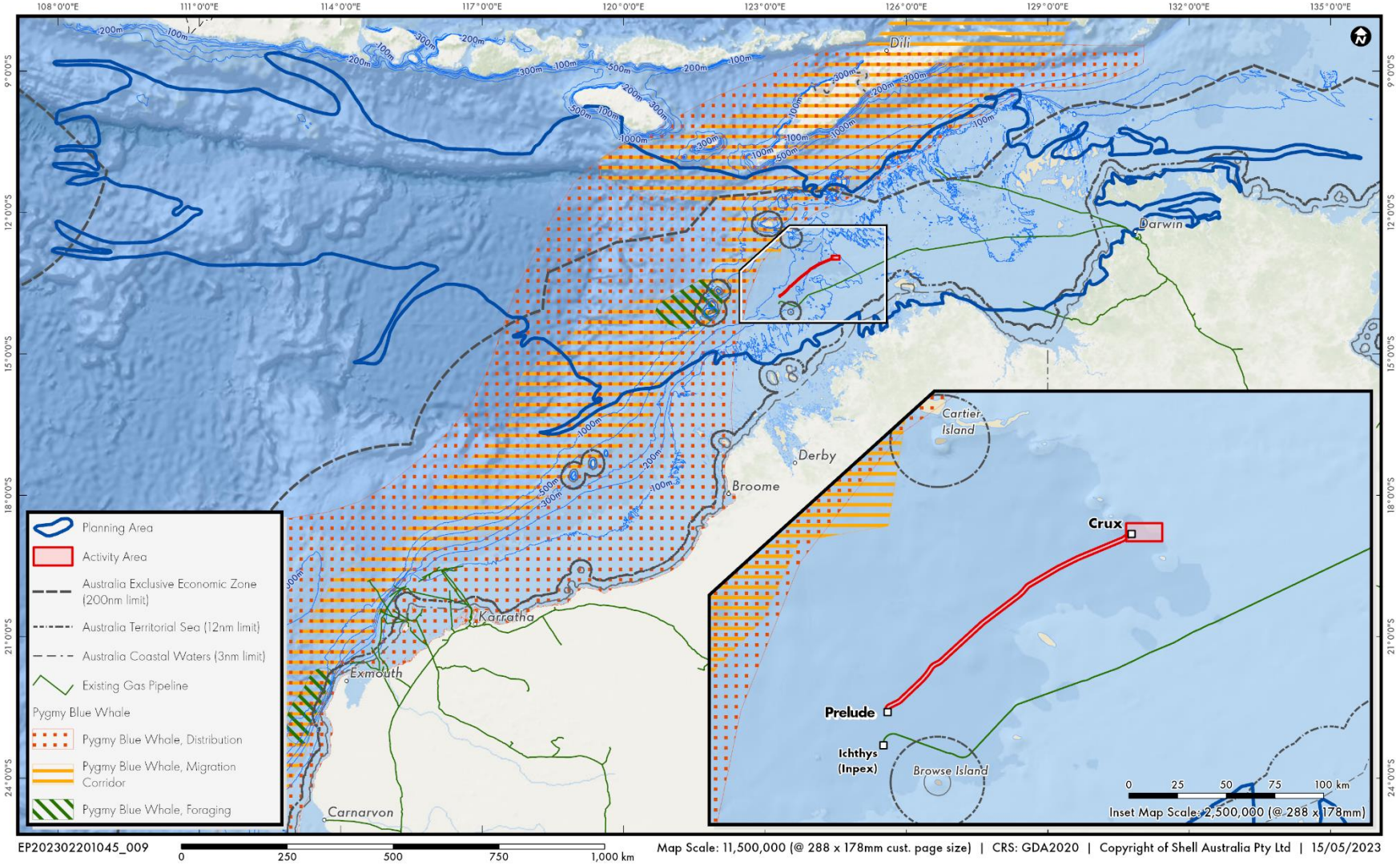


Figure 7-4: BIAs for Blue and Pygmy Blue Whales within the Planning Area

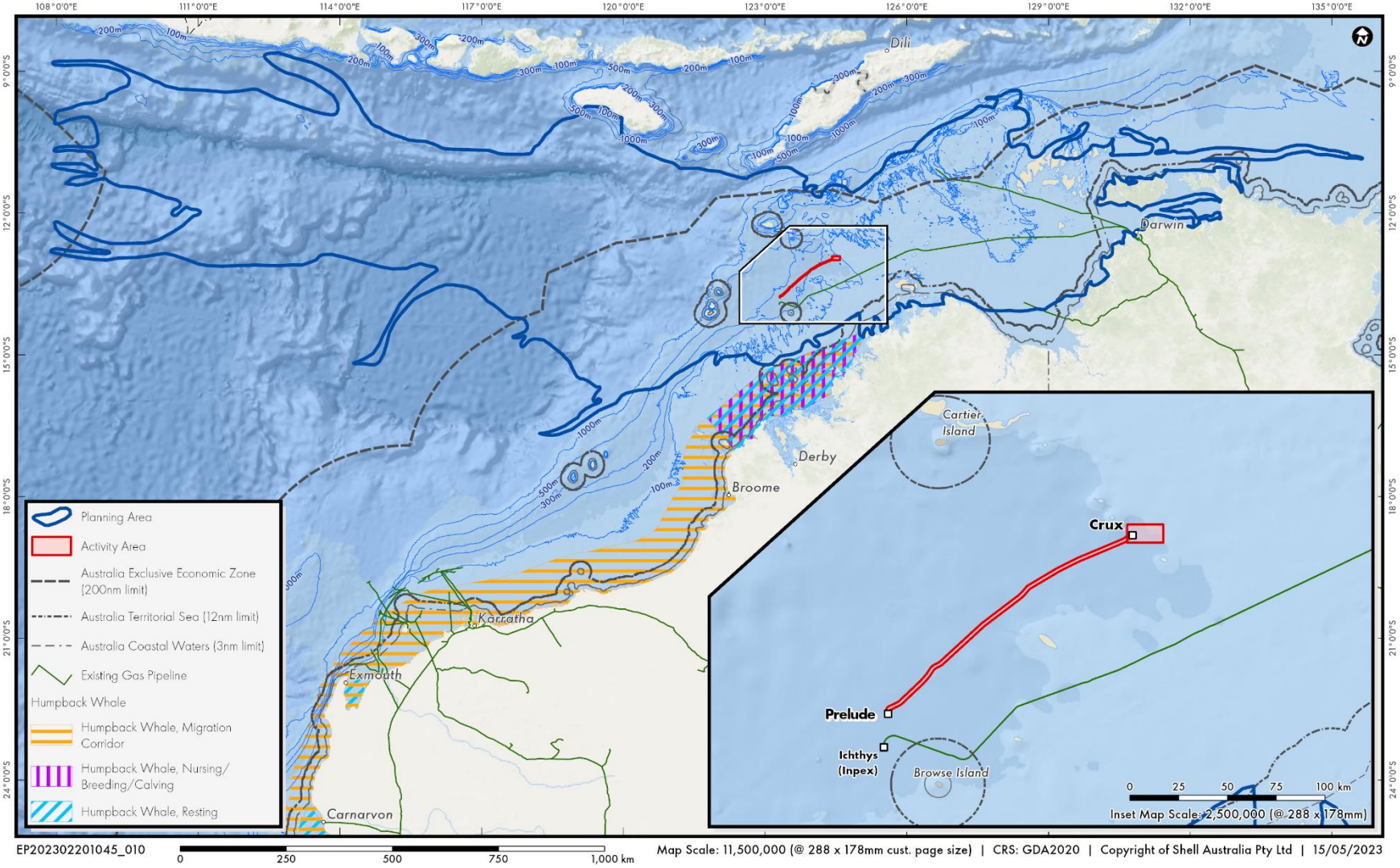


Figure 7-5: BIAs for Humpback Whales near the Planning Area

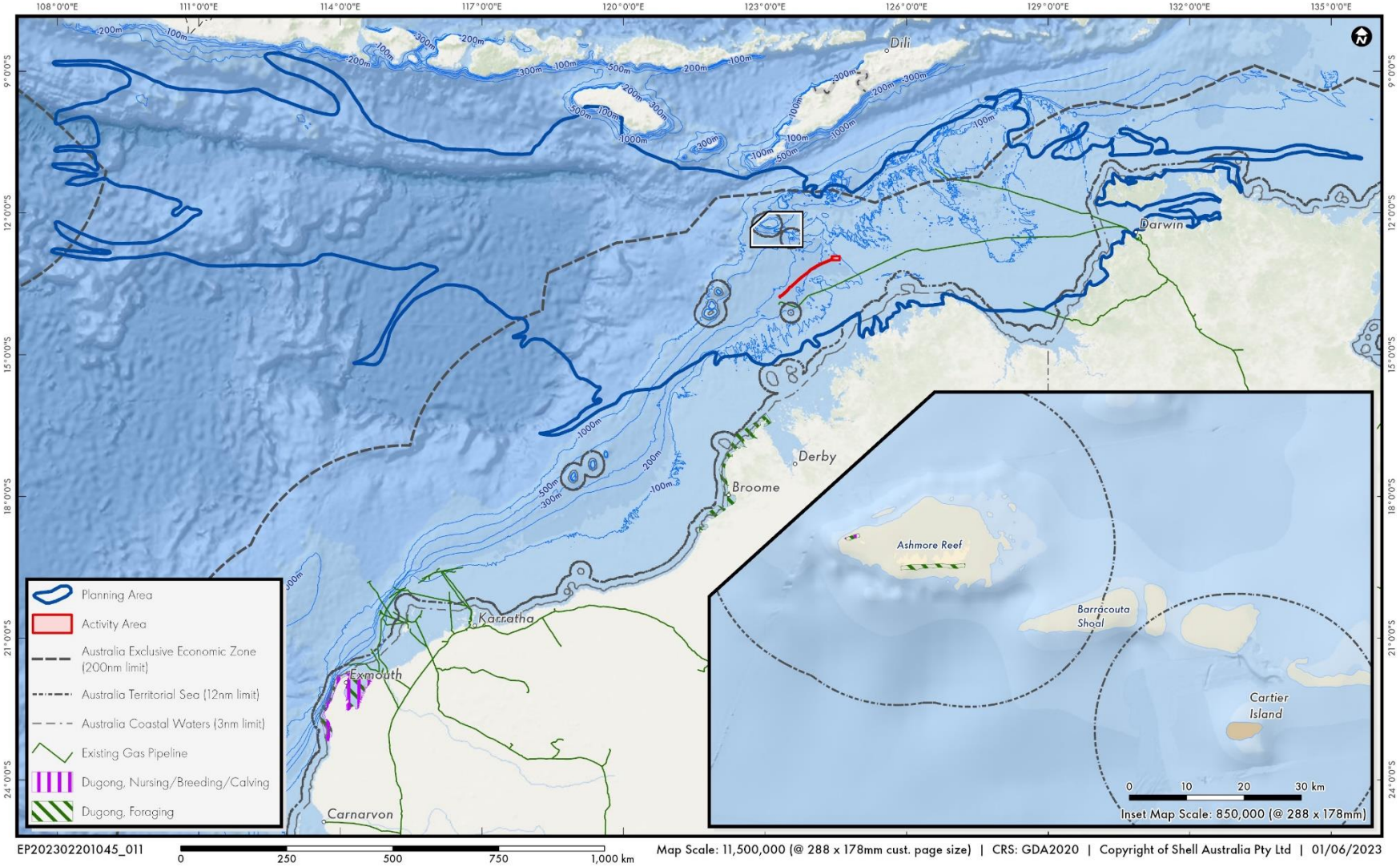


Figure 7-6: BIAs for Dugongs within the Planning Area

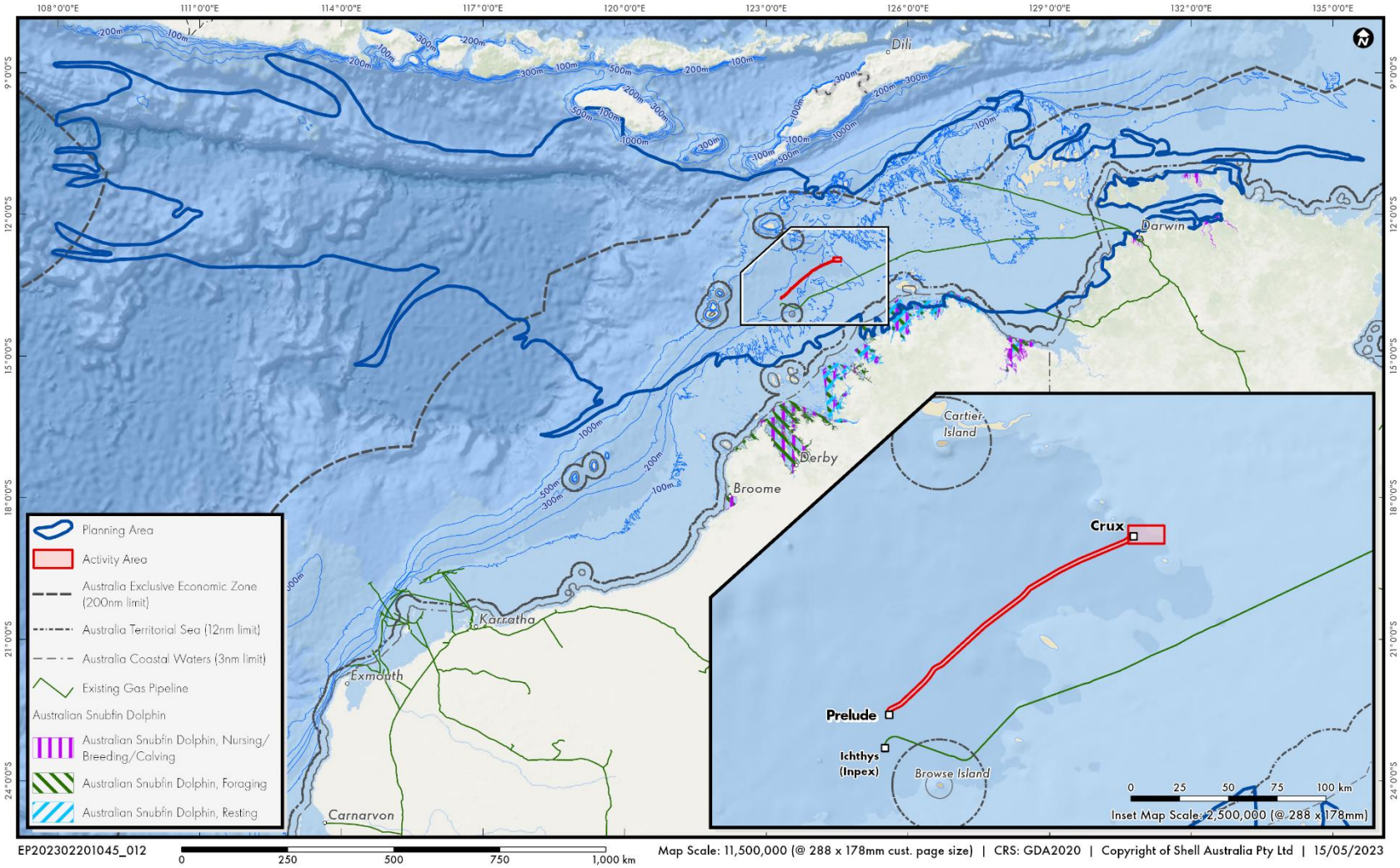


Figure 7-7: BIAs for Australian Snubfin Dolphins within the Planning Area

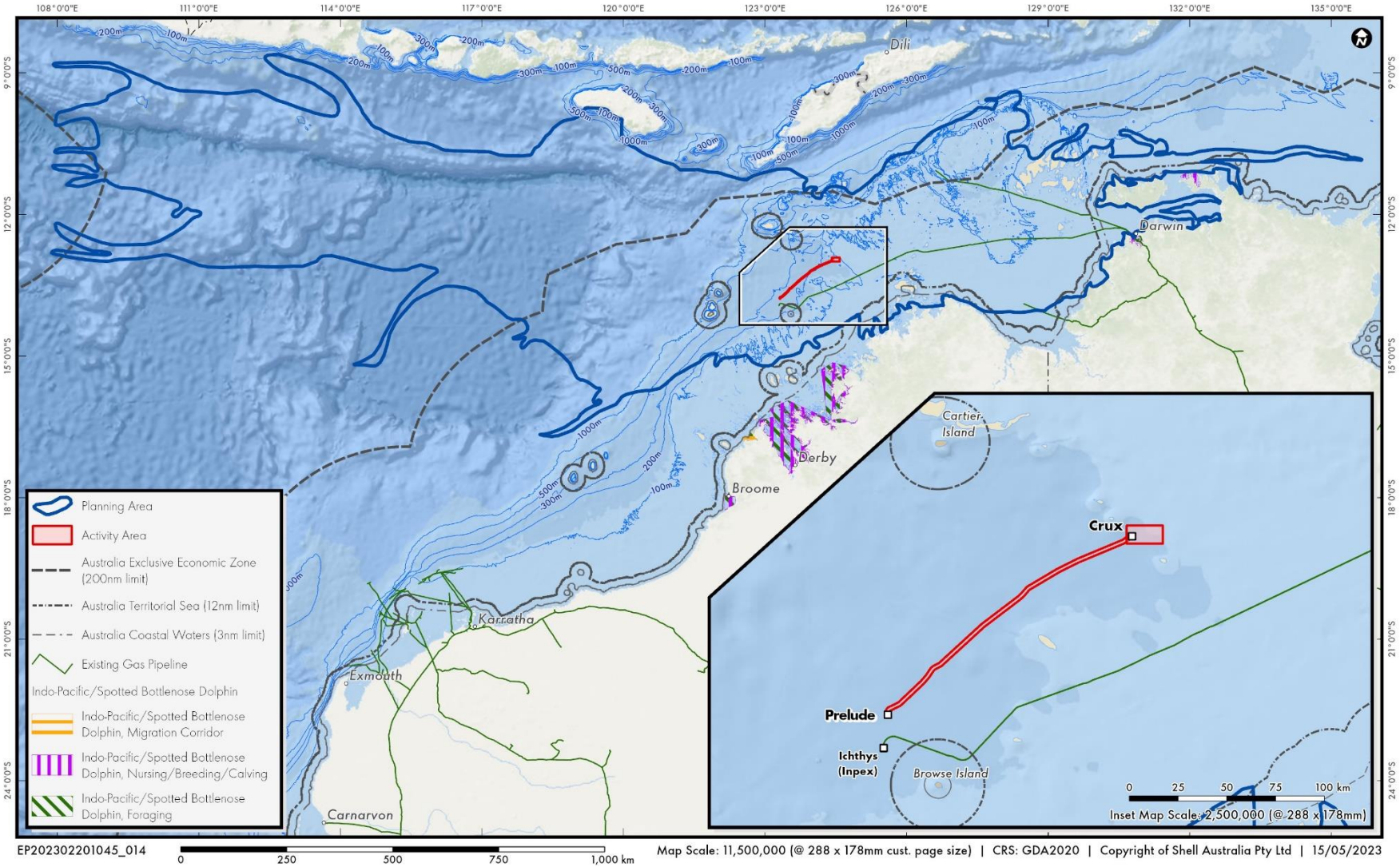


Figure 7-8: BIAs for Indo-Pacific Spotted Bottlenose Dolphins within the Planning Area

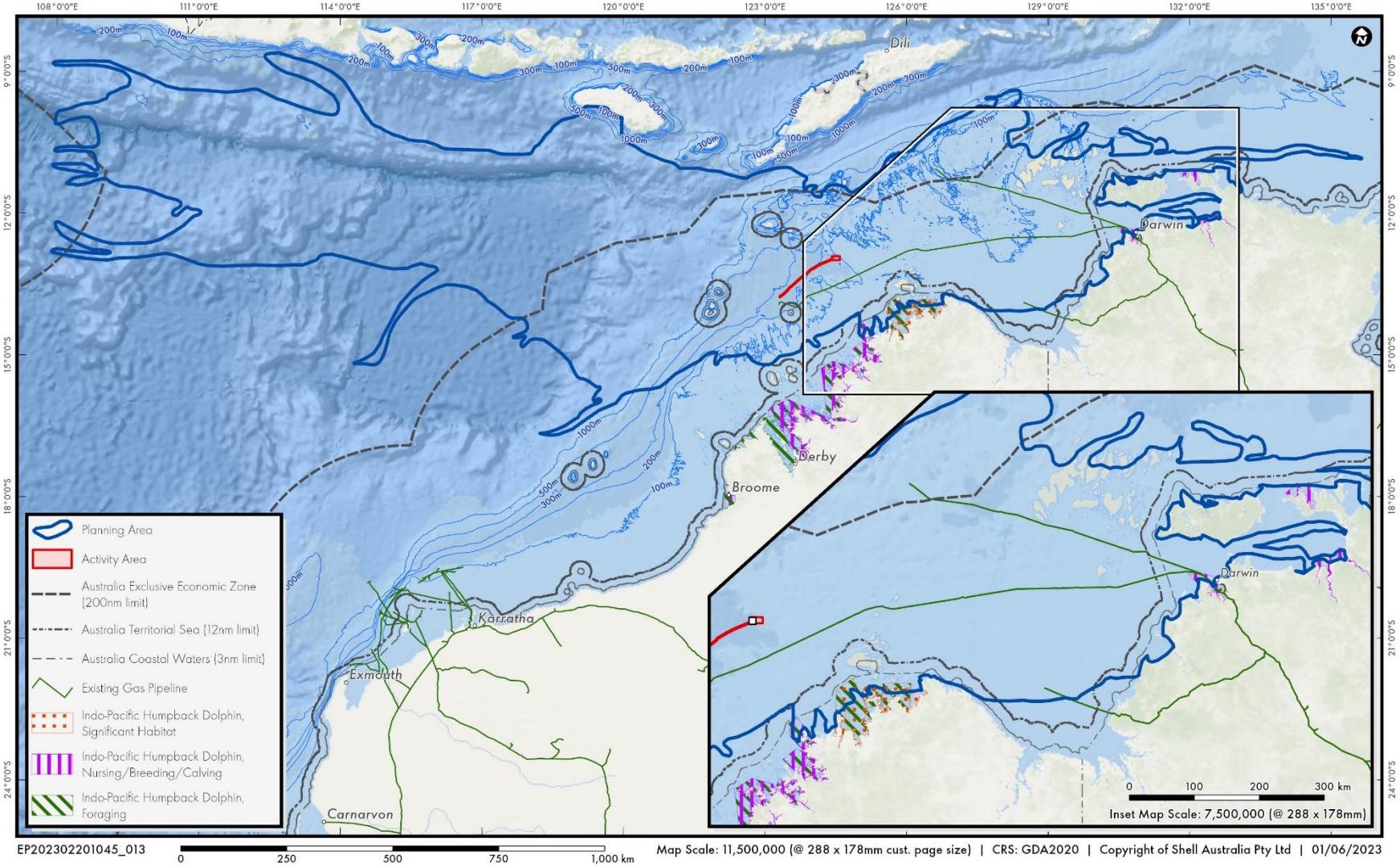


Figure 7-9: BIAs for Indo-Pacific Humpback Dolphins within the Planning Area

7.3.3.2 Marine Reptiles

Table 7-7 lists the EPBC Act listed threatened and migratory marine reptiles that may occur within the Activity and Planning Areas. No additional species were identified within the Light or Noise Assessment Area compared to the Activity Area. Table 7-8 lists the marine reptile BIAs and Table 7-9 lists the habitat critical to the survival to turtles that may occur within the Planning Area. These are shown in Figure 7-10 to Figure 7-16.

In addition to the description of marine reptiles provided in the Master Existing Environment (Section 6.5), published Conversation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n), demonstrates that this threatened species habitat is restricted to the Browse Region, with a known population existing at Scott Reef and Seringapatam Reef and a recent sighting in 2018 at Heywood Shoal (Udyawer et al. 2020). Given the location of this 2018 sighting within the mid-self shoals of the Browse Region this study, using a habitat modelling method, proposed that the dusky sea snake may also occur at similar mid-shelf shoals which run in a north easterly crescent from South of Heywood Shoal, past Cartier Island, to Ashmore Reef (Udyawer et al. 2020). As a result of documented declines in the entire seasnake community during the late 1990s and early 2000s at Ashmore Reef, Cartier Island and Hibernia Reef, recent studies have detected no dusky sea snakes at these locations (Guinea 2013; Lukoschek et al. 2013; Somaweera et al. 2021).

The habitat types listed above comprise of both emergent and subsurface complex hard coral reefs and shoals which rise up abruptly from greater than 100 m water depth. (DCCEEW 2024n). Consistent with these habitat types, the dusky sea snake is known to be a shallow-reef specialist with the only recorded detections being in 0-20 m water depth (Lukoschek et al. 2013; Udyawer et al. 2020).

Table 7-7: EPBC Act Listed Threatened and Migratory Marine Reptiles that may Occur within the Planning Area

Species Name	Common Name	EPBC Act Listing Status			Conservation Advice (CA) / Recovery Plans (RP)	Presence Type	
		Threatened	Migratory	Marine		Activity Area	Planning Area
Caretta caretta	Loggerhead turtle	Endangered	✓	✓	RP	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas	Green turtle	Vulnerable	✓	✓	RP	Foraging, feeding or related behaviour known to occur within area	Breeding known to occur within area
Dermochelys coriacea	Leatherback turtle	Endangered	✓	✓	RP, CA	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata	Hawksbill turtle	Vulnerable	✓	✓	RP	Species or species habitat known to occur within area	Breeding known to occur within area
Lepidochelys olivacea	Olive ridley turtle	Endangered	✓	✓	RP	Foraging, feeding or related behaviour likely to occur within area	Breeding known to occur within area
Natator depressus	Flatback turtle	Vulnerable	✓	✓	RP	Species or species habitat known to occur within area	Breeding known to occur within area

Species Name	Common Name	EPBC Act Listing Status			Conservation Advice (CA) / Recovery Plans (RP)	Presence Type	
		Threatened	Migratory	Marine		Activity Area	Planning Area
Aipysurus apraefrontalis	Short-nosed sea snake	Critically Endangered	×	✓	CA	Species or species habitat likely to occur within area	Species or species habitat known to occur within area
Aipysurus foliosquama	Leaf-scaled sea snake	Critically Endangered	×	✓	CA	Species or species habitat may occur within area	Species or species habitat may occur within area
Aipysurus fuscus	Dusky sea snake	Endangered	×	✓	CA	Species or species habitat may occur within area[14]	Species or species habitat likely to occur, or may occur within area
Crocodylus porosus	Salt-water crocodile, estuarine crocodile	×	✓	✓	×	×	Species or species habitat likely to occur within area

Table 7-8: BIAs of Marine Turtles that Overlap the Planning Area

Common Name	BIA Behaviour	Distance from Activity Area (~km)
Flatback turtle	Foraging	180
	Internesting	357
	Internesting buffer	268
Green turtle	Foraging	23
	Internesting	168
	Internesting buffer	65
	Mating	147
	Nesting	85
Hawksbill turtle	Foraging	85
	Internesting	810
	Internesting buffer	119
	Nesting	140

[14] While the EPBC PMST search results identified that this species or species habitat may occur within the Activity Area, spatial mapping data within the PMST indicated the nearest area where the species or species habitat may occur was approximately 4.3 km outside of the Activity Area.

Common Name	BIA Behaviour	Distance from Activity Area (~km)
Leatherback turtle	Internesting	855
Loggerhead turtle	Foraging	180
Olive ridley turtle	Foraging	180
	Internesting	605

Table 7-9: Habitat Critical to the Survival of Marine Turtles within the Planning Area

Common Name	Genetic Stock	Nesting Location	Approx. Distance from Activity Area	Internesting Buffer (km)	Nesting Period	Hatching Period
Flatback turtle	Arafura Sea	Wagait Beach to south of Point Blaze, including all offshore islands	557 km east	60	All year (peak: Jun–Sep)	Jul–Sep
		Brace Point to One Tree Point including all offshore islands	566 km east			
		Soldier Point to Pirlangimpi including Seagull Island	593 km east			
		Waters between Melville Island and Vernon Islands	672 km east			
		Field Island (Cobourg Peninsula)	809 km east			
Green turtle	Ashmore Reef	Ashmore Reef and Cartier Reef	83 km north-west	20	All year (peak: Dec–Jan)	Sep–May
	Scott Reef – Browse Island	Scott Reef	138 km south-west	20	Nov–Mar (peak: Jan–Feb)	Mar–Apr
		Browse Island	23 km south-west			
	North West Shelf	Mainland east of Mary Island to mainland adjacent to Murrara Island including all offshore islands	145 km south-east	20	Nov–Mar (peak: Dec–Feb)	Jan–May (peak: Feb–Mar)
		Browse Island	23 km south-west			
	Cobourg Peninsula	Croker Island and McCluer Island groups plus Black Point to Smith Point	843 km east	20	Oct–Apr (peak: Dec–Jan)	Dec–May (peak: Feb–Mar)
Leatherback turtle	Australia	All sandy beaches from Coburg Peninsula to Cape Arnhem including Danger Point, Wessel Islands, and Elcho Island	795 km east	20	Dec–Jan	Jan–Feb
Olive ridley	NT	Brace Point to One Tree Point, including all offshore islands	600 km east	20	All year (peak: Apr–Jun)	All year (peak: Jun–Aug)
		Soldier point to Pirlangimpi including Seagull Island	626 km east			
		Croker Island, Cobourg Peninsula, west of Murganella to the West Alligator River	798 km east			

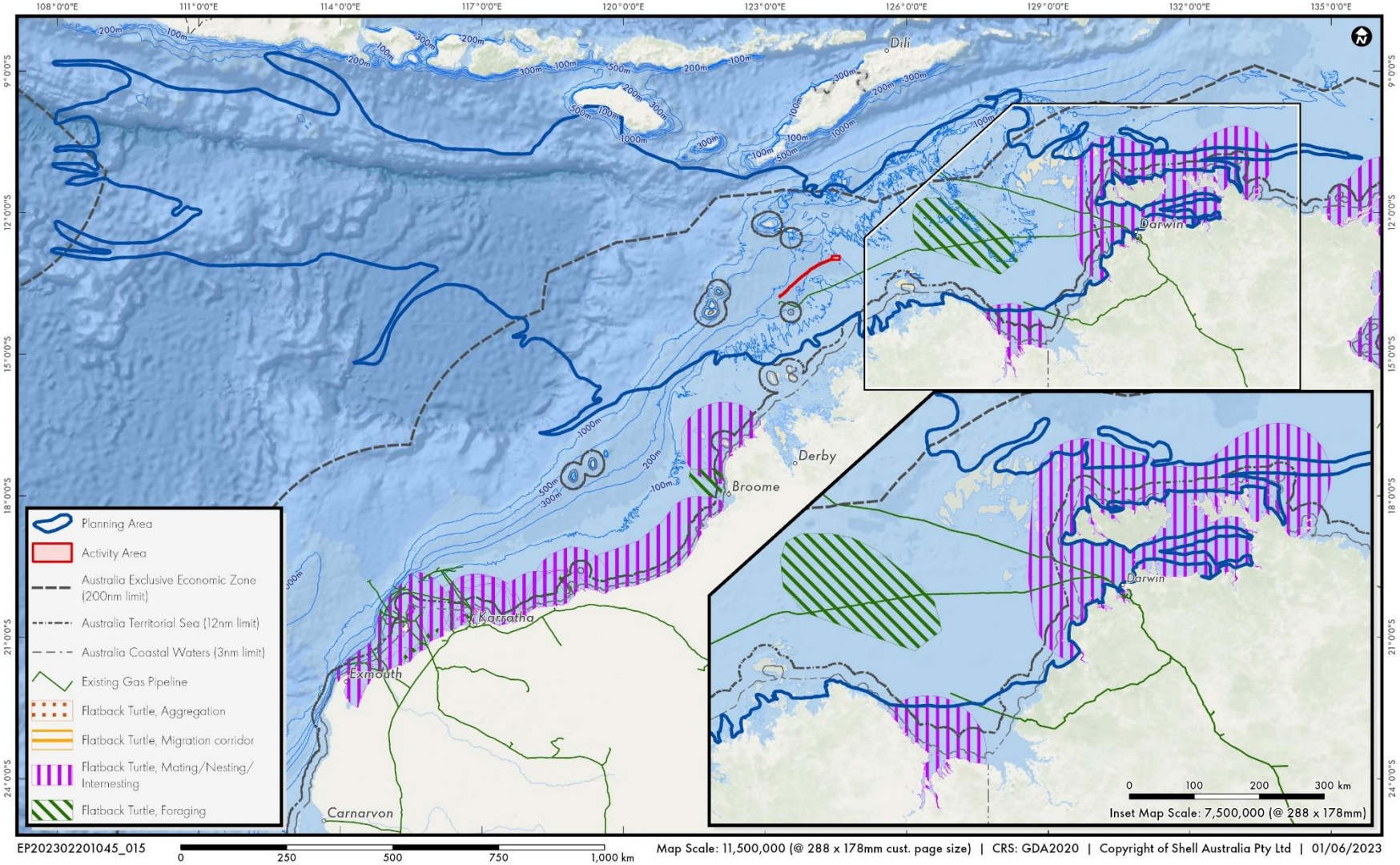


Figure 7-10: BIAs for Flatback Turtles within the Planning Area

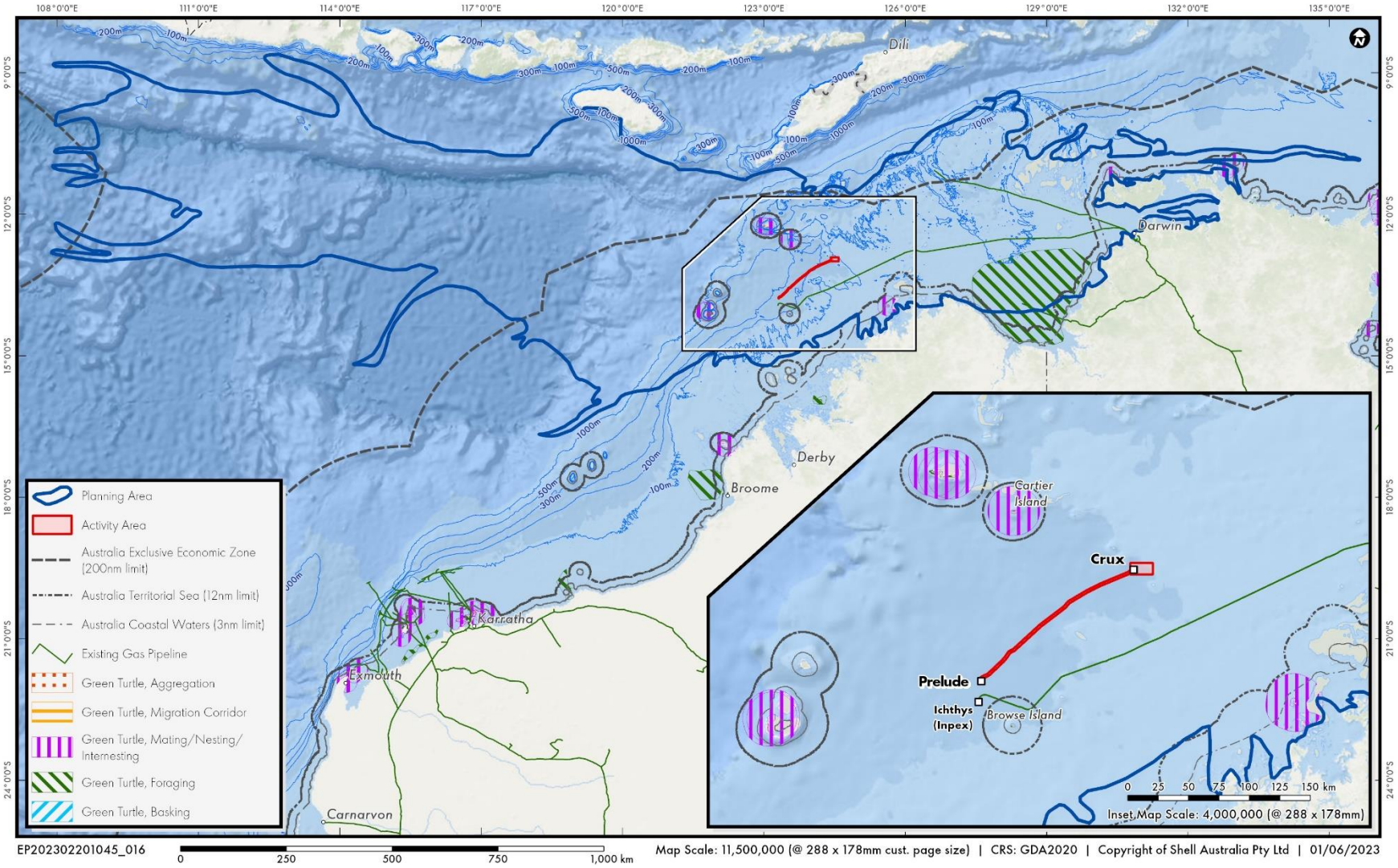


Figure 7-11: BIAs for Green Turtles within the Planning Area

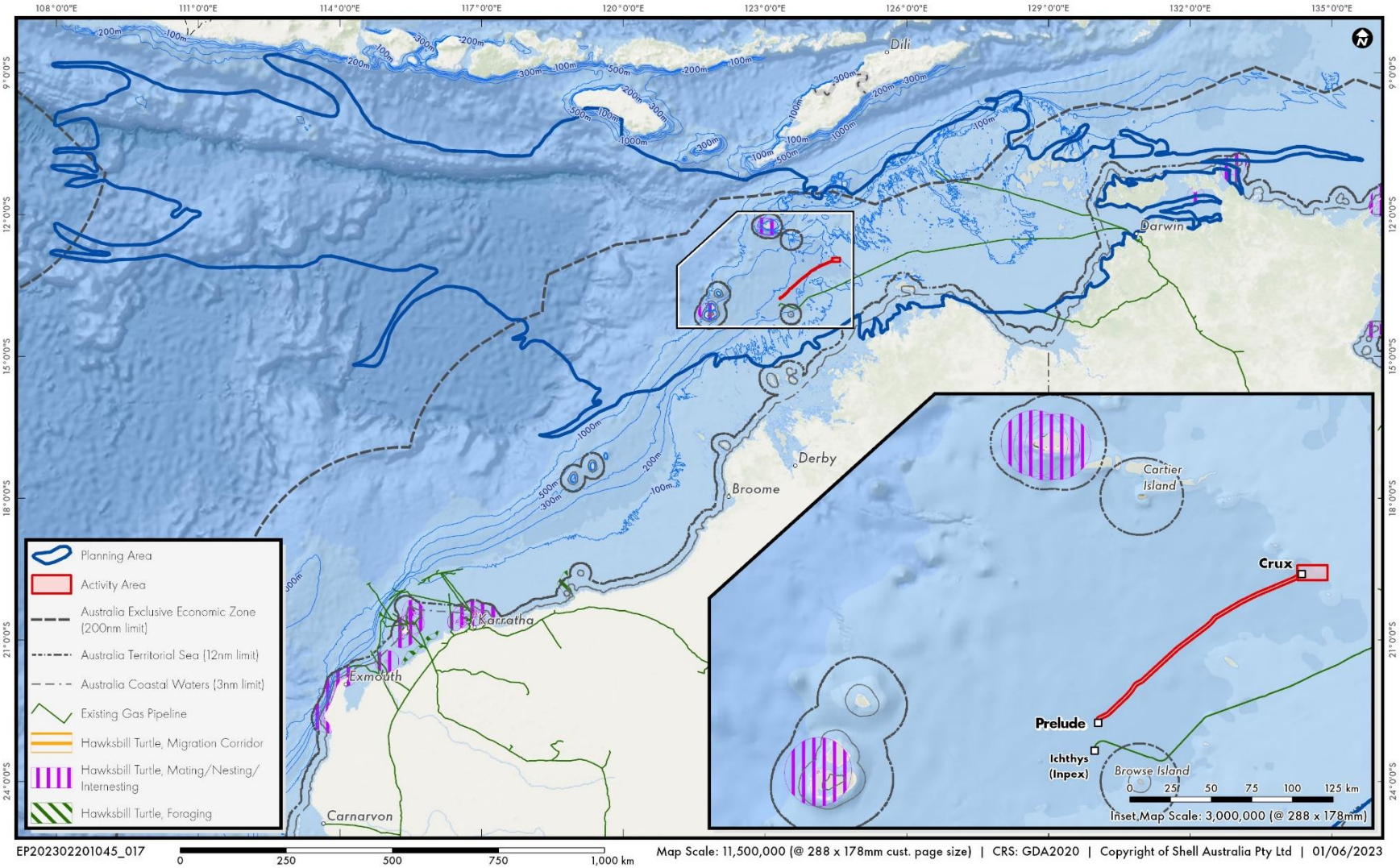


Figure 7-12: BIAs for Hawksbill Turtles within the Planning Area

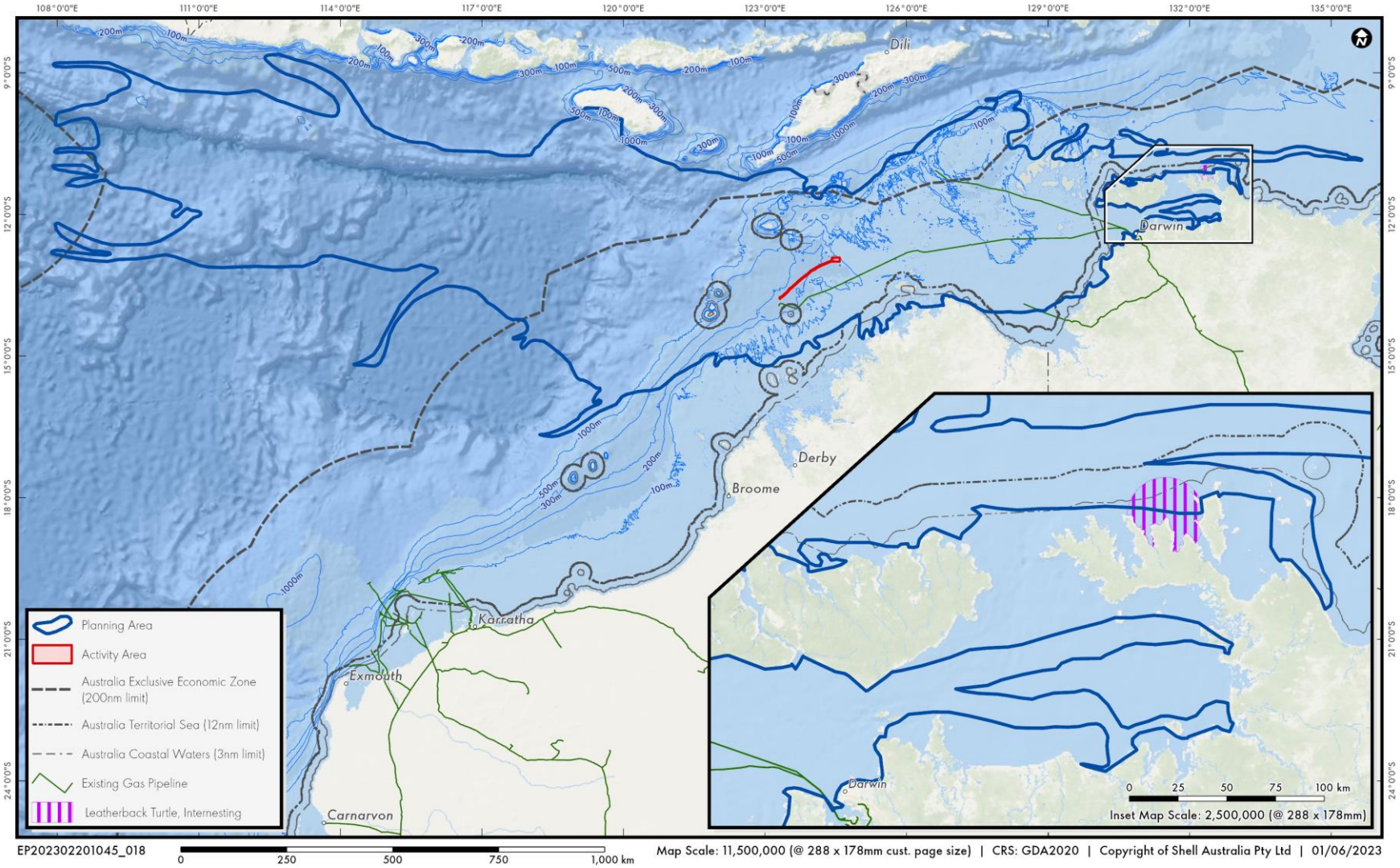


Figure 7-13: BIAs for Leatherback Turtles within the Planning Area

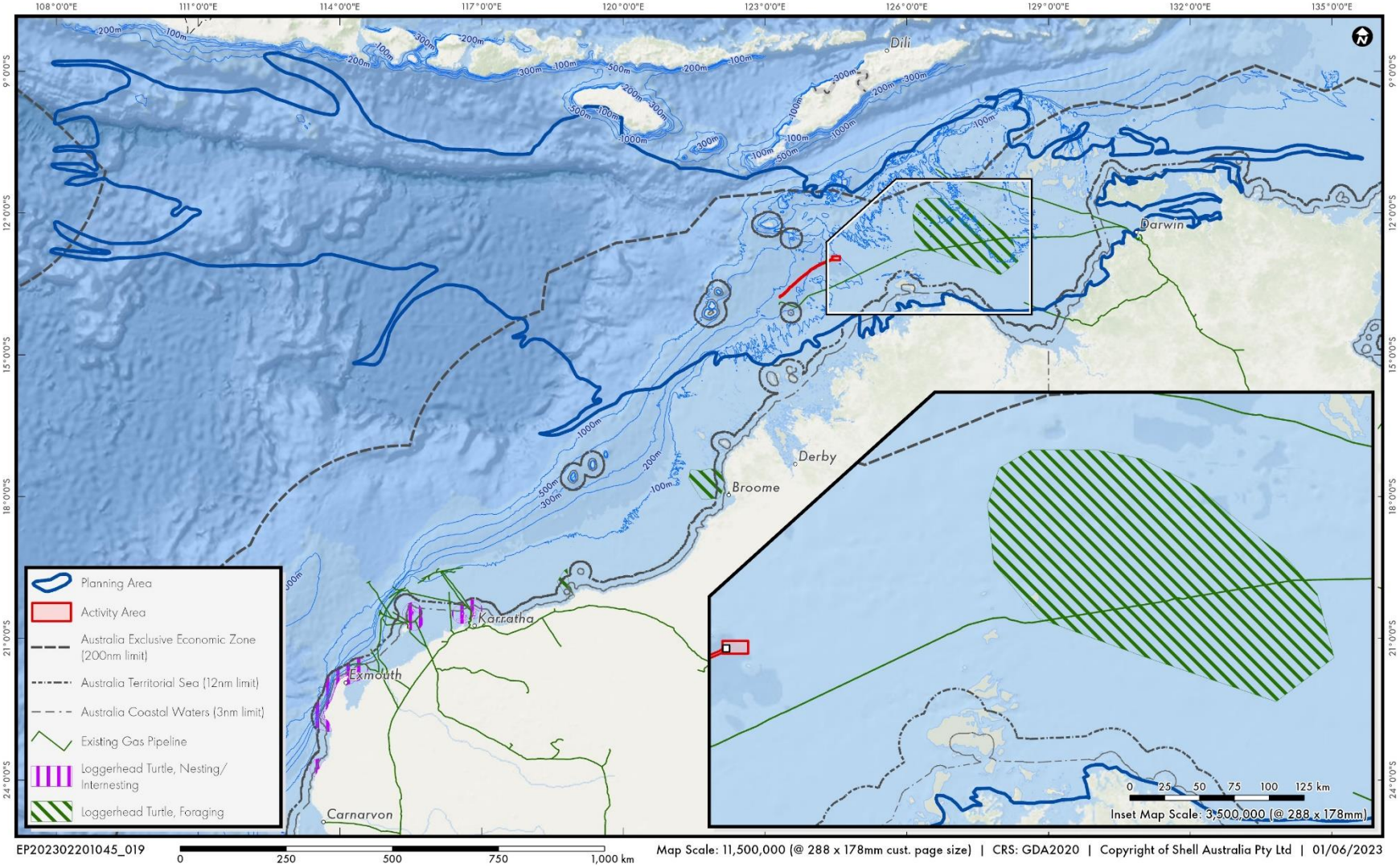


Figure 7-14: BIAs for Loggerhead Turtles within the Planning Area

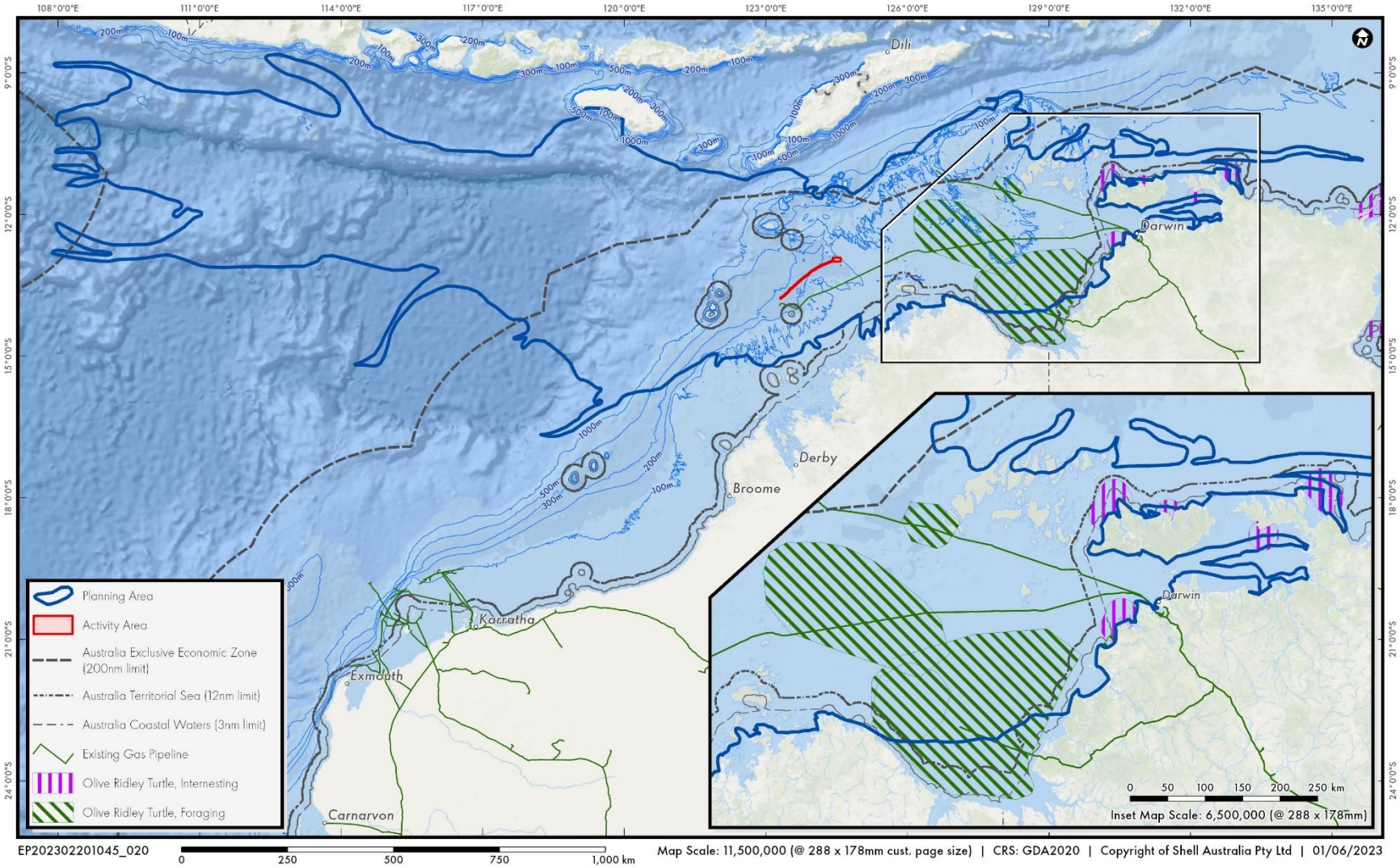


Figure 7-15: BIAs for Olive Ridley Turtles within the Planning Area

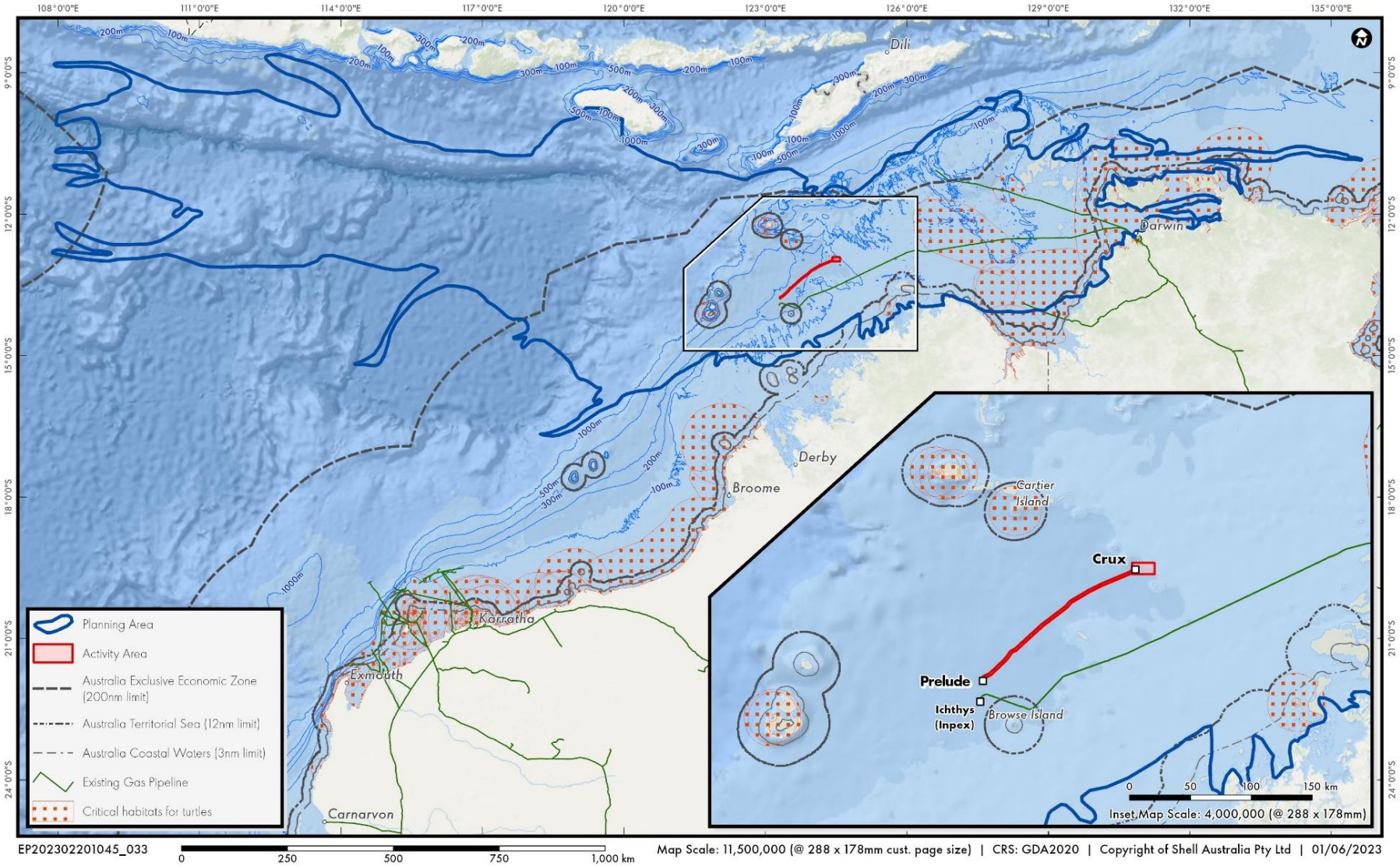


Figure 7-16: Habitat Critical for the Survival of Marine Turtles within the Planning Area

7.3.3.3 Sharks, Rays and Other Fish

Table 7-10 lists the EPBC Act listed threatened and migratory sharks, rays and other fish that may occur within the Planning Area. No additional species were identified within the Light or Noise Assessment Areas compared to the Activity Area. A foraging BIA for the whale shark intersects the Activity Area (see Figure 7-17).

Table 7-10: EPBC Act Listed Threatened and Migratory Sharks, Rays and other Fish that may Occur within the Planning Area

Species Name	Common Name	EPBC Act Listing Status			CA / RP	Presence Type	
		Threatened	Migratory	Marine		Activity Area	Planning Area
Carcharodon carcharias	White shark, great white shark	Vulnerable	✓	×	RP	Species or species habitat may occur within area	Species or species habitat may occur within area
Glyphis garricki	Northern river shark, New Guinea river shark	Endangered	×	×	CA, RP	Species or species habitat may occur within area	Breeding known to occur within area
Pristis pristis	Freshwater sawfish, largetooth sawfish, river sawfish, Leichhardt's sawfish, northern sawfish	Vulnerable	✓	×	CA, RP	Species or species habitat may occur within area	Species or species habitat known to occur within area
Pristis zijsron	Green sawfish, Dindagubba, narrowsnout sawfish	Vulnerable	✓	×	CA, RP	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Rhincodon typus	Whale shark	Vulnerable	✓	×	CA	Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	×	×	CA	Species or species habitat likely to occur within area	Species or species habitat known to occur within area
Thunnus maccoyii	Southern bluefin tuna	Conservation Dependent	×	×	×	Breeding known to occur within area	Breeding known to occur within area
Anoxypristis cuspidata	Narrow sawfish, knifetooth sawfish	×	✓	×	×	Species or species habitat may occur within area	Species or species habitat known to occur within area
Carcharhinus longimanus	Oceanic whitetip shark	×	✓	×	×	Species or species habitat may occur within area	Species or species habitat may occur within area
Glyphis glyphis	Speartooth shark	Critically Endangered	×	×	CA, RP	Not applicable (N/A)	Species or species habitat known to occur within area
Isurus oxyrinchus	Shortfin mako, mako shark	×	✓	×	×	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area

Species Name	Common Name	EPBC Act Listing Status			CA / RP	Presence Type	
		Threatened	Migratory	Marine		Activity Area	Planning Area
Isurus paucus	Longfin mako	×	✓	×	×	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Mobula alfredi	Reef manta ray, coastal manta ray	×	✓	×	×	Species or species habitat likely to occur within area	Species or species habitat known to occur within area
Mobula birostris	Giant manta ray	×	✓	×	×	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Pristis clavata	Dwarf sawfish, Queensland sawfish	Vulnerable	✓	×	CA, RP	N/A	Species or species habitat known to occur within area

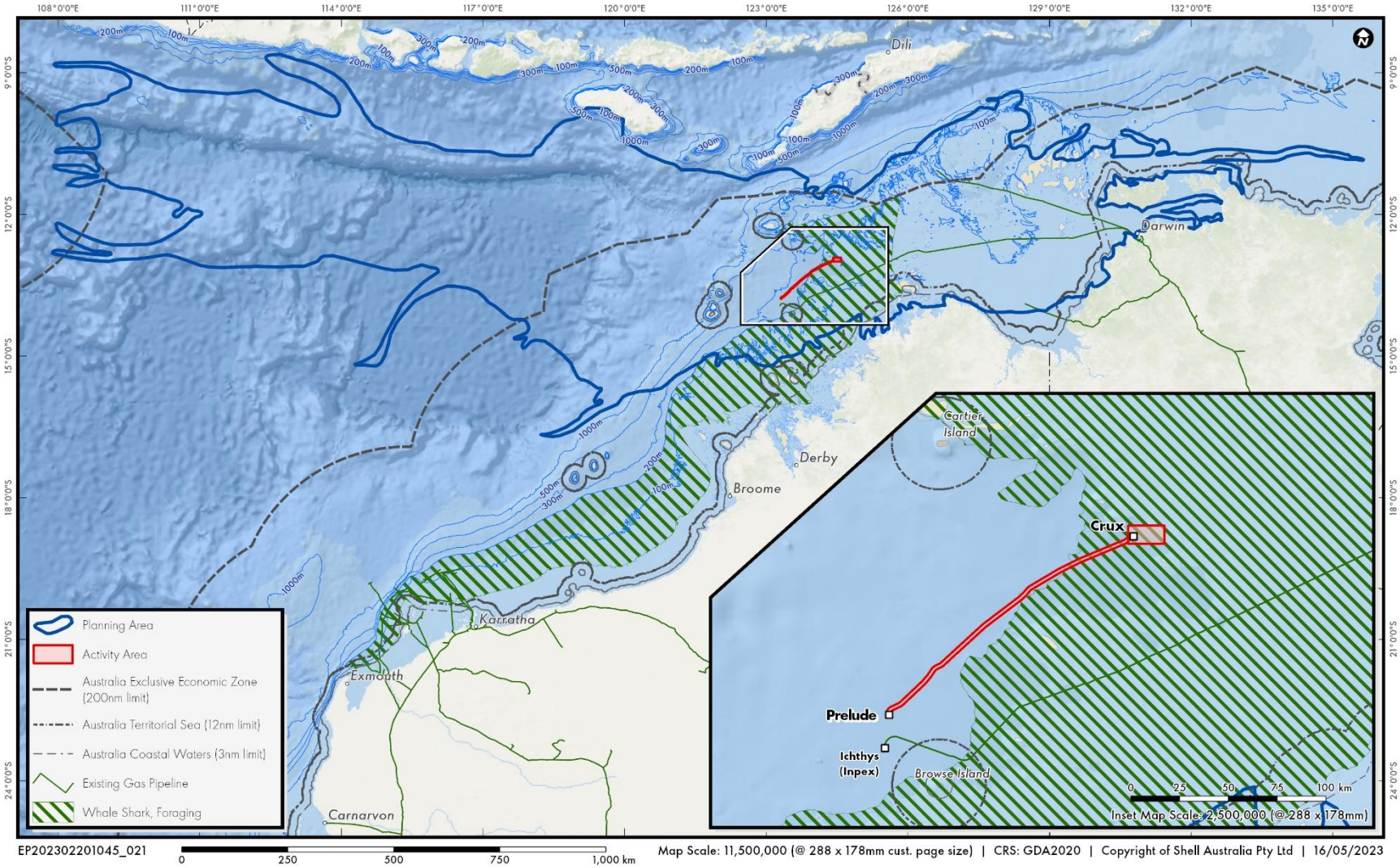


Figure 7-17: BIAs for Whale Sharks within the Planning Area

7.3.3.4 Birds

Table 7-11 lists the EPBC Act listed birds that may occur within the Activity and Planning Areas. The bird BIAs that may occur within the Planning Area are listed in Table 7-12 and shown in Figure 7-18. No additional species were identified within the Light or Noise Assessment Area compared to the Activity Area.

Table 7-11: EPBC Act Listed Threatened and Migratory Birds that may Occur within the Planning Area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Actitis hypoleucos	Common sandpiper	×	✓	CP	Species or species habitat may occur within area	Species or species habitat known to occur within area
Anous stolidus	Common noddy	×	✓	CP	Species or species habitat likely to occur within area	Breeding known to occur within area
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	×	CA	Foraging, feeding or related behaviour known to occur within area	Breeding known to occur within area
Calidris acuminata	Sharp-tailed sandpiper	Vulnerable	✓	CP	Species or species habitat may occur within area	Roosting known to occur within area
Calidris canutus	Red knot, knot	Vulnerable	✓	CA, CP	Species or species habitat may occur within area	Species or species habitat known to occur within area
Calidris ferruginea	Curlew sandpiper	Critically Endangered	✓	CA, CP	Species or species habitat may occur within area	Species or species habitat known to occur within area
Calidris melanotos	Pectoral sandpiper	×	✓	CP	Species or species habitat may occur within area	Species or species habitat known to occur within area
Calonectris leucomelas	Streaked shearwater	×	✓	CP	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Fregata ariel	Lesser frigatebird, least frigatebird	×	✓	CP	Species or species habitat likely to occur within area	Breeding known to occur within area
Fregata minor	Great frigatebird, greater frigatebird	×	✓	CP	Foraging, feeding or related behaviour likely to occur within area	Breeding known to occur within area
Numenius madagascariensis	Eastern curlew, far eastern curlew	Critically Endangered	✓	CA	Species or species habitat may occur within area	Species or species habitat known to occur within area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Papasula abbotti	Abbott's booby	Endangered	×	CA	Species or species habitat may occur within area	Species or species habitat may occur within area
Phaethon lepturus	White-tailed tropicbird	×	✓	CA, CP	Species or species habitat likely to occur within area	Breeding known to occur within area
Sula sula	Red-footed booby	×	✓	CP	Breeding known to occur within area	Breeding known to occur within area
Acrocephalus orientalis	Oriental reed-warbler	×	✓	×	×	Species or species habitat known to occur within area
Apus pacificus	Fork-tailed swift	×	✓	×	×	Species or species habitat likely to occur within area
Ardenna pacifica	Wedge-tailed shearwater	×	✓	CP	×	Breeding known to occur within area
Arenaria interpres	Ruddy turnstone	Vulnerable	✓	CP	×	Roosting known to occur within area
Calidris alba	Sanderling	×	✓	CP	×	Roosting known to occur within area
Calidris ruficollis	Red-necked stint	×	✓	CP	×	Roosting known to occur within area
Calidris subminuta	Long-toed stint	×	✓	CP	×	Roosting known to occur within area
Calidris tenuirostris	Great knot	Vulnerable	✓	CA, CP	×	Roosting known to occur within area
Cecropis daurica	Red-rumped swallow	×	✓	×	×	Species or species habitat known to occur within area
Charadrius dubius	Little ringed plover	×	✓	CP	×	Roosting known to occur within area
Charadrius leschenaultii	Greater sand plover, large sand plover	Vulnerable	✓	CA, CP	×	Species or species habitat known to occur within area
Charadrius mongolus	Lesser sand plover, Mongolian plover	Endangered	✓	CA	×	Roosting known to occur within area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Charadrius veredus	Oriental plover, oriental dotterel	×	✓	CP	×	Roosting known to occur within area
Cuculus optatus	Oriental cuckoo, Horsfield's cuckoo	×	✓	×	×	Species or species habitat known to occur within area
Epthianura crocea tunneyi	Alligator Rivers yellow chat, yellow chat (Alligator Rivers)	Endangered	×	CA	×	Species or species habitat known to occur within area
Erythrotriorchis radiatus	Red goshawk	Endangered	×	CA	×	Species or species habitat known to occur within area
Erythrura gouldiae	Gouldian finch	Endangered	×	CA	×	Species or species habitat known to occur within area
Falco hypoleucos	Grey falcon	Vulnerable	×	CA	×	Species or species habitat known to occur within area
Falcunculus frontatus whitei	Crested shrike-tit (northern), northern shrike-tit	Vulnerable	×	CA	×	Species or species habitat likely to occur within area
Fregata andrewsi	Christmas Island frigatebird, Andrew's frigatebird	Endangered	✓	CA	×	Foraging, feeding or related behaviour known to occur within area
Gallinago megala	Swinhoe's snipe	×	✓	CP	×	Roosting known to occur within area
Gallinago stenura	Pin-tailed snipe	×	✓	CP	×	Roosting likely to occur within area
Geophaps smithii blaauwi	Partridge pigeon (western)	Vulnerable	×	CA	×	Species or species habitat likely to occur within area
Geophaps smithii smithii	Partridge pigeon (eastern)	Vulnerable	×	CA	×	Species or species habitat known to occur within area
Glareola maldivarum	Oriental pratincole	×	✓	CP	×	Roosting known to occur within area
Hirundo rustica	Barn swallow	×	✓	×	×	Species or species habitat known to occur within area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Hydroprogne caspia	Caspian tern	×	✓	CP	×	Breeding known to occur within area
Limicola falcinellus	Broad-billed sandpiper	×	✓	CP	×	Roosting known to occur within area
Limnodromus semipalmatus	Asian dowitcher	Vulnerable	✓	CA, CP	×	Species or species habitat known to occur within area
Limosa lapponica	Bar-tailed godwit	×	✓	CP	×	Species or species habitat known to occur within area
Limosa lapponica baueri	Bar-tailed godwit (baueri)	Endangered	×	CA	×	Species or species habitat known to occur within area
Limosa lapponica menzbieri	Bar-tailed godwit (northern Siberian)	Endangered	×	CA	×	Species or species habitat known to occur within area
Limosa limosa	Black-tailed godwit	Endangered	✓	CA, CP	×	Roosting known to occur within area
Melanodryas cucullata melvillensis	Tiwi Islands hooded robin, hooded robin (Tiwi Islands)	Critically Endangered	×	CA	×	Species or species habitat likely to occur within area
Motacilla cinerea	Grey wagtail	×	✓	×	×	Species or species habitat known to occur within area
Motacilla flava	Yellow wagtail	×	✓	×	×	Species or species habitat known to occur within area
Numenius minutus	Little curlew, little whimbrel	×	✓	CP	×	Roosting known to occur within area
Numenius phaeopus	Whimbrel	×	✓	CP	×	Roosting known to occur within area
Onychoprion anaethetus	Bridled tern	×	✓	CP	×	Breeding known to occur within area
Pandion haliaetus	Osprey	×	✓	CP	×	Breeding known to occur within area
Phaethon lepturus fulvus	Christmas Island white-tailed tropicbird, golden bosunbird	Endangered	×	CA, CP	×	Species or species habitat may occur within area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Phaethon rubricauda	Red-tailed tropicbird	Endangered	✓	CA, CP	×	Breeding known to occur within area
Pluvialis fulva	Pacific golden plover	×	✓	CP	×	Roosting known to occur within area
Pluvialis squatarola	Grey plover	Vulnerable	✓	CA, CP	×	Roosting known to occur within area
Rhipidura rufifrons	Rufous fantail	×	✓	×	×	Species or species habitat known to occur within area
Rostratula australis	Australian painted snipe	Endangered	×	CA, RP	×	Species or species habitat likely to occur within area
Sterna dougallii	Roseate tern	×	✓	CP	×	Breeding known to occur within area
Sternula albifrons	Little tern	×	✓	CP	×	Breeding known to occur within area
Sula dactylatra	Masked booby	×	✓	CP	×	Breeding known to occur within area
Sula leucogaster	Brown booby	×	✓	CP	×	Breeding known to occur within area
Thalasseus bergii	Greater crested tern	×	✓	CP	×	Breeding known to occur within area
Tringa brevipes	Grey-tailed tattler	×	✓	CP	×	Roosting known to occur within area
Tringa glareola	Wood sandpiper	×	✓	CP	×	Roosting known to occur within area
Tringa incana	Wandering tattler	×	✓	CP	×	Roosting known to occur within area
Tringa nebularia	Common greenshank, greenshank	Endangered	✓	CA, CP	×	Species or species habitat known to occur within area
Tringa stagnatilis	Marsh sandpiper, little greenshank	×	✓	CP	×	Roosting known to occur within area

Species Name	Common Name	EPBC Act Listing Status		CA / Conservation Plan (CP) / RP	Presence Type	
		Threatened	Migratory		Activity Area	Planning Area
Tyto novaehollandiae kimberli	Masked owl (northern)	Vulnerable	×	CA	×	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis	Tiwi masked owl, Tiwi Islands masked owl	Endangered	×	CA	×	Species or species habitat known to occur within area
Xenus cinereus	Terek sandpiper	Vulnerable	✓	CA, CP	×	Roosting known to occur within area

Table 7-12: Bird BIAs Identified within the Planning Area

Common Name	BIA Behaviour	BIA Description	Distance from Activity Area (~km)
Greater frigatebird	Breeding	Islands off the Kimberley, WA, coastline including Ashmore Reef and Adele Island. Breeding may occur in May–Jun and Aug.	30
Lesser frigatebird	Breeding	Islands off the Kimberley, WA, coastline including Ashmore Reef and Adele, Lacepede and Bedout islands.	33
Red-footed booby	Breeding	Islands off the Kimberley, WA, coastline including Ashmore Reef and Adele Island. Breeding may occur in May–Jun.	30
Wedge-tailed shearwater	Breeding	Breeding at Ashmore Reef. Breeding may occur from Aug–Apr.	33
White-tailed tropicbird	Breeding	Breeding at Ashmore Reef. Breeding may occur from May–Oct.	40
Bridled tern	Breeding	Breeding at Cobourg Island. Breeding may occur all year, with primary breeding from Mar–Jun and Sep–Dec.	850
Brown booby	Breeding	Breeding at Ashmore Reef. Breeding may occur from Feb–Oct.	90
Crested tern	Breeding	Breeding at Cobourg Island. Breeding may occur all year, with primary breeding from Mar–Jul.	840
	Breeding (high numbers)	Breeding in high numbers at Seagull Island (north of Tiwi Islands). Breeding may occur from Mar–Jul, with primary breeding from Apr–Jul.	635
Lesser crested tern	Breeding	Breeding along NT coastline and Ashmore Reef. Breeding may occur from Mar–Jun.	113
Little tern	Breeding	Breeding along NT coastline. Breeding may occur in Jun, Jul and Oct.	160
	Resting	Islands off the Kimberley, WA, coastline including Ashmore Reef.	125
Roseate tern	Breeding	Breeding along NT coastline and Ashmore Reef. Breeding may occur from Mar–Jul.	113

Common Name	BIA Behaviour	BIA Description	Distance from Activity Area (~km)
	Breeding (high numbers)	Breeding along NT coastline and Ashmore Reef. Breeding may occur from Mar–Jul.	900

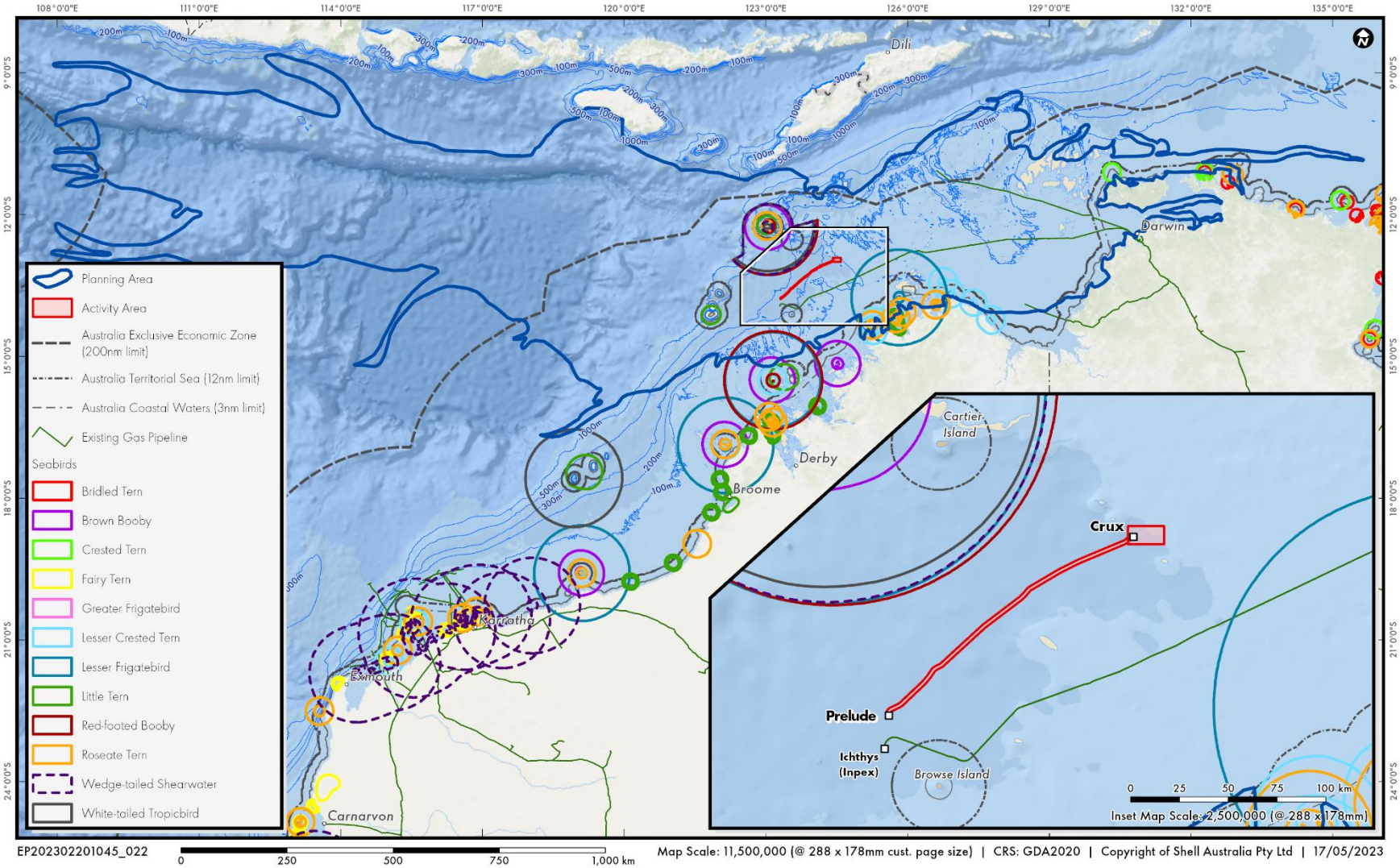


Figure 7-18: BIAs of Birds within the Planning Area

7.3.3.5 Seasonal Sensitivities of Threatened and Migratory Species

Table 7-13 lists the months that coincide with key environmental sensitivities for the Planning Area, including EPBC Act listed threatened and migratory species potentially occurring within the Activity Area. These relate to aggregation, breeding, foraging or migration of the indicated fauna.

Table 7-13: Key Environmental Sensitivities and Indicative Timings for Migratory Fauna within the Planning Area

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mammals												
Blue whale – northern migration (Exmouth, Montebello, Scott Reef)[1]												
Blue whale – southern migration (Exmouth, Montebello, Scott Reef)[2]												
Humpback whale – northern migration (Jurien Bay to Montebello)[3]												
Humpback whale – southern migration (Jurien Bay to Montebello)[4]												
Sharks, Rays and Other Fish												
Whale shark* – foraging/ aggregation near Ningaloo[5]												
Manta rays – presence/ aggregation/breeding (Ningaloo)[6]												
Reptiles												
Green turtle[7]	N,H	N,H	H	H	H	N	N	H	H	H	H	N,H
Hawksbill turtle[7]	N,H	H						N,H	H	N,H	N,H	N,H
Olive ridley turtle[7]				N	N	N,H	N,H	H				
Flatback turtle[7]	N,H	H	H	H	H	N,H	N,H	N,H	N,H	N,H	N,H	N,H
Leatherback turtle[7]	N,H	H										N
Loggerhead turtle[7]	N,H	H	H	H	H							
Birds												
Migratory shorebirds[6]												

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Key and notes

	Species likely to be present
	Peak period. Presence of animals reliable and predictable each year
N	Peak Turtle Nesting
H	Peak Turtle Hatching

1 – DSEWPaC 2012; McCauley and Jenner 2010
2 – DSEWPaC 2012; McCauley and Jenner 2010
3 –CALM 2005; Jenner et al. 2001; McCauley and Jenner 2001, Double et al. 2012
4 – McCauley and Jenner 2001
5 – DoE 2015e; Wilson et al. 2006
6 – CALM 2005, DSEWPaC 2012, Environment Australia 2002, Sleeman et al. 2010
7 – CoA 2017b
8 – Rogers et al. 2011

7.3.3.6 EPBC Management Publications

The Commonwealth publishes management plans, recovery plans (RPs), and conservation advice (CA). These publications provide guidance on threats and management measures to prevent species decline and support species recovery. The activities under this EP are not inconsistent with any of the publications, including recovery and threat abatement plans described below. To determine the relevance of each publication, the spatial extent of the species' presence, habitat, and threats were examined, within the Planning Area to identify applicable aspects for the impact and risk assessment (Section 8.3). Table 7-14 summarises relevant EPBC Act listed species and associated publications relevant to the Activity.

Table 7-14: Summary of Relevant EPBC Management Publications

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
All Vertebrate Fauna			
All vertebrate fauna	Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (CoA 2018)	Marine debris	No explicit conservation actions for non-fisheries related industries (Note: Management actions in the plan relate largely to managing fishing waste and state and Commonwealth fisheries management through regulation)
Mammals			
Cetaceans and other marine megafauna	National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (CoA 2017)	Vessel disturbance	No explicit relevant conservation actions
Sei whale	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	Noise interference	Assess and manage acoustic disturbance
		Vessel disturbance	Assess and manage physical disturbance and development activities
	Climate change	No explicit relevant conservation actions	
Blue whale	Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (CoA 2015a)	Noise interference	Assess and address anthropogenic noise
		Vessel disturbance	Minimise vessel collisions
		Climate change	No explicit relevant conservation actions
Fin whale	Approved conservation advice for *Balaenoptera physalus* (fin whale) (TSSC 2015b)	Noise interference	Assess and address anthropogenic noise
		Vessel disturbance	Minimise vessel collisions
		Climate change	No explicit relevant conservation actions
Reptiles			
Loggerhead turtle, green turtle, leatherback turtle, hawksbill turtle, flatback turtle, olive ridley turtle	National Light Pollution Guidelines for Wildlife (DCCEEW 2023b)	Light pollution	Minimise light pollution
	Recovery plan for Marine Turtles in Australia 2017–2027 (CoA 2017b)	Light pollution	Minimise light pollution
		Chemical and terrestrial discharge (oil pollution)	Ensure that spill risk strategies and response programs include management for turtles and their habitats
		Climate change	No explicit relevant conservation actions

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
		Vessel disturbance	No explicit relevant conservation actions
		Marine debris	Support the implementation of the Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (CoA 2018)
		Noise interference	No explicit relevant conservation actions
Leatherback turtle	Approved conservation advice for *Dermochelys coriacea* (Leatherback Turtle) (TSSC 2008a)	Vessel disturbance	No explicit relevant conservation actions
		Climate change	No explicit relevant conservation actions
Short-nosed sea snake	Approved conservation advice for *Aipysurus apraefrontalis* (short-nosed sea snake) (TSSC 2010a)	No additional threats identified (ex. marine debris)	None applicable
Leaf-scaled sea snake	Approved conservation advice for *Aipysurus foliosquama* (leaf-scaled sea snake) (TSSC 2010b)	No additional threats identified (ex. marine debris)	None applicable
Dusky sea snake	Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW, 2024n) sea snake	Climate change and sever weather	
		Frequent and severe marine heatwaves (acute)	The listed climate change impacts actions are related to implementing regulatory mechanisms and international diplomacy to reduce greenhouse gas emissions and are therefore not explicit relevant conservations actions for the activities described within this EP. Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: - Net-positive carbon emissions that contribute to climate change. - The risk of discharged cooling water, or other heat sources, increasing water temperature for the dusky sea snake and its habitat.
		High average water temperature (persistent)	
		Severe cyclones and storms	
		Fossil fuel exploration and extraction	
		Oil Pollution	It is essential that gas and oil exploration, extraction, production and decommissioning activities are adequately and effectively regulated and enforced to avoid negative impacts to the dusky sea snake at all stages of each project. This includes the use of a precautionary approach to avoid potential threats until further information is available from targeted research. Monitoring for compliance is essential in this remote area. Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake,

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
			including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: - The risk of oil spill affecting the dusky sea snake and its habitat. Ensure there is an effective strategy and adequate local resources and knowledge in place to rapidly respond to a large unintentional oil spill from gas and oil projects in the Browse Basin. Prioritise local storage of green dispersants which are non-toxic, non-volatile, and naturally available or renewable – and local capacity for their use. Should an oil spill occur that may impact the known or likely distribution of the dusky sea snake: - Urgently use herding agents, bioremediation agents and mechanical means to contain and break down the oil. See Australian Maritime Safety Authority: oil spill control agents. - Urgently cap or otherwise isolate the source of the oil to prevent further contamination. - Immediately resource and mobilise multiple expert wildlife care teams to search for, and rehabilitate, ill dusky sea snakes (and other threatened and priority taxa). Ensure there is sufficient expertise within the care team to assess the condition of sea snakes at sea for release or rehabilitation, effectively collect samples from live individuals for toxicology and pathology assessments, and safely collect and freeze deceased individuals for necropsy, pathology, and toxicology assessment.
		Excessive Marine Noise	Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: - All sources of excessive or constant marine noise that may impact the dusky sea snake: - Use knowledge about barotrauma in oral gulping fish as a surrogate for assessing and avoiding barotrauma in the dusky sea snake until further information is available from targeted research; noting that reef-dependent sea snakes, including the dusky sea

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
			snake, have little to no capacity to relocate to avoid noise. - Ensure all other sources of excessive or constant marine noise that may impact the dusky sea snake are eliminated, including from drilling and shipping.
		Pollution from heavy metals and other toxins	Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: The risk of other pollutants affecting the dusky sea snake and its habitat, including produce water, heavy metals and drilling waste discharges.
		Sedimentation and coral smothering	Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: The risk of other pollutants affecting the dusky sea snake and its habitat. Including those from drilling cuttings discharge.
		Marine vessels	
		Constant Marine Noise	Develop, implement and enforce regulations that require marine vessels that are operating in areas where the dusky sea snake is known or likely to occur (Map 1) to have adequate noise-quieting technology installed. This is not considered a relevant conservation action, as it relates to the development of regulation, implementation and enforcement of regulation, which is a function of relevant regulatory authorities. Develop minimal-noise operating guidelines that address constant noise exposure and distribute these to captains of vessels operating in waters where the dusky sea snake is known or likely to occur. Ensure vessels are operating under minimal-noise guidelines in these areas.
		Small and fragmented population	
		Low genetic diversity	No explicit relevant conservation actions
		Hybridisation	No explicit relevant conservation actions
Sharks and Rays			
White shark	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC 2013b)	Ecosystem effects as a result of habitat modification	No explicit relevant conservation actions
		Climate change	

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
Northern river shark	Approved conservation advice for *Glyphis garricki* (northern river shark) (TSSC 2014a)	Habitat degradation / modification	Implement measures to reduce adverse impacts of habitat degradation and/or modification
	Sawfish and river shark multispecies recovery plan (CoA 2015b)		Identify risks to important sawfish and river shark habitat and measures need to reduce those risks
Green sawfish	Approved conservation advice for green sawfish (TSSC 2008b)	Habitat degradation / modification	No explicit relevant conservation actions
	Sawfish and river shark multispecies recovery plan (CoA 2015b)		Identify risks to important sawfish and river shark habitat and measures need to reduce those risks
Whale shark	Approved conservation advice *Rhincodon typus* whale shark (DoE 2015e)	Vessel disturbance	Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations and along the northward migration route that follows the northern WA coastline along the 200 m isobath
		Habitat disruption from mineral exploration, production and transportation	Minimise offshore developments and transit time for large vessels.
		Marine debris	No explicit relevant conservation actions
		Climate change	
Dwarf sawfish	Approved conservation advice for *Pristis clavata* (dwarf sawfish) (TSSC 2009)	Habitat degradation / modification	No explicit relevant conservation actions
	Sawfish and river shark multispecies recovery plan (CoA 2015b)		Identify risks to important sawfish and river shark habitat and measures need to reduce those risks
Freshwater sawfish	Approved conservation advice for *Pristis pristis* (largetooth sawfish) (TSSC 2014b)	Habitat degradation / modification	No explicit relevant conservation actions
	Sawfish and river shark multispecies recovery plan (CoA 2015b)		Identify risks to important sawfish and river shark habitat and measures need to reduce those risks
Speartooth shark	Approved conservation advice for *Glyphis glyphis* (speartooth shark) (TSSC 2014c)	Habitat degradation / modification	Implement measures to reduce adverse impacts of habitat degradation and/or modification
	Sawfish and river shark multispecies recovery plan (CoA 2015b)		Identify risks to important sawfish and river shark habitat and measures need to reduce those risks
Birds			
All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife (DCCEEW 2023b)	Light pollution	Implement best practice light design principles and provide a suite lighting design/lighting controls to mitigate the effect of light for projects relevant to seabirds

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
Migratory shorebirds[15]	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a)	Habitat degradation / modification	Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes
		Climate Change	No explicit relevant conservation actions.
Seabirds[16]	Wildlife Conservation Plan for Seabirds (CoA 2020a)	Anthropogenic disturbance	Identify, protect, and manage seabirds and their habitats in Australia
		Pollution (marine debris, light, acute, chronic)	No explicit relevant conservation actions.
		Climate Change	No explicit relevant conservation actions.
Asian dowitcher	Conservation Advice for *Limnodromus semipalmatus* (Asian dowitcher) (DCCEEW 2024h)	Pollution	No explicit relevant conservation actions.
		Climate Change	
Abbott's booby	Conservation Advice for Abbott's Booby - *Papasula abbotti* (TSSC 2020b)	Climate Change	No explicit relevant conservation actions.
		Marine debris – plastics	
Alligator rivers yellow chat	Conservation advice *Epthianura crocea tunneyi* (Yellow chat – Alligator Rivers) (TSSC 2016g)	No explicit relevant threats	No explicit relevant conservation actions
Australian lesser noddy	Conservation advice *Anous tenuirostris melanops* Australian lesser noddy (TSSC 2015e)	Habitat degradation / modification	No explicit relevant conservation actions
		Pollution / contamination	No explicit relevant conservation actions
Australian painted snipe	Approved Conservation Advice on *Rostratula australis* (Australian Painted Snipe) (TSSC 2013)	Habitat degradation / modification	No explicit relevant conservation actions
	National Recovery Plan for the Australian Painted Snipe (*Rostratula australis*) (COA 2022)	Climate change	No explicit relevant conservation actions
Bar-tailed godwit (northern Siberian)	Approved Conservation Advice for *Limosa lapponica menzbieri* (Yakutian bar-tailed godwit) (DCCEEW 2024f)	Habitat degradation / modification	No explicit relevant conservation actions
		Climate change	

[15] Includes Asian dowitcher, bar-tailed godwit, black-tailed godwit, broad-billed sandpiper common greenshank, common sandpiper, curlew sandpiper, eastern curlew, great knot, greater sand plover, grey-tailed tattler, grey plover, lesser sand plover, little curlew, little ringed plover, long-toed stint, marsh sandpiper, little curlew, oriental plover, oriental pratincole, pacific golden plover, pectoral sandpiper, pin-tailed snipe, red knot, red-necked stint, ruddy turnstone, sanderling, sharp-tailed sandpiper, streaked shearwater, swinhoe's snipe, terek sandpiper, whimbrel, wood sandpiper and wandering tattler.

[16] Includes bridled tern, brown booby, caspian tern, Christmas Island white-tailed tropicbird, common noddy, great frigatebird, greater crested tern, greater crested tern, lesser frigatebird, little tern, masked booby, osprey, red-tailed tropicbird, roseate tern, streaked shearwater and wedge-tailed shearwater.

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
Bar-tailed godwit (western Alaskan)	Conservation Advice *Limosa lapponica baueri* (Alaskan bar-tailed godwit) (DCCEEW 2024e)	Habitat degradation / modification Pollution / contamination Climate change	No explicit relevant conservation actions
Black-tailed godwit	Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW 2024g)	Pollution Climate change	No explicit relevant conservation actions
Christmas Island frigatebird[17]	Conservation Advice for the Christmas Island Frigatebird (*Fregata andrewsi)* (TSSC 2020)	Marine debris – plastics	No explicit relevant conservation actions
Common greenshank	Conservation Advice for *Tringa nebularia* (common greenshank) (DCCEEW 2024k)	Pollution Climate change	No explicit relevant conservation actions
Crested shrike-tit (northern), northern shrike-tit	Conservation Advice *Falcunculus frontatus whitei* (crested shrike-tit – northern) (TSSC 2000)	No explicit relevant threats	No explicit relevant conservation actions
Curlew sandpiper	Conservation advice *Calidris ferruginea* curlew sandpiper (DCCEEW 2023f)	Pollution / contamination Climate Change	No explicit relevant conservation actions
Eastern curlew	Conservation advice *Numenius madagascariensis* eastern curlew (DCCEEW 2023e)	Pollution / contamination Climate Change	No explicit relevant conservation actions
Gouldian finch	Conservation Advice *Erythrura gouldiae* (Gouldian finch) (TSSC 2016h)	No explicit relevant threats	No explicit relevant conservation actions
Great knot	Conservation advice *Calidris tenuirostris* great knot (DCCEEW 2024d)	Habitat degradation / modification	No explicit relevant conservation actions
Greater sand plover	Conservation Advice for *Charadrius leschenaultii* (greater sand plover) (DCCEEW 2023g)	Habitat degradation / modification Climate Change	No explicit relevant conservation actions
Grey falcon	Conservation Advice *Falco hypoleucos* Grey Falcon (TSSC 2020a)	Climate Change	No explicit relevant conservation actions
Grey plover	Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW 2024j)	Pollution Climate Change	No explicit relevant conservation actions

[17] Species or species habitat is not known to be present within planned impact areas. Therefore, conservation advice is not evaluated within Section 9.13.

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (TSSC 2016d)	Habitat degradation / modification Climate Change	No explicit relevant conservation actions
Masked owl (northern)	Conservation Advice *Tyto novaehollandiae kimberli* (masked owl – northern) (TSSC 2015j)	No explicit relevant threats	No explicit relevant conservation actions
Masked owl (Tiwi Islands)	Approved Conservation Advice *Tyto novaehollandiae melvillensis* (masked owl – Tiwi Islands) (TSSC 2015k)	No explicit relevant threats	No explicit relevant conservation actions
Partridge pigeon (eastern)	Approved Conservation Advice *Geophaps smithii smithii* (partridge pigeon eastern) (TSSC 2015i)	No explicit relevant threats	No explicit relevant conservation actions
Partridge pigeon (western)	Approved Conservation Advice *Geophaps smithii blaauwi* (Partridge Pigeon – western) (TSSC 2008c)	No explicit relevant threats	No explicit relevant conservation actions
Red goshawk	Conservation Advice *Erythrotriorchis radiatus* (red goshawk) (DCCEEW 2023d)	Climate Change	No explicit relevant conservation actions
Red knot, knot	Approved conservation advice for *Calidris canutus* (Red knot) (DCCEEW 2024c)	Pollution / contamination Climate Change	No explicit relevant conservation actions
Red-tailed tropicbird	Conservation Advice for *Phaethon rubricauda westralis* (Indian Ocean red-tailed tropicbird) (DCCEEW 2023j)	Climate Change	No explicit relevant conservation actions
Ruddy turnstone	Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW 2024a)	Pollution Climate Change	No explicit relevant conservation actions
Sharp-tailed sandpiper	Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW 2024b)	Pollution Climate Change	No explicit relevant conservation actions
Terek sandpiper	Conservation Advice for *Xenus cinereus* (terek sandpiper) (DCCEEW 2024k)	Pollution	No explicit relevant conservation actions
Tiwi Islands hooded robin	Conservation Advice Melanodryas cucullata melvillensis hooded robin (Tiwi Islands) (TSSC 2018)	No explicit relevant threats	No explicit relevant conservation actions

Species / Sensitivity	EPBC Management Publication	Key threats identified in the RP/CA	Relevant Conservation Actions
Christmas Island White-tailed tropicbird	Conservation Advice *Phaethon lepturus fulvus* (white-tailed tropicbird, Christmas Island) (TSSC 2014d)	Pollution / contamination (oil spills)	No explicit relevant conservation actions

7.3.4 Protected Areas

7.3.4.1 Commonwealth Marine Area

The Commonwealth marine environment is classed as a matter of national environmental significance (MNES) under the EPBC Act. The Commonwealth marine area is defined as any part of the sea, including the waters, seabed and airspace, within Australia's EEZ or over the continental shelf of Australia that is not state or NT waters, and extends from three to 200 nm from the coast. The Planning Area occurs within waters off WA and NT that are part of three bioregions:

- North-west Marine Region (NWMR) comprising the Commonwealth waters and seabed extending from the WA–NT border to Kalbarri, WA (DEWHA 2008a)
- North Marine Region (NMR) comprising Commonwealth waters from west Cape York Peninsula to the NT–WA border (DNP 2018b)
- Indian Ocean Territories (IOT) comprising Commonwealth waters and seabed surrounding Christmas Island and Cocos (Keeling) Islands, located ~2,600 km and ~2,930 km north-west of Perth, respectively (DNP 2022).

The Activity Area is located within the NWMR, which is characterised by shallow-water tropical marine ecosystems and is home to globally significant populations of internationally threatened species (DEWHA 2008a). The NWMR is subdivided into provincial bioregions—the Activity Area is within the Timor Province (IMCRA v4.0). The Planning Area also overlaps additional provincial bioregions, including the Northwest Shelf Province, Northwest Transition, Northwest Shelf Transition, Northern Shelf Province, Timor Province and Christmas Island Province, as shown in Figure 7-19.

7.3.4.2 Marine Parks

The Activity Area—including the noise and Light Assessment Areas—does not overlap marine protected areas (MPAs), such as AMPs or state and territory marine parks. Table 7-15 lists the AMPs within the Planning Area and these are shown in Figure 7-20. Table 7-16 lists the WA and NT marine parks within the Planning Area with distances from the Activity Area; these are shown in Figure 7-20. Section 6.6.8 of the Master Existing Environment describes the values and sensitivities of the MPAs, except for the Christmas Island AMP. The Christmas Island AMP was established in 2022 and covers an area of 277,016 km^2, located 2,600 km northwest of Perth (DNP 2022).

The objectives of the Christmas Island Marine Park Management Plan (draft)are to provide for the following:

- protection and conservation of biodiversity and other natural, cultural and heritage values
- ecologically sustainable use that supports positive social and economic outcomes (DNP 2024).

The AMPs and many state and territory MPAs have management plans that outline the objectives for managing the protected area. Where applicable, Shell considered these management objectives in the environmental risk assessment (see Section 9.14).

Table 7-15: AMPs within the Planning Area

AMPs	IUCN Category	Distance from Activity Area (~km)
Kimberley[18]	Multiple Use Zone (IUCN VI)	80
	National Park Zone (IUCN II)	155

[18] Within North-west Marine Parks Network (Director of National Parks 2018a)

AMPs	IUCN Category	Distance from Activity Area (~km)
	Habitat Protection Zone (IUCN IV)	165
Cartier Island[18]	Sanctuary Zone (IUCN Ia)	80
Ashmore Reef[18]	Sanctuary Zone (IUCN Ia)	128
	Recreation Use Zone (IUCN IV)	148
Oceanic Shoals[19]	Multiple Use Zone (IUCN VI)	162
	Special Purpose Zone (Trawl) (IUCN VI)	370
	Habitat Protection Zone (IUCN IV)	525
	National Park Zone (IUCN II)	595
Argo-Rowley Terrace[18]	National Park Zone (IUCN II)	322
	Multiple Use Zoe (IUCN VI)	330
Joseph Bonaparte Gulf[19]	Multiple Use Zone (IUCN VI)	450
	Special Purpose Zone (IUCN VI)	475
Arafura[19]	Multiple Use Zone (IUCN VI)	915
	Special Purpose Zone (IUCN VI)	1010
Christmas Island[20]	National Park Zone (IUCN II)	1580

Table 7-16: WA and NT Marine Parks within the Planning Area

State and Territory Reserves	Jurisdiction Location	Distance from Activity Area (~km)
Marine Parks		
North Kimberley	WA (marine)	80
Garig Gunak Barlu	NT (marine)	830
Nature Reserves		
Browse Island	WA (terrestrial)	42
Lesueur Island	WA (terrestrial)	305
Low Rocks	WA (terrestrial)	182
Scott Reef	WA (marine)	153
National Parks		
Charles Darwin	NT (terrestrial)	685
Djukbinj	NT (terrestrial)	745
Garig Gunak Barlu	NT (terrestrial)	830
Mary River	NT (terrestrial)	775
Niiwalarra Islands	WA (terrestrial)	230
WA Indigenous Protected Areas		
Balanggarra	WA (terrestrial)	305
Marri-Jabin (Thamarrurr – Stage 1)	NT (terrestrial)	565
Uunguu	WA (terrestrial)	155

[19] Within North Marine Parks Network (Director of National Parks 2018b)

[20] Within Indian Ocean Territories Marine Park Network; as of October 2024 the Christmas Island draft management plan is being finalised following the closure of public consultation in September 2024 (DCCEEW 2024)

State and Territory Reserves	Jurisdiction Location	Distance from Activity Area (~km)
Nature Parks		
Holmes Jungle	NT (terrestrial)	691
NT Coastal Reserves		
Casuarina	NT (terrestrial)	684

7.3.4.3 Wetlands of International and National Importance

Sites recognised under the Convention on Wetlands of International Importance (the Ramsar Convention), referred to as Ramsar wetlands, are protected under Part 3 of the EPBC Act and are MNES. Table 7-17 describes the Ramsar and nationally important wetlands identified within or adjacent to the Planning Area (Appendix F), as shown in Figure 7-21. The closest wetland to the Activity Area is Ashmore Reef, ~128 km away. The environmental values for these Ramsar wetlands are also summarised in Section 6.6.7 of the Master Existing Environment. This Activity will not contravene a plan of management for a RAMSAR wetland or cause unacceptable impacts to the ecological character of these RAMSAR wetlands.

Table 7-17: Ramsar Wetlands within the Planning Area, including Distance from Activity Area

Wetland	Description	Distance from Activity Area (~km)
International Importance (Ramsar)		
Ashmore Reef Commonwealth Marine Reserve	Ashmore Reef supports an abundance and diversity of birds; 72 species have been recorded at this Ramsar site, with 12 species recorded breeding (Hale and Butcher 2013). Ashmore Reef was designated as a Ramsar wetland based on these characteristics: • largest atoll in the region • managed for conservation purposes since 1983 • each wetland type is in near natural condition, with low densities of coral predators and disease • its three islands are the only vegetated islands within the Timor Province bioregion • supports 64 threatened species • considered a true 'hotspot' of biological diversity within the Timor Province bioregion and within the broader NWMR • supports 47 species of waterbird listed as migratory under international treaties and three species of migratory turtle (green, hawksbill and loggerhead). • supports breeding of green and hawksbill turtles, dugongs and 20 species of waterbird • regularly supports >40,000 waterbirds including large numbers of migratory shorebirds and breeding seabirds (Hale and Butcher 2013) Ashmore Reef is also recognised as a KEF and is within the Ashmore Reef AMP (see Section 7.3.4.2).	128
Kakadu National Park	The Planning Area boundary is adjacent to the Kakadu National Park and Ramsar site. The site meets all nine nomination criteria of the Ramsar Convention due to these characteristics (BMT WBM 2010): • features representative wetland habitats at a bioregional level • supports populations of vulnerable wetland species • is a centre of endemism and high biodiversity including diversity of habitats • supports key life-cycle functions such as waterbird breeding and refugia values • sustains substantial populations of waterbirds and fish diversity • provides important fish nursery and spawning habitats • supports at least 1% of the national population of several non-avian wetland species.	830
Cobourg Peninsula	The southern islands of the Cobourg Peninsula Ramsar site (excluding the peninsula) surround the Planning Area boundary. The site meets five of the nine Ramsar Convention nomination criteria and contains unique biodiversity and heritage assets, with diverse landforms, habitats, and wildlife including these characteristics (BMT WBM 2011):	845

Wetland	Description	Distance from Activity Area (~km)
	• diverse coastal and inland wetland types • supports threatened species including endangered turtles • maintains regional biodiversity • supports life-cycle functions such as turtle and waterbird breeding and refugia values • provides important fish nursery and spawning habitats • significant social and cultural values with a rich Indigenous, Macassan, and European history, with Indigenous people living on the peninsula for >40,000 years.	
Nationally Important Wetlands		
Ashmore Reef	Ashmore Reef is one of only three emergent oceanic reefs in the north-eastern Indian Ocean, and the only one with vegetated islands. The Ashmore Reef reserve comprises three islets surrounded by intertidal reef and sand flats and deeper subtidal reef and sand flats. Some 95 bird species have been recorded from the reef and its adjacent waters, 43 of which are listed on the JAMBA and CAMBA migratory birds agreements. The islets are an important staging point for wading birds migrating between Australia and the northern hemisphere (DCCEEW 2023).	128
Finniss Floodplain and Fog Bay Systems	Finniss Floodplain and Fog Bay Systems is a beach-fringed, curved bay with continuous intertidal mudflats, and a modified but relatively intact floodplain with extensive paperbark swamps. Tidal range is ~7.6 m and the floodplain wetlands are fresh water (probably poikilohaline), whereas tidal areas are mesosaline (as seawater) and poikilohaline.	615
Daly-Reynolds Floodplain-Estuary System	Daly-Reynolds Floodplain-Estuary System is a major floodplain-tidal wetlands system with substantial areas of all the principal features (including a major river) of such a system in the NT. It is one of the largest floodplains in the NT with the largest catchment of any major freshwater floodplain system. Tidal range is 8.1 m. Water salinity: Floodplain wetlands are fresh, poikilohaline; tidal areas are mesosaline (as seawater) and poikilohaline.	625
Port Darwin	Port Darwin is a shallow branching embayment of the NT, supporting one of the NT's largest discrete areas of mangrove swamp. The tidal range is 8 m.	700
Shoal Bay – Micket Creek	Shoal Bay – Micket Creek contains wetland marshes, mangrove woodlands, beaches, mudflats, creeks and estuaries. The wetland area stretches from Lee Point, which is outside Department of Defence property, around the coast to Gunn Point. However, the Commonwealth components are scattered, with the largest components being the Leanyer Air Weapons Range (no longer used operationally) and the Shoal Bay Receiving Station areas. The quality of the sites vary, and much of the area is degraded. Nearby urbanisation, uncontrolled recreational use (e.g. off-road vehicles), wetland drainage, pollution and chemical spraying to control mosquito numbers have contributed to the degradation. The area has conservation value due to its proximity to Darwin, its educational value and refuge habitat for waterbirds (DCCEEW 2023).	710
Kakadu National Park	Kakadu National Park contains part or all of the catchments of two large and two smaller river systems, including a mosaic of contiguous wetlands associated with them. Of the large rivers, almost all the catchment of the South Alligator River and part of that of the East Alligator River are contained within the park. The entire catchment of the smaller West Alligator and part of the Wildman River catchment are contained within the park. The wetlands and their catchments encompass sandstone plateau communities, escarpments, lowland open forest and woodland savanna, seasonal floodplains, tidal flats, estuaries and offshore islands. Most of the wetlands lie in the Torresian	830

Wetland	Description	Distance from Activity Area (~km)
	biogeographic system. The small areas of wetland in the south of the park lie in the southern and Eyrean and Torresian botanical provinces. The floodplains and other wetlands support about three million waterbirds (from >60 species). Large populations of many other vertebrate and invertebrate species are also found.	
Cobourg Peninsula System	Cobourg Peninsula System is a mangrove swamp occurring around tidal channels and islands not associated with substantial riverine inflow; it is one of the largest discrete blocks of mangrove in the NT.	845
Murgenella-Cooper Floodplain System	Murgenella-Cooper Floodplain System is a floodplain-tidal wetland system in the NT, with relatively low volume of freshwater inflow. Tidal range is more than 6 m.	890

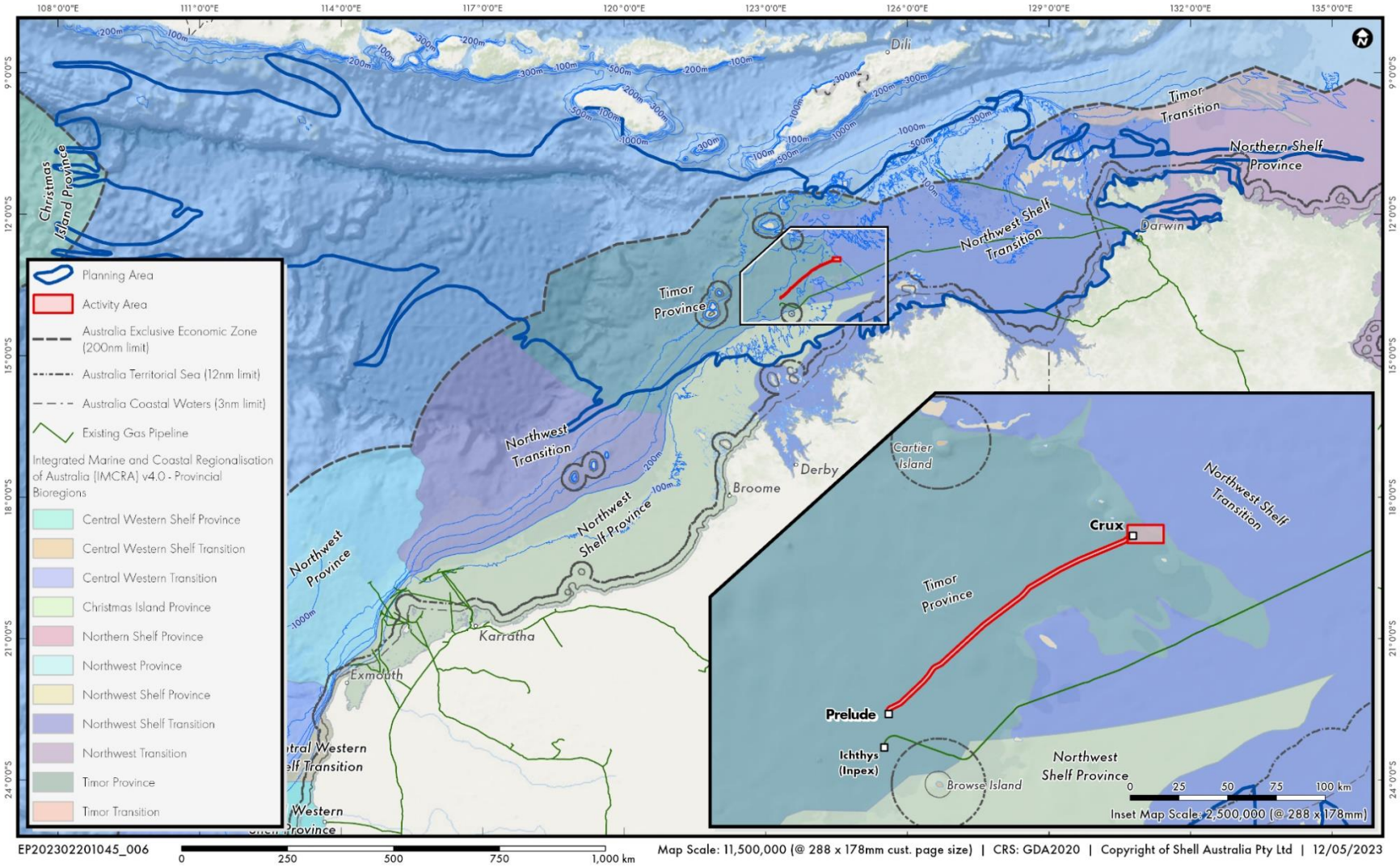


Figure 7-19: IMCRA Provincial Bioregions

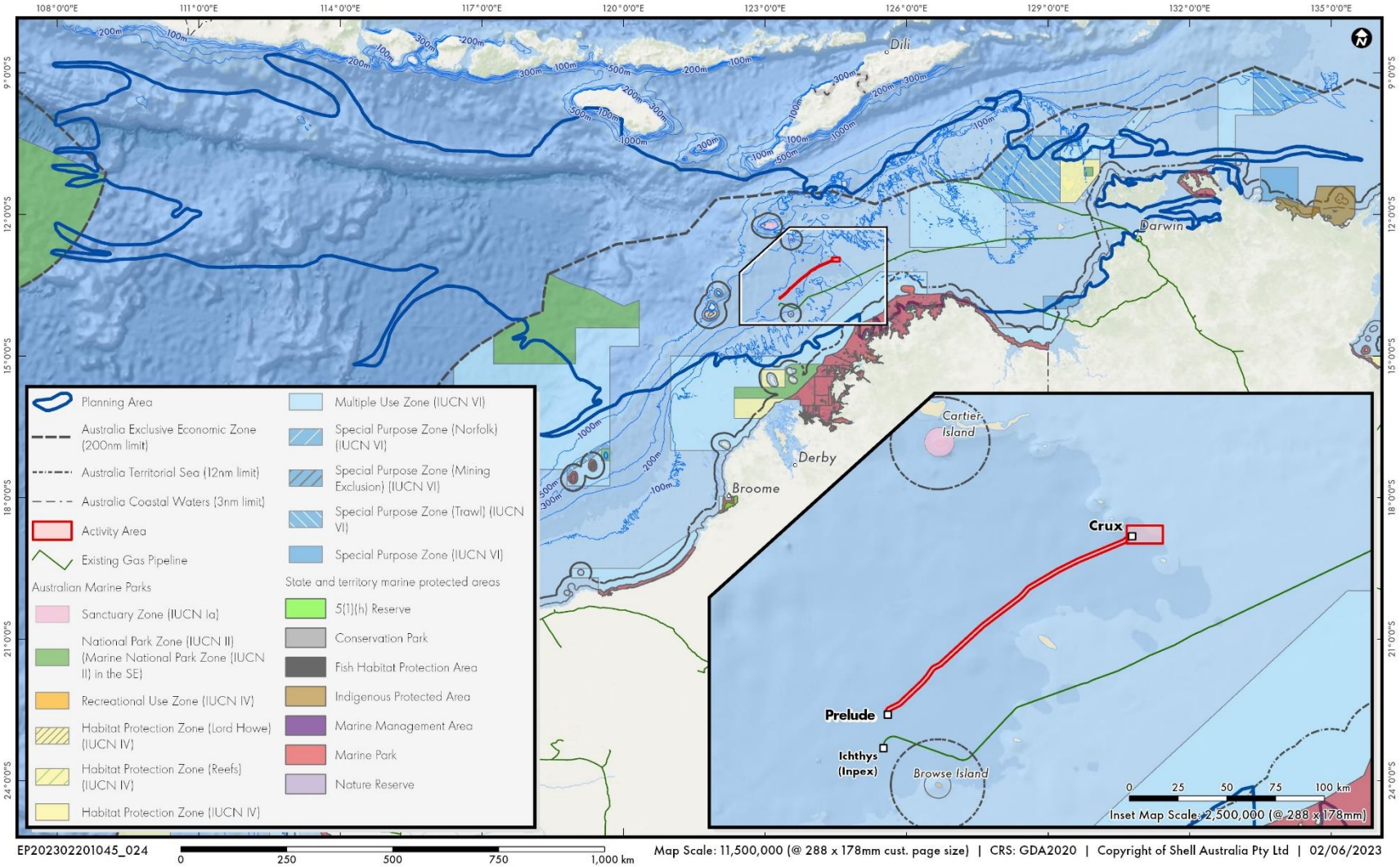


Figure 7-20: Commonwealth and State (and Territory) Protected Areas within or near the Planning Area

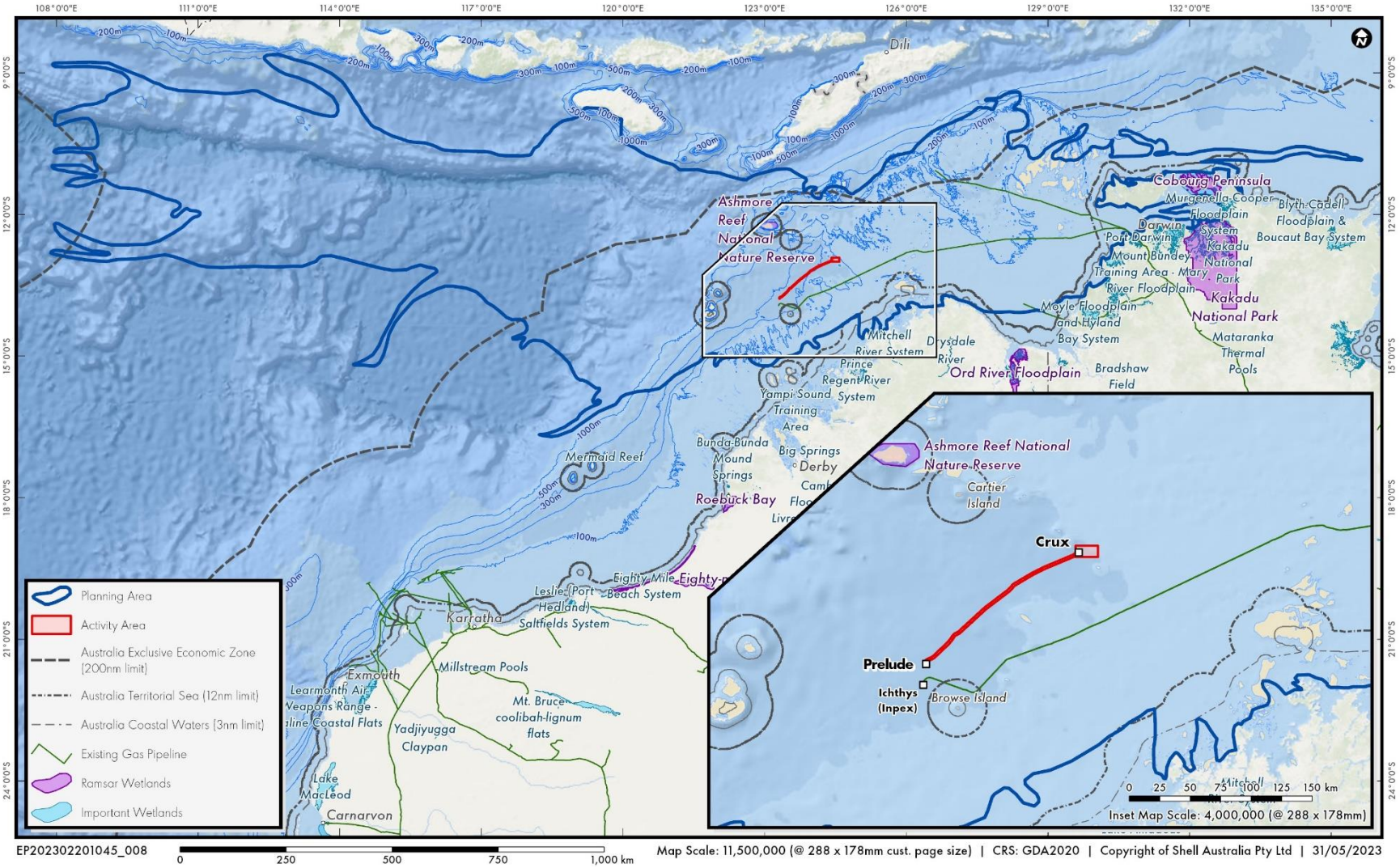


Figure 7-21: Wetlands of International and National Importance within or near the Planning Area

7.3.4.4 World, Commonwealth and National Heritage Places

No World heritage properties and no Commonwealth or National heritage places are within the Activity Area. Table 7-18 lists and Figure 7-22 shows the World heritage properties, and Commonwealth and National heritage places within or proximal to the Planning Area. Further detail on these values and sensitivities are described in Sections 6.6.4, 6.6.5 and 6.6.6 of the Master Existing Environment.

Note: The protected matters report (Appendix F) identified the Larrakeyah Barracks (Headquarters Building, Precinct and Sergeants Mess) and the Royal Australian Air Force (RAAF) Base (Commanding Officers Residence, Precinct, and Tropical Housing) within the Planning Area. Further examination confirmed that these Commonwealth heritage places fall outside the modelled spatial data and will not be credibly impacted. Hence, these places are not considered further.

Table 7-18: World, National and Commonwealth Heritage Listed Places within the Planning Area

Listed Place	Distance from Activity Area (~km)
World Heritage Properties	
Kakadu National Park	830
Commonwealth Heritage Places	
Ashmore Reef National Nature Reserve	128
Scott Reef and surrounds	153
National Heritage Places	
The West Kimberley	145
Kakadu National Park	830

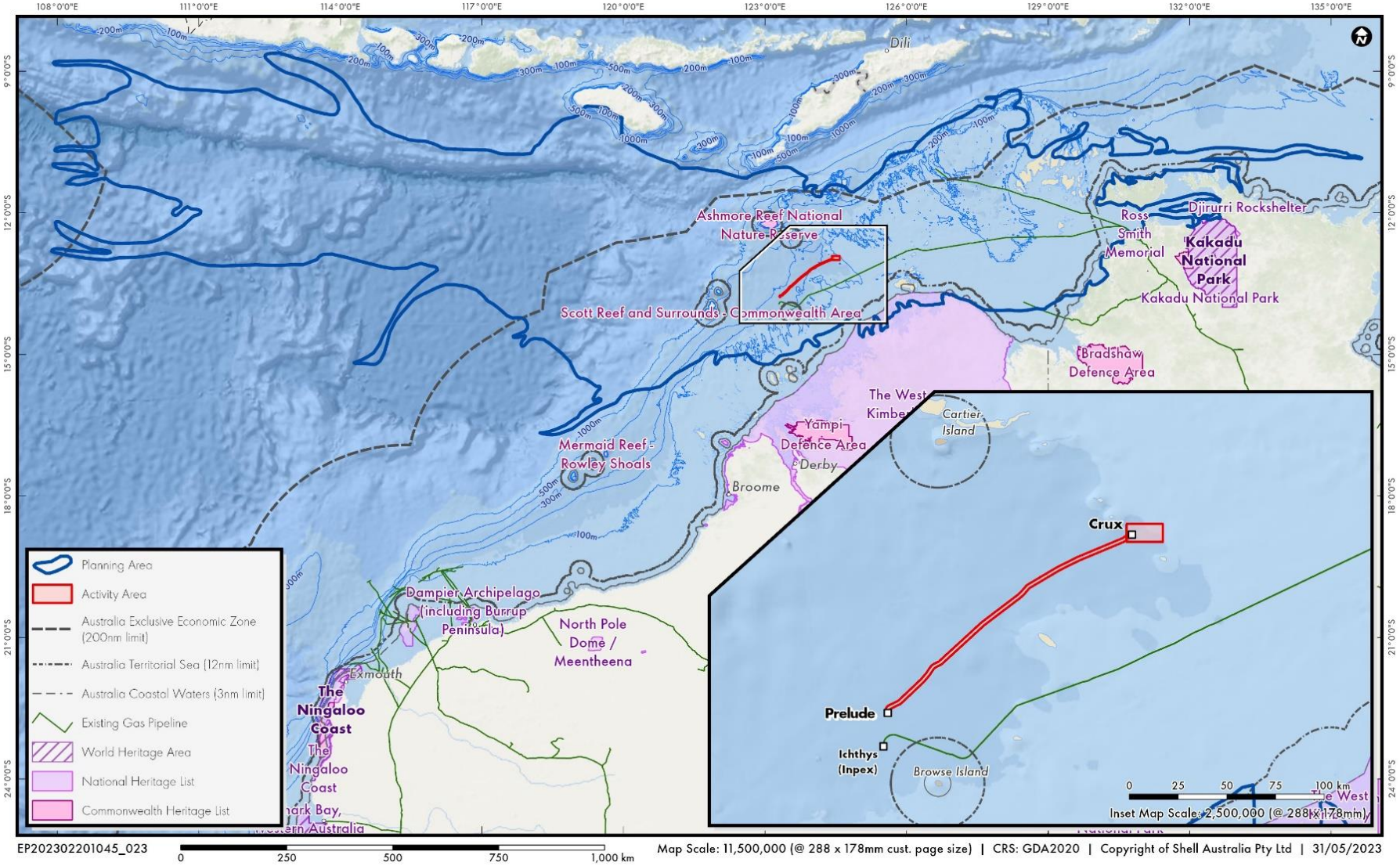


Figure 7-22: World, Commonwealth and National Heritage Places

7.4 Socioeconomic and Cultural Environment

7.4.1 Indigenous Cultural Features

The Planning Area overlaps traditional Country of the Indigenous People of Australia[21]. This section describes the features that intersect the Planning Area relevant to the consideration of the cultural and social values of Indigenous People. The relevant cultural and social values are described in Section 7.4.2.

Shell acknowledges the decision of the Federal Court in Munkara v Santos NA Barossa Pty Ltd (No 3) [2024] FCA 9 and its interpretation of 'cultural features' – specifically, that:

- beliefs and values (which are properly characterised as cultural features of a place) must be held by the relevant people as a people;
- there must be a 'sufficient cogent or coherent belief that is sufficiently accepted so that it can be described as having normative content for the people or community' in order to constitute a 'cultural feature'; and
- the question of whether a sufficient cogent or coherent belief (that is sufficiently accepted) exists can be answered by reference to the customs and practices of the relevant people.

7.4.1.1 Indigenous People and Communities

Indigenous People have the oldest living cultural history in the world (NARVIS 2021). The presence of Indigenous People in northern Australia dates back more than 60,000 years and is evidenced in the rich Indigenous cultural records that include some of the oldest cultural sites in Australia (Section 7.4.2.1.4) (Northern Land Council 2023a). Indigenous People reside in regional and remote settlements along the coastline of the mainland, on offshore islands (e.g. Bathurst Island and Melville Island of the Tiwi Islands), as well as inland areas on the mainland.

Country is an important concept to Indigenous People. The term Country is often used by Indigenous People to describe family origins and associations with particular parts of Australia, both land and sea. The expressions Country and Sea Country are used by Indigenous People to refer to the land and waters *which constitute Aboriginal traditional areas as ancestrally distinct and linguistically bounded geographic areas (*Kearney et al. 2023 p106*).* Country is inclusive of many environments that *are ecologically, geographically, ancestrally and socially configured* (Kearney et al. 2023). For Indigenous People Country is a combination of the land, sea, rivers and islands and all that they contain and sustain.

Country is described further in Section 7.4.2.1.1.

Although many Indigenous People do not live permanently on traditional Country, families and individuals retain close personal connections with their Country and visit regularly for extended trips, to care for Country, find traditional foods and connect with important sites. Regular connection to Country is of significant importance for Indigenous People.

Numerous different Indigenous groups have connections to different parts of Country within the Planning Area. These family groups are representative of many different Indigenous language groups, the languages of which have been spoken for millennia.

7.4.1.2 Land and Sea Tenure and Ownership

Both traditional and contemporary systems of land and sea ownership are present within the Planning Area. Each tenure is described in the following sections.

7.4.1.2.1 Traditional land and sea ownership

The marine areas located within the Planning Area have been lived in, cared for and managed by many Indigenous People for thousands of years. There are complex systems of rules, rights, customs and traditional knowledge that govern Indigenous People's interactions with each other and their land and sea estates within the Planning Area.

[21] The term Indigenous People includes all people of Aboriginal and Torres Strait Islander descent.

For Indigenous People, Country is not bound by state and territorial borders or maritime boundaries distinguished by international conventions or economic jurisdiction. An example of this is evident in the answer provided by Mary Yarmirr, under cross-examination to the question of the extent of her traditional Sea Country in the 1998 Federal Court hearing of the Croker Island Native Title claim[22]:

> '*As far as my eyes can carry me'* (Mary Yarmirr 1998, cited in AHRC 2001).

Culture and ancestral features provide the necessary political distinction of traditional Country. Customary law, passed from generation to generation informs traditional land and sea ownership (Northern Land Council 2023b).

7.4.1.2.2 Contemporary Land and Sea Ownership

The Planning Area includes extensive marine and coastal areas to which Indigenous People have statutory ownership and rights, protected through the *Native Title Act 1993* (Cth) and ALRA. In addition, cultural and social connections are recognised through ILUAs, IPAs and other mechanisms that exist proximate to the Planning Area.

The Planning Area intersects with land and sea areas in which Native Title and/or Aboriginal land rights extend.

Native Title

Native Title determinations provide formal recognition under Australian law of the complex cultural system of Indigenous People's ongoing relationships, interests, rights, and responsibilities in relation to land and sea. Native Title can be non-exclusive or exclusive and can co-exist with other property rights (e.g. pastoral stations). Native Title can exist over both land and sea estates. Indigenous Peoples[23] and their relationship and custodianship of their Country is protected by the *Native Title Act 1993* (Cth) and any determinations made by the NNTT.

Table 7-19 and Figure 7-25 presents Native Title determinations that exist within the Planning Area sourced from the NNTT (2023) database *Native Title Determination Outcomes*. Notably, the Planning Area includes waters located within the Croker Island Native Title Determination, a landmark decision of the Federal Court of Australia (FCA). The FCA held that Native Title exists regarding all of the area of sea and seabed claimed. The Court rejected arguments that Native Title cannot exist in offshore areas. Section 7.4.2.3 and Appendix E describes the rights and interests held by the Native Title holders. Whilst traditional ownership of Sea Country in some areas has been formally recognised through Native Title and Aboriginal freehold land tenure, many other Indigenous People claim use of and connection to Sea Country.

Table 7-19: Native Title Determination Outcomes (Native Title Exists) within the Planning Area

Short Name	NNTT Number	Sea Determination[1] (Y/N)	Registered Native Title Body Corporate (RNTBC)	State or Territory
Balanggarra (Combined)	WCD2013/005	No	Balanggarra Aboriginal Corporation RNTBC	WA
Croker Island	DCD1998/001	Yes	Top End (Default Prescribed Body Corporate) Aboriginal Corporation RNTBC	NT
Uunguu[24] Part A	WCD2011/001	Yes	Wanjina-Wunggurr Aboriginal Corporation RNTBC	WA

Notes: [1] The application includes an area of sea that is bounded by the high-water mark and the exclusive economic zone limit.

Source: NNTT 2023 with data extracted 28 February 2023.

[22] In 1998 the Federal Court of Australia found that native title existed in relation to the sea and sea-bed around Croker Island (refer to Mary Yarmirr & Ors v NT of Australia & Ors [1998] FCA 1185 (4 September 1998)).

[23] The term Traditional Owner in this document recognises the Indigenous People who assert traditional ownership and native title rights and interests in relation to land and water within the Planning Area. It acknowledges the connections to Country and culture held by the Indigenous People.

[24] The Native Title Application known as Uunguu Part A is known as Wanjina Wunggurr Uunguu by the Indigenous People, as identified in the Healthy Country Plan, *Uunguu: Looking after Wunambal Gaambera Country 2010 - 2020*. The Indigenous People identify their Country as Wunambal Gaambera Country, and refer to themselves as the Wunambal Gaambera people. In this document, we refer to the people as Wunambal Gaambera people, and the Country as Wunambal Gaambera Country. The authors accept responsibility for any incorrect use of names and apologise unreservedly.

Indigenous Land Use Agreements

The NNTT (2022 p16) defines an ILUA as a voluntary, legally binding agreement about the use and management of land or waters, made between one or more native title groups and non-native title interest holders in the ILUA area (such as grantee parties, pastoralists or governments).

Table 7-20 and Figure 7-26 provides the ILUAs that have been publicly notified or registered and include marine areas located below the mean high water mark and within the Planning Area. The majority of listed ILUAs cover consent for doing a particular future act or class of acts. Two of the ILUAs are for co-management of protected areas that are located within the Planning Area (i.e. Mary River National Park, and Balanggarra Aboriginal Corporation [BAC] KSCS ILUA).

Table 7-20: Registered Indigenous Land Use Agreements

ILUA Name	Tribunal Number	Representative Party	Agreement Type
Mary River National Park ILUA	DI2004/047	NLC	Area Agreement
Kenbi ILUA	DI2017/001	NLC	Area Agreement
BAC KSCS ILUA	WI2017/007	Balanggarra Aboriginal Corporation	Body Corporate

Source: NNTT 2023 with data extracted 28 February 2023

Aboriginal Freehold Land

Indigenous land rights in the NT are supported by the ALRA and reflected in Aboriginal freehold land tenure. The framework for Aboriginal freehold land under the ALRA is unique to the NT. Aboriginal freehold land is held by a Land Trust for the benefit of the Indigenous People and land is inalienable (i.e. it cannot be bought or sold). Aboriginal Land Councils provide support to Aboriginal Land Trusts.

Within the NT, the boundaries of Aboriginal freehold land extend to the low water mark (LWM) and include both subsurface area and water. Coastal Aboriginal freehold land may encompass intertidal area. This was affirmed in 2008 through the Blue Mud Bay decision[25] of the High Court of Australia.

In northern Australia, the intertidal zone can stretch over long distances.

The Planning Area includes territorial waters that overlap with the Aboriginal freehold land boundary under ALRA (Figure 7-27). With respect to the majority of Aboriginal freehold land that intersects with the Planning Area, the Northern Land Council provides support to the respective Indigenous People in carrying out consultation and negotiations related to future activities on the land.

7.4.1.3 Ancient Landscapes

Past coastal environments and climate played a central role in the development of early human communities (Erlandson and Fitzpatrick 2006; Rick and Fitzpatrick 2012 in Lebrec et al. 2022). There is evidence indicating that land areas that were once inhabited by humans are now submerged (O'Leary et al. 2020). Post glacial sea level rise resulted in the inundation and submergence of cultural sites covering the period from first arrival to Australia, an estimated 65,000 years ago, to the present sea level elevations that occurred around 7,500 years ago (O'Learly et al. 2020). The Ancient coastline at 125 m depth contour KEF (Table 7-4) in the North West region (Figure 7-3) represents the lowest sea level during Indigenous occupation (O'Leary et al. 2020; Williams et al. 2018). In 2020 researchers associated with the Deep History of Sea Country Project (Benjamin et al. 2020) reported the first confirmed ancient underwater archaeological site from the continental shelf, located off the Murujuga coastline in north-western Australia.

Shell commissioned an independent specialist consultant to undertake a desktop assessment of the potential presence of First Nations underwater cultural and social values within the Activity Area (Cosmos Archaeology 2023). First Nations underwater cultural heritage was defined as all tangible and intangible cultural expressions that are associated with and claimed by Indigenous groups within Australia (past and present) and which occurs in and is attributable to contexts that are now submerged by waters.

[25] NT of Australia v Arnhem Land Aboriginal Land Trust [2008] High Court of Australia 29 (30 July 2008)

Tangible cultural heritage refers to the physical manifestation of human cultural behaviour. It is most commonly described as archaeological evidence but is inclusive of all other physical forms and material traces that are significant to a cultural group, community, a nation, and/or humanity. As the location of the study area is some distance from the current shoreline the archaeological remains would be that associated with submerged terrestrial sites – that is First Nations sites that were inundated during last interglacial sea level rise.

Intangible heritage referred to cultural associations and imprints on the landscape that involve practices, oral traditions, ancestral narratives, performing arts, local knowledges and practices concerning nature, the environment and the universe, laws and other socio-political skills. Intangible cultural heritage exists through enactments by members of a cultural group[26] and introduces a clear cultural right to safeguarding, instruction on which is provided for by the UNESCO Convention for the Safeguarding of Intangible Cultural Heritage. Safeguarding is oriented towards recognition of the wealth of knowledge and skills that are transmitted intergenerationally.

Cosmos Archaeology (2023) concluded:

- The eastern half of the infield zone (outside of the Activity Area) was at one time above sea level since the continent of Australia was occupied by humans. In the north eastern quadrant (approximately) where the marine geophysical data was of sufficient quality three distinct landforms were identified—savannah type landscape, a block field type area and a limestone mesa like plateau. All three landforms would be host to a variety of archaeological sites in varying condition with potential cave sites in the escarpments of the limestone mesa formation being more likely to contain relatively intact archaeological deposits. These landforms could have held strong cultural connections with the ancestors of the Gambere, Wunambul (Wunambal Gambera), Worora (Dambimangari), Umida (Wanjina Wunggurr), Unggarangi (Maylaya), Jawi and Bardi (Bardi Jawi Niimidman). Consultation with the cultural groups was recommended to confirm whether these connections still exist.
- The southeastern quadrant (outside of the Activity Area) could not be assessed due to the poor quality of the publicly available marine geophysical data.
- The western half of the infield zone is below 130 m LAT (includes all proposed infrastructure locations covered under this EP) which is the maximum extent of exposed land since humans have occupied the continent. As such, there will not be any impacts to the tangible First Nations underwater cultural heritage. The impact with intangible underwater cultural heritage will need to be assessed through consultation with the Gambere, Wunambul, Worora, Umida, Unggarangi, Jawi and Bardi.

During targeted consultation, Indigenous groups did not confirm that cultural connections still exist with landforms to the north-east of Crux. However, Bardi Jawi identified cultural sites closer to shore, including: an ancient ceremonial site underwater on the Dampier Peninsula coast that's 40,000 years old, and huts 1–3 km offshore on a small island reef that are part of songlines of the Djarindjin community and are sacred underwater ceremony.

[26] As noted in Munkara v Santos NA Barossa Pty Ltd (No 3) [2024] FCA 9, this cultural heritage must be held communally by the group, although need not be the subject of consensus.

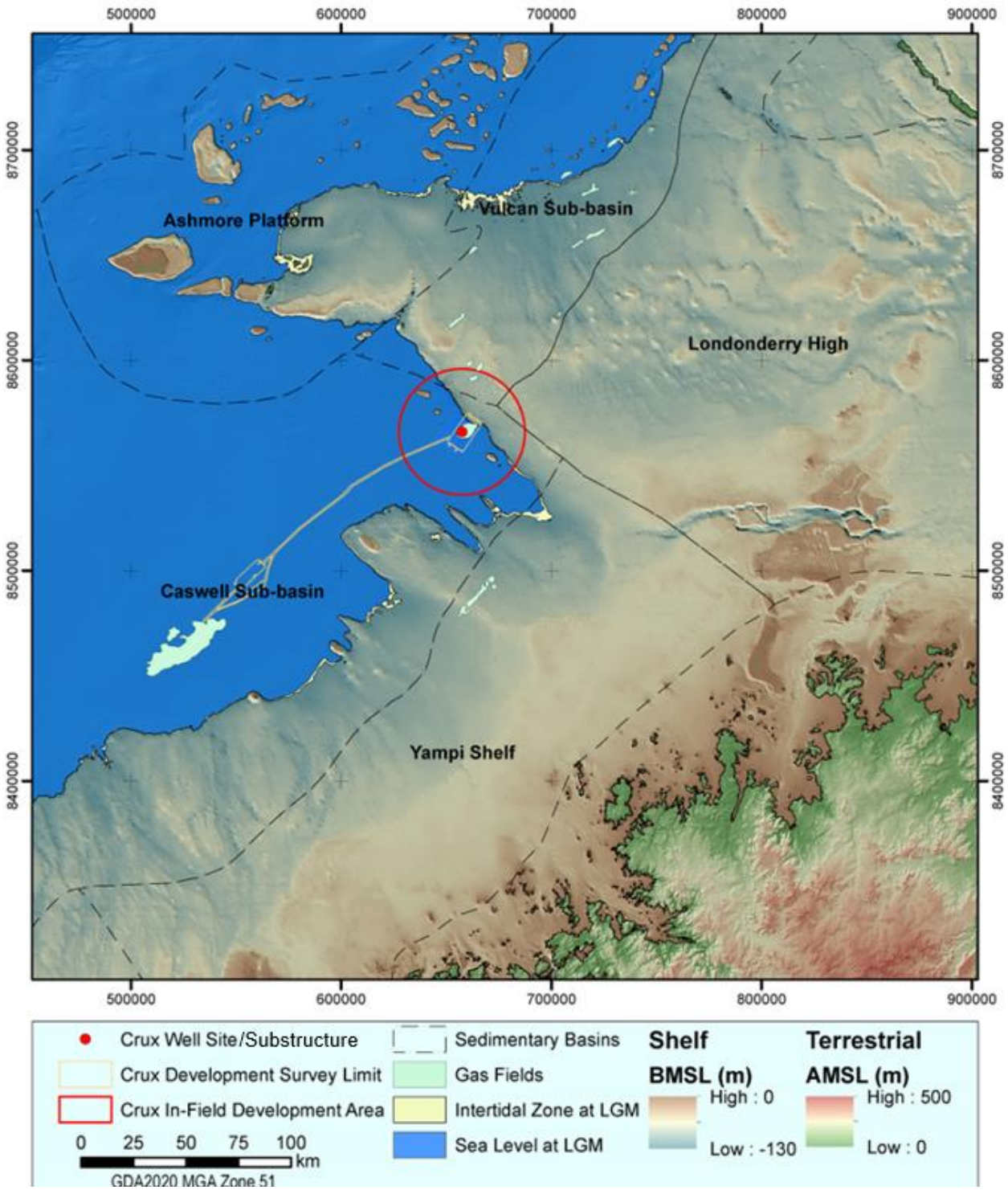


Figure 7-23: Map of study area in relation to submerged landforms off the Kimberley Coast

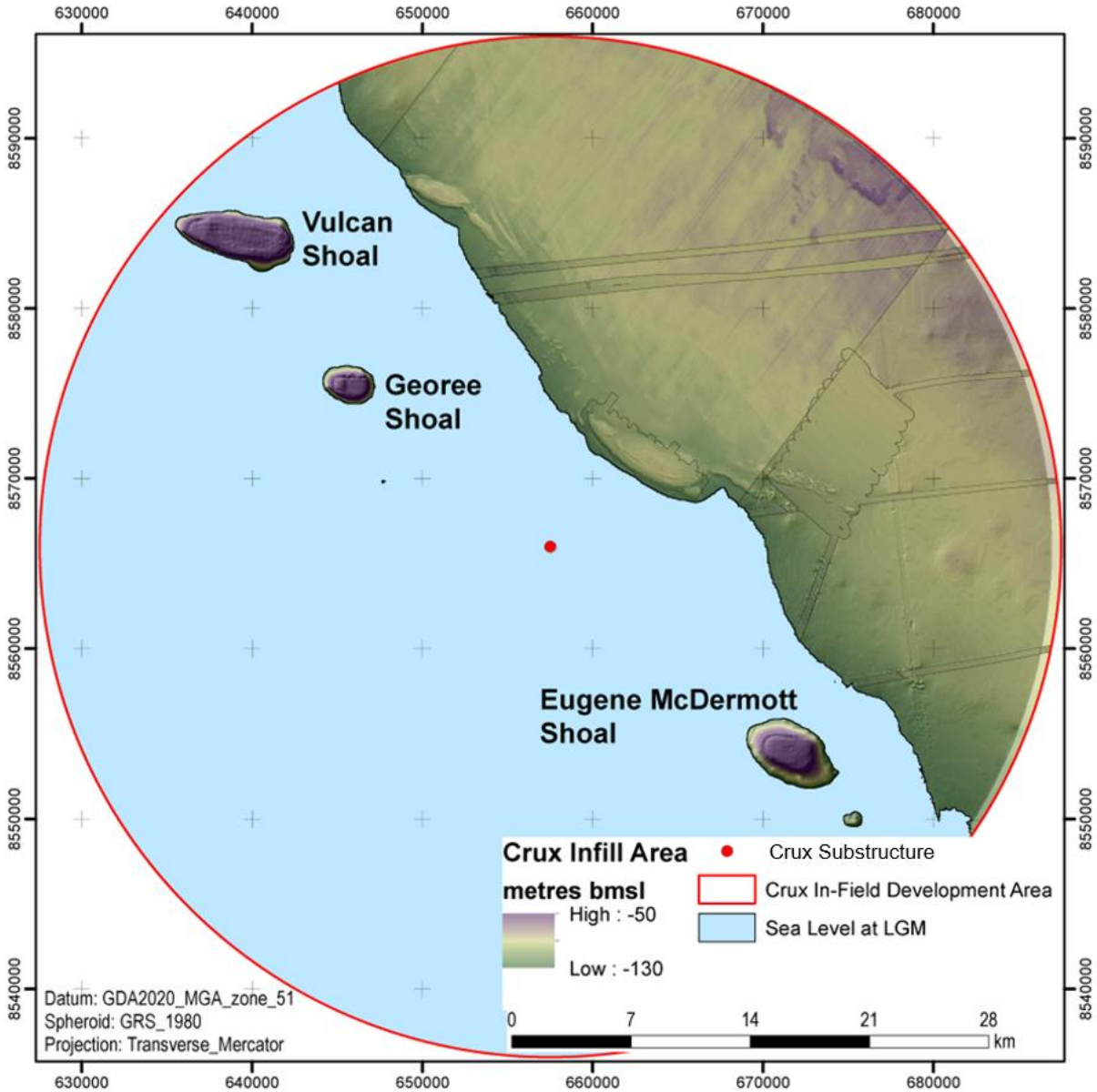


Figure 7-24: Elevations of submerged landforms in the Crux in-field study area, showing coastline during the Lowest Glacial Maximum (LGM).

7.4.1.4 Indigenous Protected Areas

IPAs are areas of land and/or sea managed by Indigenous groups as protected areas for biodiversity conservation through voluntary agreements with the Australian Government. IPAs form a component of Australian's National Reserve System. For Indigenous People, IPAs support the realization of custodianship and stewardship obligations for Country. The boundaries of IPAs can be aligned with Native Title boundaries, or wholly contained within. In 2022 the Australian Government announced a program (the Sea Country IPA Program) to expand the IPA network to include coastal and marine areas. Through the Sea County IPA Program, the Australian Government is seeking to strengthen the conservation and protection of the marine and coastal environments, while creating employment and economic opportunities for Indigenous People (NIAA 2023). Section 7.3.4.2 describes the marine parks within the Planning Area that coexist with IPAs and Native Title. Most IPAs are dedicated under marine park IUCN Categories V and VI (Figure 7-20), which promote a balance between conservation and other sustainable uses to deliver social, cultural and economic benefits for local Indigenous communities (DCCEEW 2023c). Indigenous People are active participants in the

management of IPAs through land and sea ranger programs (Section 7.4.2.1.4) and other custodian and management activities.

Table 7-21 describes the two dedicated IPAs and one IPA in consultation within the Planning Area. The information presented in Table 7-21 is primarily drawn from the DCCEEW and augmented with publicly available information drawn from the relevant IPA management plans and healthy Country plans of Indigenous groups with interests in the IPAs.

Table 7-21: Indigenous Protected Areas within the Planning Area

IPA Name	Status	Sea Country[27]	Description
Balanggarra	Declared	Yes	The Balanggarra IPA, declared in 2013 has a gazetted area of 1,083,000 ha and supports the long-term management of Balanggarra traditional Country (DCCEEW 2020a). The IPA is dedicated under IUCN Category VI. The IPA is situated in the northern-Kimberley region and intersects with five major river systems, namely the King, Forest, Pentecost, Durack, and Ord Rivers, as well as the Cambridge Gulf and the Timor Sea. The IPA is managed by the Balanggarra Rangers.
Marri-Jabin (Thamarrurr – Stage 1)	Declared	Yes	Gazetted in 2009, the Marri-Jabin covers an area of approximately 71,200 ha and was dedicated under IUCN category IV (NIAA 2023b). The Thamarrurr Land and Sea Rangers oversee the management of the IPA and carry out a range of critical activities, such as surveying and managing invasive weeds, feral animals, marine invertebrates, and diseases. The rangers also monitor the habitats of threatened species, including sea turtles, while managing fire and documenting and preserving significant cultural sites. Additionally, they are committed to passing on traditional knowledge to the next generation, ensuring the continuation of cultural practices and values for years to come (NIAA 2023b).
Uunguu	Declared	Yes	The Uunguu IPA, dedicated in 2010 is located in north Kimberley and covers an area of over 760,000 ha on the land of the Wunambal Gaambera people (NIAA 2023c). The IPA was dedicated under IUCN category VI. The Uunguu Rangers are responsible for the management of Land and Sea Country. Their tasks include pest control, cultural heritage conservation, monitoring the health of plants and animals, and implementing Right-way Fire, a method of fire management that involves a mosaic of fires being burnt in the cool season to prevent wildfires in the hot, dry season. The Uunguu Rangers are also responsible for visitor management through the Uunguu Visitor Pass and have established a seasonal base at Garmbemirri on Anjo Peninsula, as well as working out of Kandiwal Community at Ngauwudu (Mitchell Plateau). The Uunguu IPA is a vital area for the Wunambal Gaambera people and requires continued conservation and management efforts (NIAA 2023c).
Tiwi Islands	In consultation	Yes	The proposed Tiwi Islands IPA, spans 750,000 ha and comprises a region that is home to at least 20 EPBC Act listed threatened species, including the Brush-tailed Rabbit-rat, Northern Brush-tailed Phascogale, Butler's Dunnart, and Eastern Curlew. The proposed IPA includes extensive tall tropical savanna forests, numerous rainforest patches, and coasts that serve as nesting sites for marine turtles, seabird rookeries, and migratory shorebirds (DCCEEW 2023c). This IPA is being managed by the Tiwi people, who have a deep understanding of the land, its ecology, and cultural significance. They are supported by Tiwi Indigenous rangers, who work to

[27] Denotes whether the IPA includes marine components.

			conserve the region's diverse ecosystems and protect its unique species (DCCEEW 2023c).

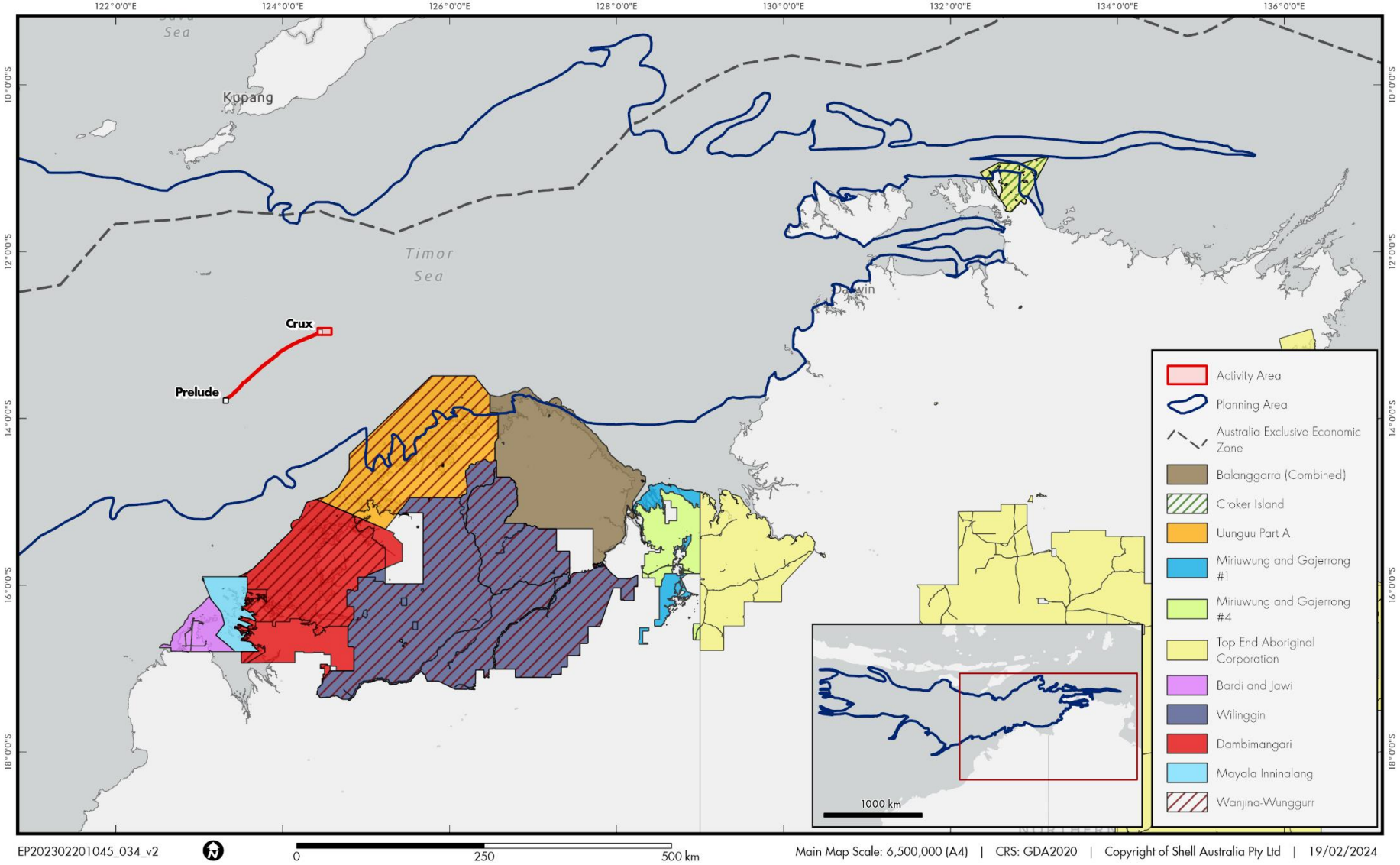


Figure 7-25: Native Title Within or Coastally Adjacent[28] to the Planning Area

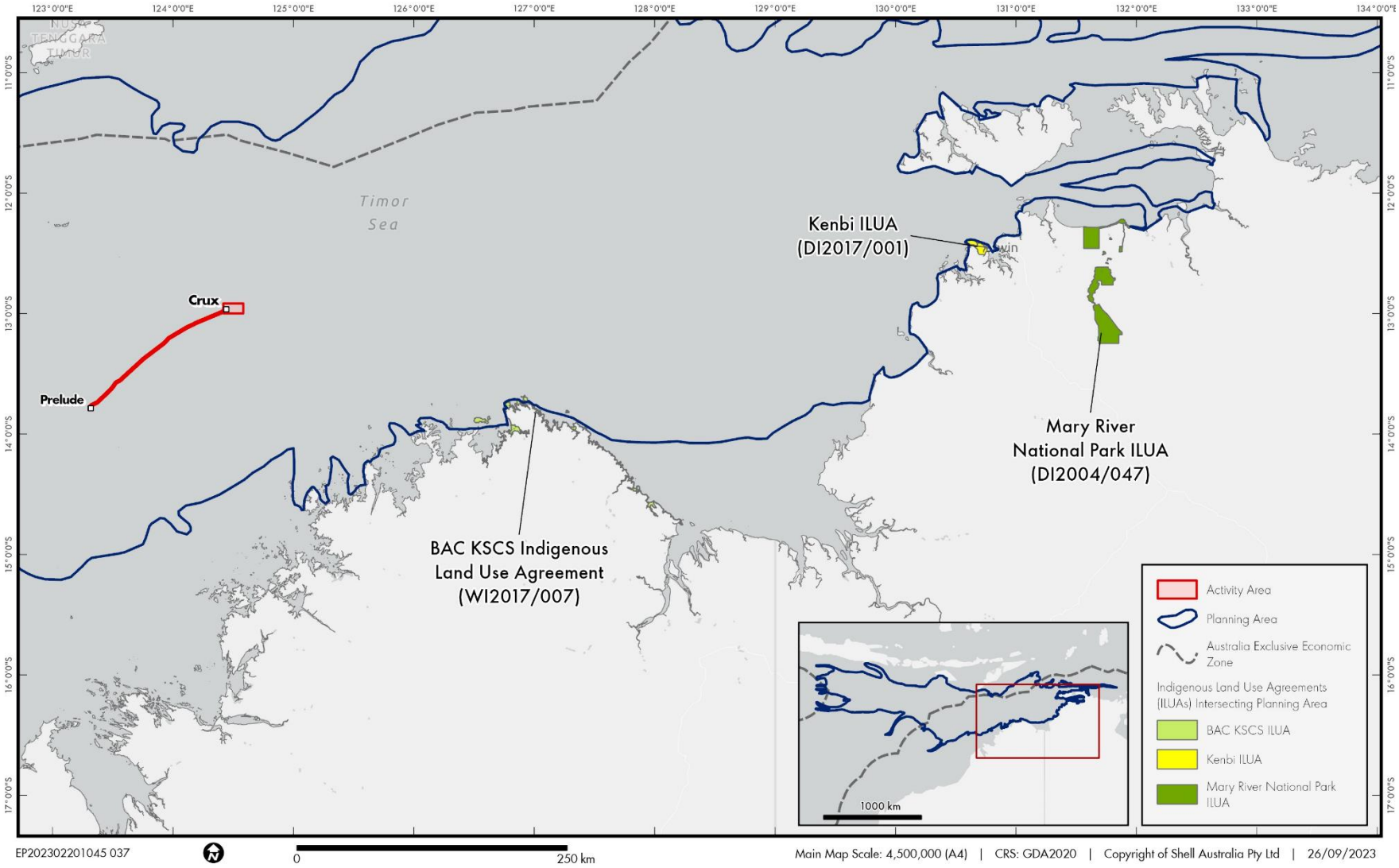


Figure 7-26: Indigenous Land Use Agreements

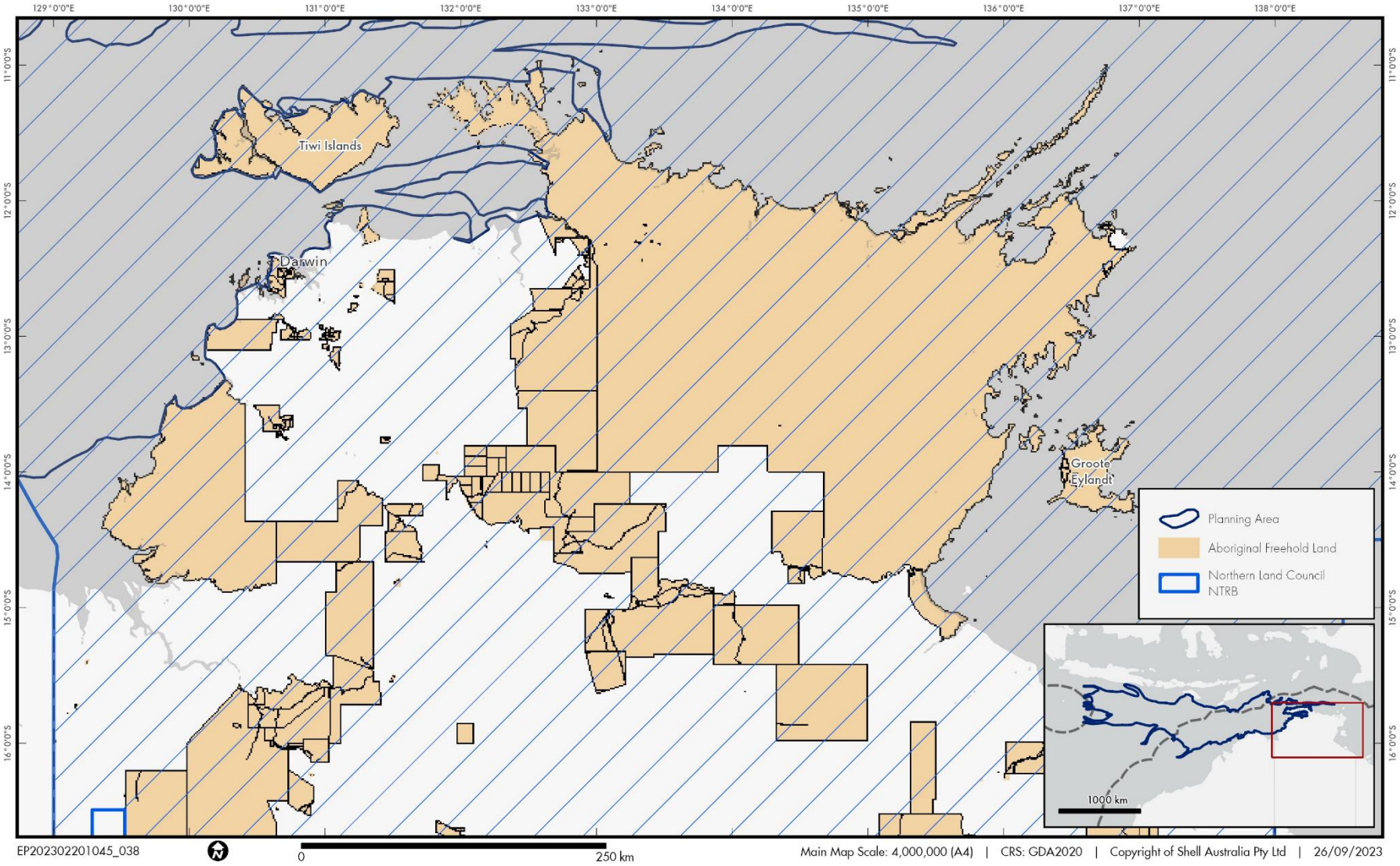


Figure 7-27: Aboriginal Freehold Land Within or Proximal to the Planning Area

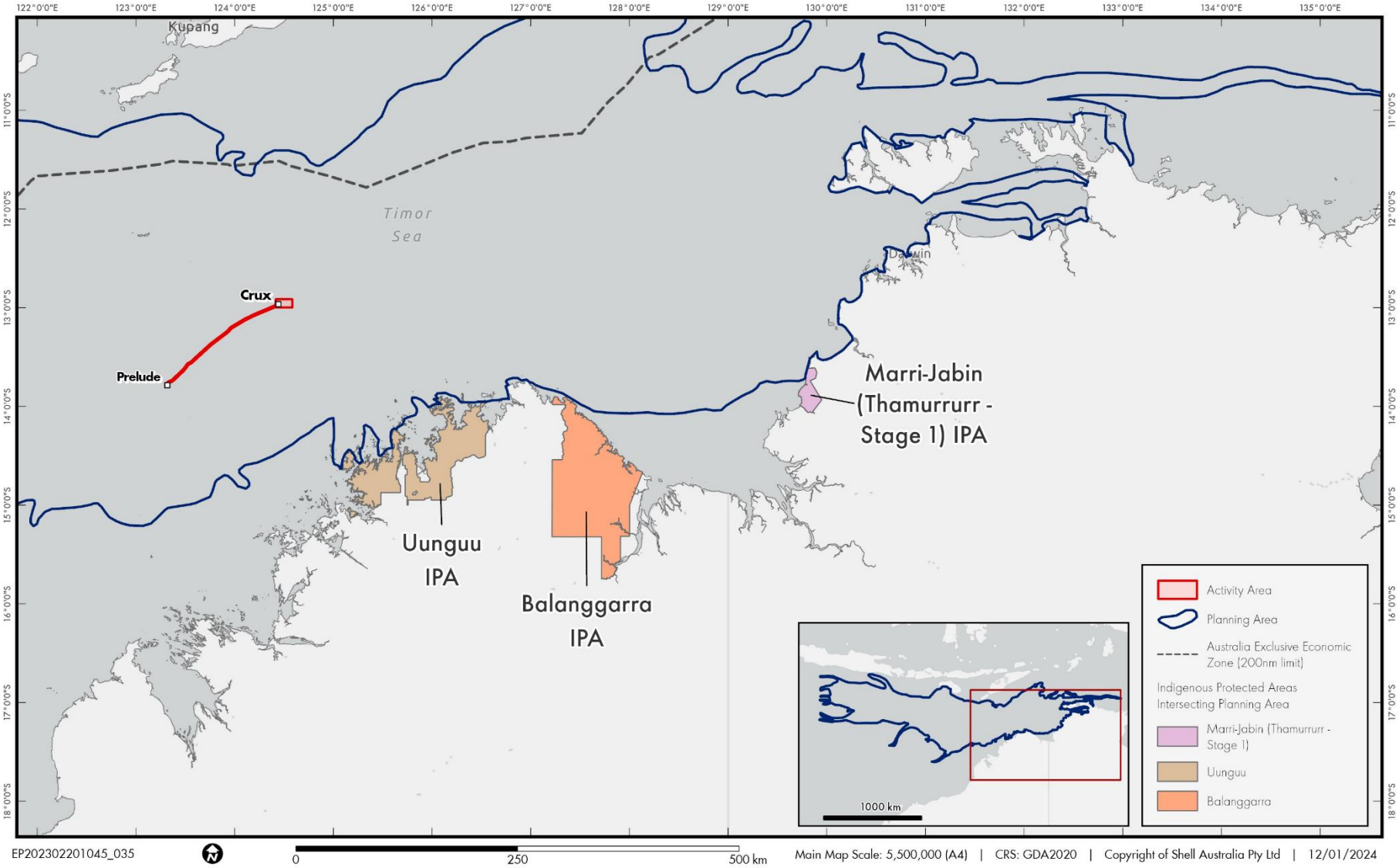


Figure 7-28: Indigenous Protected Areas

7.4.2 Indigenous Cultural Heritage Values

7.4.2.1 Overview

This section describes the values and sensitivities associated with the Indigenous cultural and social features of the Planning Area and focusses on the following aspects:

- Caring for Country, including:
- Country
- Law and spirituality
- Traditional knowledge
- Conservation and healthy Country
- Land and sea resource use practices
- Indigenous People's rights and interests.

Information in this section has been sourced from Joint Management Plans (JMPs) prepared for a number of protected areas (e.g. IPAs and marine reserves), Commonwealth government and Aboriginal Land Council websites, Healthy Country Plans prepared by various Indigenous organisations and books published by Dambimangara and Wunambal Aboriginal Corporations:

- Nyara Pari Kala Niragu (Gaambera): Gadawara Ngyaran-gada (Wunambal): Inganinja Gubadjoongana (Woddordda): We are coming to see you. 2021.
- Karadada, J. et al. (2011). Uunguu Plants and Animals: Aboriginal Biological Knowledge from Wunambal Gaambera Country in the North-west Kimberly.

The purpose of this section is to highlight the many and varied cultural and social values of Indigenous People and the associated interests and activities that overlap the Planning Area, and in particular, Sea Country. The following sections avoid detailed descriptions of specific areas of cultural significance including cultural heritage sites and sites associated with songlines and dreaming stories, and also avoids reproduction of Dreaming stories. This information is retained in ownership by the associated Indigenous group.

7.4.2.1.1 Caring for Country

The coastal areas, islands and surrounding waters of northern Australia have been used and occupied by Indigenous People for thousands of years. The water and lands are components of Indigenous cultural landscape that are of enormous significance to Indigenous People.

For Indigenous People, Country is homeland, where culture, history, traditions and social structures are embedded, connected and find full meaning. Custodianship means caring for Country (i.e. land and water, plants and animals) as if land and seas are kin (Janke et al. 2021).

> *Country is filled with relations speaking language and following Law, no matter whether the shape of that relation is human, rock, crow, wattle… Country is family, culture, identity. Country is self.* (Kwaymullina 2005)

In the context of the Planning Area, many elements within Sea Country form significant components of Indigenous People's culture, including their history, dreaming and creation stories (discussed in Section 7.4.2.1.2). Marine life, cultural sites, and places of significance are directly connected to the wellbeing and everyday life of Indigenous People. The health and wellbeing of Sea Country is one and the same as the health and wellbeing of Indigenous People. Hence any potential changes in the condition of Sea Country (such as that which could result from activities associated with the Activity) may have implications for the health and wellbeing of Indigenous People who may have connection to the affected Sea Country area.

Many Indigenous People with traditional Land and Sea Country within the Planning Area (e.g. the Tiwi People, Wunambal Gaambera People and Balanggarra People) refer to themselves as Saltwater People – people who have a vibrant and traditional society based on a deep relationship with Sea Country.

7.4.2.1.2 Law and spirituality

Indigenous law and spirituality are intertwined with the land, the people and creation. Indigenous law and spirituality reinforce culture and sovereignty. Indigenous People have a complex system of law (also referred to as lore), that preceded European arrival. The term law refers to the stories, customs, beliefs and spirituality of Indigenous People. Law is passed on through generations- through songs, stories, and dance and it guides how Indigenous People live their everyday lives.

For Indigenous People customary law provides the rules and responsibilities for looking after culture, plants, animals, people and Country. Customary law and protocols provide rules on how to interact with the land, kinships and community. Different Indigenous groups have different law systems, and many are strongly related to creation stories such as the Wanjing and Wunggurr of the Wunambal Gaambera people and the Wolara the Creator, of the Balanggarra people (both Native Title holders within the Planning Area).

Songlines and Totemic Systems

Songlines are the Indigenous travel routes that crossed the Country (land and sea), linking important sites, locations and clans. Songlines are maps of the land and sea. Songlines include dreaming pathways or tracks—forged by Creator Spirits during the Dreaming. Many of these Songlines have specific ancestral stories attached to them. Literature reviews indicate that Songlines exist along the coast of northern WA and the NT. There are sacred sites entwined with the Songlines. For saltwater peoples, stories and Songlines locate, interpret and inscribe knowledges of the Dreaming tracks, bodies and movements of ancestral beings that crisscross Sea Country. A number of the natural features within the Planning Area (e.g. islands, reefs and coastline features) form core components of Dreaming stories for different Indigenous People.

For the Balanggarra people the saltwater and islands of Balanggarra Sea Country are Dreaming creations (BAC 2011). The saltwater was created by Wolara as he 'poled his canoe' in the coastal regions. The pole of Wolara also created some of the islands in Balanggarra Sea Country (Balanggarra Ventures Ltd 2021). The King George River and Berkley Rivers are of high cultural significance to the Balanggarra people. King George Falls are the male and female Wungkurr (Department of Parks and Wildlife 2016).

The creation stories of the Tiwi People describe creation events for Bathurst and Melville Islands, the whirlpool on the east coast of Melville Island, and the four skin groups (yiminga) in Tiwi culture (Tiwi Land Council n.d).

During consultation with the Larrakia People, it was identified that there is an underwater cultural site, called Lightning Man, located off Croker Island, northeast of Darwin, NT.

Totems connect Indigenous People on a spiritual level, providing a deeper connectivity and understanding to their family groups, their Country, Dreaming and creation events. Many of the marine species found within the Planning Area are of totemic value to different Indigenous People.

Marine animals and plants found in Sea Country hold special cultural significance to different Indigenous People and may be important for subsistence and medicinal purposes.

For example, the dugong and marine turtle are both of high cultural value to the Wunambal Gaambera people, Balanggarra People, Tiwi People and many other Indigenous groups (Karadada, J. et al. 2011). Marine turtles are a key food source for Saltwater people (WWF n.d.). Table 7-8 and Table 7-9 list the turtle BIAs and habitat critical to the survival of marine turtles within the Planning Area.

Table 7-6 lists the BIAs for marine mammals such as dugongs and whales. BIAs for dugongs overlap the Planning Area, the nearest BIA around Ashmore Reef, the nearest of which is the foraging (high density seagrass beds BIA) around Ashmore Reef -south) with calving, breeding, nursing and foraging BIAs at Ashmore Reef – Far West. Considering the habitat preference of the species, dugongs are expected to occur in coastal waters and around islands where seagrass is present. The whale is an important totem for many Indigenous groups around Australia (WCA n.d.).

The mullet is the totem of the Takaringuwi skin group in the Tiwi culture (Tiwi Land Council n.d. a). A BIA for whale sharks also occurs within the Planning Area as part of their broader migratory movement.

7.4.2.1.3 Traditional Knowledge and language

Indigenous People have strong and extensive traditional knowledge (both cultural and ecological) of their Country and natural processes. This knowledge has been used for thousands of years to maintain a sustainable balance between the use and care of their natural environment. This knowledge is alive today and

evident in law, culture and practices. Traditional knowledge requires the building up of understanding over time and can be defined as a 'cumulative body of knowledge, practice and belief' (Berkes 2008 p7 in Kearney et al. 2023). Indigenous People are increasingly concerned about the difficulties in being able to pass on their traditional knowledge. Active and ongoing participation in land and sea management is a means by which Indigenous People are seeking to improve the intergenerational transfer of knowledge, critical to future health of Land and Sea Country.

Intergenerational Knowledge Transfer

Older Indigenous People, in particular those who are senior, cultural leaders or law-people are responsible for passing on traditional cultural and ecological knowledge to young people. Knowledge transfer is traditionally undertaken on-Country through the sharing of stories, song and dance, participation in ceremony and rituals, making tools, engaging in land and resource use activities (e.g. hunting, fishing), learning about bush tucker and traditional medicine. Maintaining easy access to traditional Country and traditional resources (e.g. Sea Country resources) and ensuring protection of important cultural heritage sites is imperative for the ongoing transfer of traditional knowledge.

Indigenous children learn about customary laws and protocols through many avenues including observing and participating in customs and ceremonies such as songs and dances on Country. Such laws, traditions and customs do not exist in the past as historical practices, but are considered living, contemporary and vital.

7.4.2.1.4 Conservation and Healthy Country

Biological and ecological values

For Indigenous People, Sea Country within the Planning Area is rich not only in cultural values, but in biological and ecological values. For Indigenous People of Sea Country, fish, marine mammals and sea birds, coral and fringing reef communities are all important components of biodiversity values. Many of these values are already described in Section 7.3. Managing and conserving the ecological values of Sea Country is important to Indigenous People with custodial responsibilities for Sea Country, and to the broader Indigenous community.

Contemporary land and sea management

Indigenous land and sea management across the Planning Area is undertaken in accordance with the objectives of key plans including Healthy Country Plans and IPA Management Plans. Healthy Country Plans are contemporary representations of Indigenous land and sea management and represent the way Indigenous People can manage and implement their traditional knowledge, whilst still looking after Country in ways prescribed by the old people.

Many IPAs have corresponding Healthy Country Plans or tailored management plans (e.g. Uunguu Indigenous Protected Area: Wundaagu (Saltwater) Country, Plan of Management 2016-2020 [WGAC 2017]), prepared by each relevant Indigenous group. Healthy Country Plans, IPA management plans and JMPs for marine areas articulate Indigenous people's aspirations for Country and seek to fulfill their cultural responsibility to look after Country.

Management Plans and Joint Management

Indigenous land and sea management across the Planning Area is undertaken in accordance with the objectives of key plans including Healthy Country Plans (introduced as part of the IPA planning and management process) and dedicated IPA management plans, and in the case of marine reserves – JMPs (e.g. Mary River National Park JMP). These plans are contemporary representations of Indigenous land and sea management and represent the way Indigenous People can manage and implement their traditional knowledge, whilst still looking after Country in ways prescribed by the old people.

Many IPAs have corresponding Healthy Country Plans or tailored management plans (e.g. Uunguu Indigenous Protected Area: Wundaagu (Saltwater) Country, Plan of Management 2016-2020 [WGAC 2017]), prepared by each relevant Indigenous group. Healthy Country Plans, IPA management plans and JMPs for marine areas articulate Indigenous People's aspirations for Country and seek to fulfill their cultural responsibility to look after Country.

Land and Sea Ranger Programs

A network of established Indigenous land and sea ranger programs is present across WA and NT, and a number of land and sea ranger programs, with activities and interests, operating across the Planning Area.

Land and sea rangers work on Land and Sea Country across tenure, including Native Title lands and protected areas. Many of the land and sea ranger programs across WA and NT are supported by the Commonwealth and State funding. Land and sea rangers care for Country, combining traditional knowledge of Country with contemporary training and experience. Rangers are engaged in protecting and monitoring the health of Sea Country, particularly marine species such as turtle and dugong. Many of the land and sea ranger programs are delivered as part of broader Aboriginal Land Council or Aboriginal Corporation operations.

For example, the Kimberley Land Council operates a Kimberley Ranger Network comprised of eight ranger groups. Of these groups, the Balanggarra Rangers conduct programs and activities within the Planning Area.

The Uunguu Rangers look after Land and Sea Country within the Uunguu IPA.

The Garngi rangers, based at Minjilang on Croker Island look after approximately 110,000 ha of Land and Sea Country around the Croker Islands. The rangers undertake extensive marine debris surveys and clean ups each year and are involved in a turtle survey and monitoring program at McClure and Grant Islands. In addition, the Garngi Rangers work closely with the AAPA in registering multiple sacred sites and installing appropriate signage (NIAA 2020).

The Tiwi Marine Ranger program based on the Tiwi Islands was initiated in response to Indigenous People seeking a greater role in Sea Country management. Program activities include coastal surveillance patrols, marine debris surveys, monitoring of sea turtle nesting and crested tern rookeries, visitor site management and raising community awareness about marine debris. The Tiwi Marine Rangers hold positions on Territory and national committees and advisory groups. They have been trained by NT Fisheries to undertake regulatory activities under the *NT Fisheries Act*, and currently hold Certificates in Fisheries Compliance (Tiwi Land Council n.d).

Ranger programs also engage in research activities in partnership with research institutions and state and federal government. For example, within the Planning Area the Tiwi Marine Rangers are part of a collaborative project with the NT Government investigating the viability of growing black lip oysters (*Intada margerafida*) to commercial size on the Melville Island coast.

Recent studies have also found that IPAs and associated ranger programs contribute considerable social, cultural and environmental benefits for local Indigenous People and for the Australian public as a whole (SVA 2016; Austin et al. 2017). Native Title, IPAs and JMPs for Country give strength and security to Indigenous People to look after Country.

Cultural heritage sites and protection

For Indigenous People, the protection of sacred and significant cultural sites forms a central focus of looking after Country. Cultural sites can tell different narratives about creation, Indigenous lore (law) and history. All Country is considered a cultural place, and there are rules and requirements for how Indigenous People look after it. Healthy Country Plans and IPAs help Indigenous People look after cultural heritage sites. Aboriginal Land Councils and Aboriginal Corporations, together with Land and Sea Rangers work together to control access to cultural heritage sites and sacred areas including Sea Country sacred sites.

Cultural sites are specific sites identified and protected through Australian law and which include particular places of importance to Indigenous People, in a broader landscape of cultural significance.

The Planning Area overlaps sites of Aboriginal cultural heritage as described in the following sections. A search of the WA Department of Planning Lands and Heritage Aboriginal heritage places and Aboriginal heritage surveys datasets identified no registered Indigenous heritage places within the Planning Area. Not all cultural sites are recorded or registered and captured through database searches. This can be attributed to a number of reasons including but not limited to distrust of government and desire to keep important sites private. In WA all Indigenous heritage sites, registered and unregistered, are protected under the *Aboriginal Heritage Act 1972* (WA).

A search of the NT AAPA Sacred Sites Register was undertaken to identify potential sacred sites (registered and recorded) that overlap with the Planning Area. The term sacred site is defined in Section 3 of the *Aboriginal Sacred Sites Act 1989* (NT) by reference to its meaning in the ALRA which provides a sacred site is:

"a site that is sacred to Aboriginals or is otherwise of significance according to Aboriginal tradition, and includes any land that, under a law of the NT, is declared to be sacred to Aboriginals or of significance according to Aboriginal tradition".

Based on information provided by AAPA there are recorded[29] sacred sites, registered[30] sacred sites, burial sites, and other sites[31] located within the Planning Area. The majority of registered and recorded sites are located along the mainland coastline or island coastlines within the intertidal zone. However, there are some registered and recorded sacred sites located in marine areas off the coastline of the Tiwi Islands and the mainland.

Protected areas

Section 7.3.4.2 describes the protected areas within the Planning Area including State and Commonwealth marine conservation areas, IPAs and places of national heritage. There are tangible and intangible Indigenous cultural heritage values associated with these protected areas, particularly IPAs. This section describes the cultural values and sensitivities of these protected areas with reference to Indigenous People's connection to Country, custodianship and care for Country.

Cultural and Social Values of Indigenous Protected Areas

As discussed in Section 7.4.1.4 there are two IPAs and one proposed IPA located wholly or partially within the Planning Area. Table 7-22 summarises the cultural and social values of these IPAs. The Balanggarra IPA is located proximate to the Planning Area and includes parts of the Balanggarra Native Title determination. Given the IPAs proximity to the Planning Area, the cultural and social values identified by the Balanggarra peoples have also been considered. The description of values focusses principally on Sea Country elements as these overlap the Planning Area. The values and priorities described in Table 7-22 are likely to underpin Indigenous People concerns about potential damage to coastal areas, or pollution of sea water within the Planning Area.

Table 7-22: IPAs Cultural Values and Sensitivities

Cultural Values and Sensitives of the IPA	Cultural Values and Sensitives Description
Protection of reefs, beaches and islands.	Particular reefs, beaches and islands can be special places for different Indigenous People. Some islands have burial sites, rock art, stone arrangements, artifact scatters and shell middens dating back thousands of years. Visiting and looking after islands is critically important to Indigenous People.
Protection of saltwater fish	Resources from the sea, particularly fish resources are particularly important to Indigenous People. Fish resources are the most available food on Sea Country. Finding fish and seasonal fishing arrangements are passed on as traditional knowledge. Hunting is undertaken seasonally and in accordance with traditional knowledge. Indigenous People of Sea Country hold the view that all animals from the sea are healthy when the sea water they are living in is healthy.
Protection of important marine species (e.g. fish, turtle and dugong).	Fish and turtle (particularly green turtle) are important traditional foods for many Indigenous People. Traditional hunting of marine species such as turtle and dugong is a significant component of culture, ongoing connection to Country and traditional knowledge transfer. Dugong are hunted for ceremonial purposes by many coastal Indigenous groups.
Protection of sites of cultural significance	The protection and maintenance of significant sites of culture heritage for Indigenous enjoyment is a common value across all dedicated IPAs. Some cultural sites are associated with Aboriginal law and Songlines and are important for the intergenerational transfer of traditional knowledge. Indigenous People have a cultural obligation to visit important sites of cultural significance to check on their health, and to preserve their health.

Source: information extracted from a review of the Wunambal Gaambera Health Country Plan (WGAC 2010), supporting information for the proposed Tiwi Islands sea Country IPA and the Thamarrurr Development Corporation website (for the Marri-Jabin IPA).

[29] A recorded sacred site is a site that is known to the AAPA but has not been registered and includes recorded sacred burial sites. AAPA may hold the information required to register the site should this become the wishes of the custodians. Alternatively, a recorded sacred site may still require further research in order to obtain all necessary information. The recorded coordinate point for a sacred site is a reference point only and does not necessarily indicate the location or extent of any specific site feature.

[30] A registered sacred site is a site that has been added to the Register of Sacred Sites maintained by the AAPA following the process set out in Part III Division 2 of the *Aboriginal Sacred Sites Act 1989* (NT).

[31] Other sites include archaeological places or sacred objects. These places and objects are protected under the *Heritage Act 2011* (NT).

Marine Parks

Table 7-15 lists the AMPs within the Planning Area and these are shown in Figure 7-20. Seven of the eight AMPs have dedicated network management plans which describe the associated Indigenous cultural values. A finalised management plan is not currently in place for Christmas Island Marine Park which was dedicated in 2022. The draft management plan describes the cultural values of the park to the Chinese and Malay communities, including knowledge, beliefs, practices, language, traditions, places, objects, collections, stories and oral histories (DNP 2024). A number of the AMPs overlap with Commonwealth and National Heritage Places. The Planning Area intersects a WA marine park— North Kimberley (~80 km from the Activity Area) and an NT marine park— Garig Gunak Barlu (~830 km from the Activity Area); these are shown in Figure 7-20.

The primary Indigenous value associated with the marine parks relate to the use of Sea Country. Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their Sea Country for tens of thousands of years.

Table 7-23 summarises the Indigenous cultural values within the marine parks that overlap the Planning Area.

Table 7-23: Marine Parks Cultural Values and Sensitivities

Name	Cultural Values
AMPs	
Arafura	Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their Sea Country for tens of thousands of years. The Yuwurrumu members of the Mandilarri-Ildugij, the Mangalara, the Murran, the Gadura-Minaga and the Ngaynjaharr clans have responsibilities for Sea Country in the Marine Park. These clans have Native Title determined over part of their Sea Country, which is included in this Park.
Argo-Rowley Terrace	Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their Sea Country for tens of thousands of years.
Ashmore Reef	Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their Sea Country for tens of thousands of years (DNP 2018a p121). Tourism, recreation and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation (DNP 2018a p121)
Cartier Island	Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their Sea Country for tens of thousands of years. Scientific research is an important activity in the Marine Park (DNP 2018a p124).
Joseph Bonaparte Gulf	Sea Country is valued for Indigenous cultural identity, health, and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their Sea Country for tens of thousands of years. The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people have responsibilities for Sea Country in the Marine Park. They are represented by the following PBCs: Miriuwung and Gajerrong Aboriginal Corporation, and BAC. These corporations are the points of contact for their respective areas of Sea Country in the Marine Park.
Kimberley	The Wunambal Gaambera people, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's Sea Country extends into the Kimberley Marine Park. The Wunambal Gaambera people's country includes daagu (deep waters), with about 3,400 km^2 of their Sea Country located in the Marine Park. Sea Country is culturally significant and important to the identity of these Indigenous groups. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have an unbroken connection to their Sea Country, having deep spiritual connection through Wunggurr (creator snakes) that still live in the sea. Staple foods of living cultural value include saltwater fish, turtles, dugong, crabs, and oysters. Access to Sea Country by families is important for cultural traditions, livelihoods and future socioeconomic development opportunities.

Name	Cultural Values
	The national heritage listing for the West Kimberley recognises the following key Cultural and Social Values: • Wanjina Wunggurr Cultural Tradition which incorporates many Sea Country cultural sites; • Log-raft maritime tradition, which involved using tides and currents to access warrurru (reefs) far offshore to fish; • Interactions with Makassan traders around sea foods over hundreds of years • Important pearl resources that were used in traditional trade through the Wunan and in contemporary commercial agreements. The Wunambal Gaambera, Dambimangari and Bardi Jawi people consider that these values extend into the Kimberley Marine Park. The Wanjina Wunggurr is law of the Wunambal Gaambera and Dambimangari people and it is recognised that sea Country, land, plants and animals were put there by Wanjina Wunggurr. Under Wanjina Wunggurr law, the Wunambal Gaambera and Dambimangari people have a responsibility to manage Country, to maintain the health of the Country and all living things. The Wunambal Gaambera, Bardi Jawi, Mayala and the Nyul Nyul people have had native title determined over parts of their sea Country included in this Park (DNP 2018a p119).
Oceanic Shoals	Sea Country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous People have been sustainably using and managing their sea Country for tens of thousands of years. The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people have responsibilities for sea Country in the Marine Park. They are represented by the following PBCs: Miriuwung and Gajerrong Aboriginal Corporation and BAC. These corporations are the points of contact for their respective areas of sea Country in the Marine Park.
State and Territory Marine Parks	
North Kimberley Marine Park	The North Kimberley Marine Park covers an area of almost 2 million ha. The long-standing connections, rights and interests of Indigenous People have been recognised through Native Title determinations for the lands and waters in and adjacent to the North Kimberley Marine Park for the Wunambal Gaambera, Balanggarra, Ngarinyin and Miriuwung Gajerrong people. The Indigenous People have cultural, spiritual and social connections to the north Kimberley Sea Country (DBCA 2023). The marine park is of intrinsic biological, ecological and cultural value for Indigenous People, but also provides Indigenous People with cultural, recreational and commercial benefits. The marine park contains many places of cultural and spiritual importance to Indigenous People. Whilst most locations occur on land, many are sea-related. Registered sites include those with artifacts, ceremonial and mythological paintings, fish traps, burial grounds, quarrying, many-made structures and middens (Department of Parks and Wildlife 2016). The marine park is jointly managed with Indigenous People in accordance with the North Kimberley Marine Park Joint Management Plan 2016 (Department of Parks and Wildlife 2016). Joint management of the marine park provides opportunities for Indigenous People to fulfill cultural obligations to care for Country, record and share cultural and language, and the intergenerational transfer of traditional knowledge.
Garig Gunak Barlu National Park Incorporating marine park) (NT)	Indigenous People have lived on and used the Peninsula for between 40,000 and 60,000 years. In many Dreamtime stories across the NT, it is considered that the Creation Ancestors first entered Australia via Malay Bay near the Peninsula before travelling across the rest of the Country creating people and places. The Garig Gunak Barlu National Park is managed under a joint management arrangement between the Indigenous people of the peninsula and the Parks and Wildlife Commission of the NT. This was the first formal joint management arrangement in Australia. (DCCEEW 2021). The establishment of the Gurig National Park was agreed to by the NT Government and the Indigenous People to resolve a pending land claim under the *Aboriginal Land Rights (NT) Act* (Cth). Rather than proceeding with the claim, the Traditional Owners consented to the establishment of the National Park in return for regaining title to their traditional lands. When the National Park was established, the Cobourg Peninsula Sanctuary Land Trust was formed. The NLC is authorised to perform functions under NT law for the *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Act 1981* (Cth).

Source: DNP 2018a,b,c

World, Commonwealth and National Heritage Places

Table 7-18 lists and Figure 7-22 shows the World heritage properties and Commonwealth and National heritage places within the Planning Area. The key Indigenous People cultural and social values associated with these places is summarised in Table 7-24. The national and international protection given to a number of these specific areas is significant for Indigenous People in that it supports custodial obligations to care for Country.

Table 7-24: World, Commonwealth and National Heritage Places Cultural Values and Sensitivities

Listed Place	Cultural and Social Values	Distance from Activity (~km)
World Heritage Properties		
Kakadu National Park	Kakadu National Park, recognised as both a World heritage property and a National heritage place, is significant for its outstanding cultural and natural values. As a World heritage property, it represents exceptional examples of natural ecosystems and demonstrates significant ongoing ecological and biological processes. As a National heritage place, it is identified for its deep and continuous association with Indigenous culture and heritage, including ancient rock art sites and the preservation of cultural traditions and practices by the Bininj/Mungguy people (UNESCO n.d.)	830
Commonwealth Heritage Places		
Ashmore Reef National Nature Reserve	Significant for its history of human occupation and use (DCCEEW 2023). Many of the marine species that use the marine waters of Ashmore Reef are of cultural (including totemic) significance to Indigenous People.	128
Scott Reef and surrounds	Many of the marine species that use the marine waters of Scott Reef are of cultural (including totemic) importance to Indigenous People.	153
National Heritage Places		
The West Kimberley	Significant for its Indigenous and historic values including the history of the *gaalwa* (double log raft) and the use of *gooward* (pearl shell) for ceremonial purposes and trading far afield by the Bardi and Jawi people.	145
Kakadu National Park	Refer previous entry.	830

Threats to Country

Through the IPA process and associated Healthy Country Plan framework, Indigenous People have identified specific threats to the health of land and sea Country. Frequently identified threats include:

- Loss of traditional knowledge and connection to Country. Literature review of Healthy Country Plans suggests that this is one of the biggest threats. Traditional knowledge links the Country to its people and conversely the people to their Country
- Illegal commercial fishing by Australian and foreign fishing vessels as well as overfishing by recreational and commercial fishers who access areas without permission
- Lack of culturally appropriate consultation with Indigenous People, particularly in relation to cultural sites, sea resources such as turtle and dugong
- Climate change and potential changes in sea levels, climatic conditions including rainfall and resulting impacts on Country including land and sea resources, and the integrity of cultural heritage sites
- Coastal pollution such as general rubbish, oil and fuel spills at sea and marine debris. Coastal pollution is a threat to marine life particularly turtles and marine mammals

- Lack of land and sea management capacity. Traditional sea Country is often extensive in size and difficult to reach, hindering stewardship practices
- Lack of infrastructure to access Country. Without access to Country, it is difficult for elders to effectively pass on traditional knowledge to younger generations
- Difficulty in gaining permission to access Country, and frequently changing regulations and conditions to access Country.
- Resource extraction activities (e.g. sea mining, oil and gas drilling). Indigenous People are concerned about the potential risks these activities present to marine fauna resources (e.g. fish, turtle and dugong), and risks associated with accidents during operations as well as potential disturbance of the marine floor during pipeline construction and increased shipping activity.

7.4.2.2 Land and Sea Resource Use Practices

7.4.2.2.1 Customary use of land and sea

Indigenous People engage in the customary use of sea Country proximate to the Planning Area. Access to and customary use of sea Country is an important part of Indigenous culture, integral to maintaining connection to Country and the health and wellbeing of Indigenous People.

Customary activities undertaken in sea Country within the Planning Area include hunting for food and ceremonial purposes, visiting and maintaining cultural sites, making medicine, engaging in ceremonial activities, sharing traditional knowledge including passing on important Dreaming stories, and general on-Country recreation shared with family. Many customary rights to land and sea resource use are protected through Native Title and/or are provided for through management plans. Customary activities are also managed in accordance with the cultural protocols of different Indigenous groups.

Examples of customary use within the Planning Area include the harvesting of green turtles by the Tiwi people for food, and the collection of sea turtle eggs. Dugongs are an important food source for many coastal Indigenous People including the Tiwi people, the Balanggarra people and other Indigenous People.

7.4.2.2.2 Contemporary land and sea resource use

Indigenous People engage in a range of different resource use activities in the sea Country located within the Planning Area. These activities include land management (as described in Section 7.4.2.1.4), commercial fishery and aquacultural activities, and cultural based tourism activities.

Commercial fisheries activities

A number of Indigenous People are engaged in commercial fishing activities in Territorial waters within the Planning Area. In the NT, the Blue Mud Bay decision (Section 7.4.1.2) was the catalyst for changes to coastal fishing licences which facilitated greater opportunity for the participation of Indigenous People in commercial fishing activities. Previously, just one licence was available in each Indigenous coastal community and the catch could only be sold within that community. Now there can be more than one licence holder and the catch can be sold commercially to markets further afield (FRDC 2018). The total allowable catch for each licence is five tonnes a year. Licence holders can target mullet, Blue Threadfin, queenfish, Milkfish, trevally and reef fish such as cod, parrotfish, Coral Trout and snapper (FRDC 2018).

There a no known aquaculture licences under the *Fish Resources Management Act 1994* (WA) that overlap with the Planning Area, and are held by Indigenous People or organisations.

Cultural based tourism

As described in Section 7.4.5, the Kimberley, WA and areas around Darwin, NT are important visitor destinations for Australian and international tourists. Areas of sea Country within the Planning Area feature spectacular scenery, diverse wildlife and cultural heritage, all of which provide opportunities for nature-based and cultural recreational activities and tourism experiences.

Indigenous People are using or have aspirations to use their IPAs, JMPs for marine parks and land tenure arrangements (Native Title and Freehold land tenure) to develop commercial opportunities based around cultural connections and conservation tourism. Existing commercial cultural based tourism activities operating within the Planning Area include expedition cruise boat operations, nature-based on Country guided tours,

luxury wilderness retreats, on Country marine based experiences, learning about Country, and art and cultural immersion experiences.

Commercial land and sea management

The IPAs are also being used by native title groups to undertake environmental management contracts and fire management projects. Both IPAs and JMPs present opportunities for the direct employment of Indigenous People but also the delivery of fee for service management work. The Crocodile Islands Rangers and the Garngi Ranger group from Croker Islands are funded to undertake marine debris clean-ups, sea Country patrols and surveillance operations.

7.4.2.3 Indigenous People's Rights and Interests

7.4.2.3.1 Statutory rights and interests

This section describes the recognised rights and interests of Indigenous People derived from Native Title determinations and ALRA.

Native Title determinations recognising the existence of native title that overlap the Planning Area are presented in Table 7-19. Holders of Native Title are afforded certain rights and title to land and sea. These rights may include the right to camp, hunt and gather on land and sea, rights of access, use and occupation, perform ceremony and protect cultural sites. The various rights granted are different for each Native Title determination. Importantly Native Title holders have the right to be consulted about decision or activities that could affect the enjoyment of Native Title rights and interests.

Native Title holders may be granted exclusive Native Title rights in some areas of a determination, and non-exclusive rights in other areas. Within WA, Native Title rights held over waters seaward of the high-water mark are generally non-exclusive. Appendix E provides an example of the types of rights and interests afforded Native Title holders with determinations that overlap the Planning Area.

Aboriginal freehold rights are in addition to Native Title rights, exclusive access to closed seas, protection of sacred sites and management of IPAs. Aboriginal Land Councils recognised under ALRA hold the rights to Aboriginal Freehold Land and support Indigenous People in decisions about their land. Indigenous People who hold Aboriginal freehold land have the primary spiritual responsibility for sacred sites on the land and are entitled by culture and tradition to hunt and gather on that land. As Aboriginal freehold land includes the intertidal zone, there are Indigenous People with rights and interest in Territorial waters that overlap the Planning Area. Indigenous People have control over who enters their land and intertidal zone and what they do there. The Northern Land Council (NLC) and the Tiwi Land Council (TLC) issue permits in consultation with Indigenous People to non- Indigenous people seeking to access Aboriginal land and waters.

7.4.2.3.2 Self determination

Self-determination refers to the movement, both political and social, of Indigenous People and communities to have full agency in determining how the lives of Indigenous People are governed, to have full autonomy in decisions that affect Indigenous communities and to have control over the economic, social, and cultural development which may impact Indigenous communities (AHRC n.d.). The theme of self-determination is intrinsically important when considering Indigenous rights and interests that overlap the Planning Area (i.e. Native Title, jointly managed marine parks, IPAs). In terms of economic self-determination, Indigenous-owned tourism operations with interests within the Planning Area have similar significance.

Within the Planning Area, Native Title, Aboriginal freehold land tenure, IPAs and jointly managed marine parks empower collective self-determination through recognising the Indigenous ownership of the land. This 'ownership' of land grants Indigenous People the right to carry out cultural practices, and to use the land for social and economic benefit. These cultural practices include hunting and gathering of animal and food species, the maintaining of significant cultural sites and Country, law and ceremonial practices. The recognition of Indigenous rights and interests is integral to understanding their collective value for overall Indigenous health and well-being.

7.4.3 Marine Archaeology

Under the Commonwealth *Underwater Cultural Heritage Act 2018* (UCH Act), if an Indigenous People (referred to as First Nations) UCH site is discovered in Commonwealth waters, it may be declared as protected under section 19 of the UCH Act (DCCEEW 2023a). The Planning Area partially intersects parts of the Kimberley, WA and NT coastlines, which host numerous culturally significant sites, including sites that contribute to the national heritage value of the West Kimberley National Heritage Place and Kakadu National Park. The location of the proposed infrastructure is below 130 m LAT which is the maximum extent of exposed land since humans have occupied the continent; hence there will not be any impacts to the tangible First Nations underwater cultural heritage (Cosmos 2023).

Under the UCH Act, Australia's UCH (such as historic [i.e. >75 years old] shipwrecks, sunken aircraft and other types) is automatically protected, whether or not their existence or location is known (DCCEEW 2023a). There are no known shipwrecks or other UCH sites within the Activity Area (see Figure 7-29; DCCEEW n.d.). Multiple historic shipwrecks and sunken aircraft occur within the Planning Area; however, these are highly unlikely to be affected because they are predominantly on the seabed and are some distance from the Activity Area. The closest shipwreck to the Activity Area is the *Runnymede* (wrecked in 1878), ~19 km from the Activity Area. Near Ashmore Reef and Cartier Island are unnamed Indonesian fishing vessels and the *Sinar Bonerate* (wrecked in 1999), and near Browse Island are the *Browse Island Unident* (wrecked in 1880) and *Selina* (wrecked in 1901) (DCCEEW n.d.).

7.4.4 Fishing

7.4.4.1 Traditional Fishing

In 1974, Australia recognised access rights for traditional Indonesian fishers in shared waters north of Australia, granting long-term fishing rights in recognition of the long history of traditional Indonesian fishing in the area. An MOU between the governments of Australia and Indonesia allows traditional Indonesian fishers to continue their customary practices. This area is known as the 'MOU Box'. This MOU box covers Scott Reef and surrounds, Seringapatam Reef, Browse Island, Ashmore Reef and Cartier Island, representing an area of approximately 50,000 km^2. The MOU Box allows Indonesian fishers to fish in designated areas using traditional methods only. These methods include reef gleaning, free-diving, hand lining and other non-mechanised methods.

The Activity Area intersects the MoU Box. Trochus, sea cucumbers (holothurians), abalone, green snail, sponges, giant clams and finfish, including sharks, are targeted by the traditional fishers. As traditional fishers primarily target shallow-water species, interaction is considered unlikely and limited to fishers transiting to reef locations. Scott Reef is currently the principal reef in the MOU Box and is utilised season is July to October due to more favourable wind conditions, and to allow fishers to sun dry their catch on their boat decks.

Restrictions were introduced around Ashmore Reef and Cartier Island following their designation as Nature Reserves under the *National Parks and Wildlife Conservation Act 1975* (Cth) in 1983 and 2000, respectively. Restrictions permit the use of access to parts of Ashmore Reef for shelter, freshwater and to visit grave sites only.

Dugong, fish and marine turtles are important components of Indigenous People's culture and diet. They continue to actively manage their sea Country in coastal waters and coastlines in order to protect and manage the marine environment, its resources and cultural values. Traditional Indigenous fishers, hunters and gatherers generally use waters within 3 nm of the coastline (NT Government 2015) or surrounding nearshore islands; however are not considered to be active within the offshore waters of the Activity Area.

7.4.4.2 Recreational Fishing

Currently, no known recreational fishing activities occur in the Activity Area because the site is too far from shore to be accessed by recreational anglers in small boats. Even at relatively high speed (30 km/h), it would take >15 hours for a recreational boat to reach the Activity Area from the nearest port (Broome, WA).

Recreational fishing, particularly boat-based angling, occurs throughout the Planning Area. Recreational angling is centred around access nodes (e.g. marinas, boat launching facilities) at towns across the Kimberley region. Recreational anglers typically target demersal and pelagic fish species for consumption and sport. In the NT, annual expenditure by recreational fishers and the charter fishing industry is estimated at >AU$100 million (NT Government 2019).

7.4.4.3 Commercial Fisheries

A number of Commonwealth (see Figure 7-30), WA (Figure 7-31, Figure 7-32 and Figure 7-33) and NT (Figure 7-34, Figure 7-35 and Figure 7-36) fishery management areas are located within or proximal to the Activity and Planning Areas. Table 7-25 assesses the potential for interaction within the Activity Area, and Section 6.6.9 of the Master Existing Environment provides further detail on the fisheries that have been identified through desktop-based assessment and consultation.

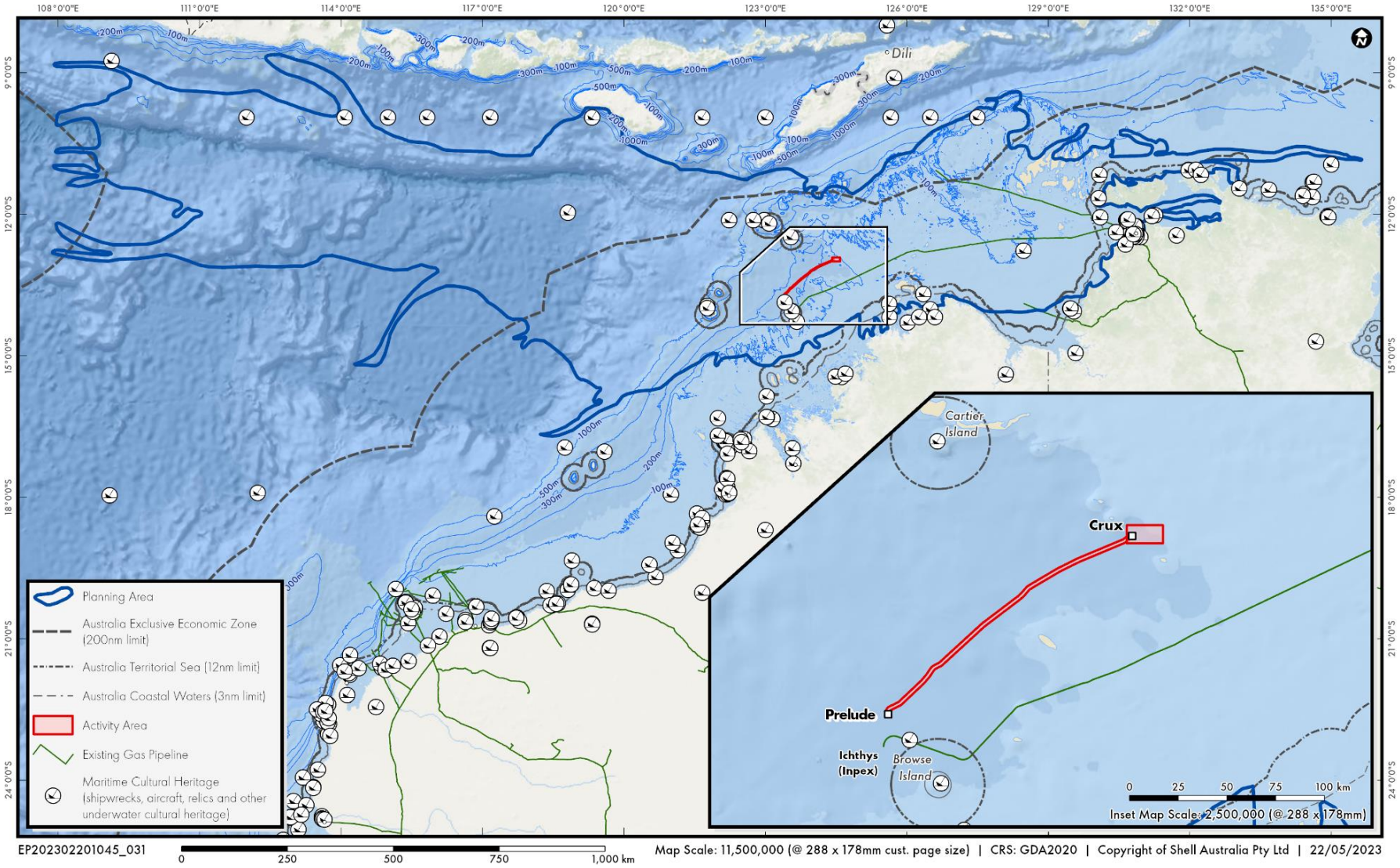


Figure 7-29:Underwater Cultural Heritage

Table 7-25: Commercial Fisheries within the Planning Area

Fishery Name	Planning Area	Activity Area	Potential for Interaction within Activity Area	
Commonwealth-managed Fisheries				
North West Slope Trawl Fishery	✓	✓	✓	The total catch in the North West Slope Trawl Fishery for the 2019–2020 season was 111.5 t, over 306 days with scampi making up ~65% of the total catch from vessels. There were 6 active vessels and 7 fishing permits in the 2019–2020 season (Patterson et al. 2021). The total area of the waters fished during the 2019–2020 fishing season did not overlap the Activity Area (Patterson et al. 2021). However, the total area fished during the 2018–2019 fishing season overlapped the Activity Area; therefore there is potential for interaction with the fishery within the Activity Area.
Western Tuna and Billfish Fishery	✓	✓	×	In recent years, fishing effort in the Western Tuna and Billfish Fishery has concentrated off south-west WA (Patterson et al. 2021). Since 2005, <5 vessels have been active in the fishery each year (Patterson et al. 2021). During 2020 there was 161 t of catch from 231,085 pelagic longline hooks. Although the fishery management area operates in the Activity Area, the maximum area fished has not overlapped the Activity Area (Patterson et al. 2021). Therefore, there is no potential for interaction with this fishery within the Activity Area.
Northern Prawn Fishery	✓	×	×	The fishery management area does not overlap with the Activity Area; therefore, Shell considers there is no potential for interaction with this fishery within the Activity Area.
Western Deepwater Trawl Fishery	✓	×	×	The Western Deepwater Trawl Fishery is permitted to operate only in deep waters from the 200 m isobath, as far north as North West Cape. The fishery management area does not overlap the Activity Area; therefore, Shell considers there is no potential for interaction with this fishery within the Activity Area.
WA-managed Fisheries				
Mackerel Fishery	✓	✓	✓	The Activity Area overlaps with the Mackerel Managed Fishery management area. Catch effort in the 2020 season was 288 t (Spanish mackerel) and 11 t (grey mackerel) (Lewis and Watt 2021). The Activity Area occurs in the 125242 10 nm Catch and Effort System (CAES) block and there was no fishing effort from the Mackerel Managed Fishery in that block between 2016 and 2020 inclusive (DPIRD 2021). Less than 3 vessels have been active in the Mackerel Fishery in the 60 nm CAES block (block 12240) that overlaps with the Activity Area; therefore, Shell considers there to be potential for interaction with this fishery within the Activity Area.
Northern Demersal Scalefish	✓	✓	✓	The Northern Demersal Scalefish Managed Fishery management area overlaps the Activity Area. Catch effort in the 2020 season was 1,419 t. (Newman et al. 2021). Between 2011 and 2020 (inclusive) only five vessels were active within the 10 nm CAES block (12240) that overlaps the Activity Area (DPIRD 2021). Therefore, there is potential for interaction with this fishery within the Activity Area.
West Coast Deep Sea Crustacean	✓	✓	×	The West Coast Deep Sea Crustacean Managed Fishery can fish in water deeper than the 150 m isobath and therefore overlaps the Activity Area.

Fishery Name	Planning Area	Activity Area	Potential for Interaction within Activity Area	
				Total catch in the 2020 season was 153 t (How and Baudains 2021). However, fishing effort is concentrated between Carnarvon and Fremantle; therefore, there is no potential for interaction with this fishery within the Activity Area.
Pearl Oyster Fishery	✓	✓	×	The Activity Area overlaps within management zone 3, but it is much deeper than safe diving depths in which pearl oyster fishing occurs. Most pearl fishing occurs in inner continental shelf waters (<30 m deep) along the Kimberley and Pilbara coastlines. Total catch for the 2020 season was 455,980 shells (Hart et al. 2021). Between 2011 and 2020 (inclusive), no vessels were active within the 60 nm CAES block (12240) overlapping the Activity Area. Because this fishery is diver-based (i.e. restricted to safe diving depths) there is no potential for interaction with the fishery within the Activity Area.
Marine Aquarium and Specimen Shell	✓	✓	×	Given the nature of the Marine Aquarium and Specimen Shell fisheries, effort is expected to be largely restricted to coastal waters <30 m deep. Therefore, no fishing effort occurs within or near the Activity Area, and there is no potential for interaction with this fishery within the Activity Area.
Abalone Fishery	✓	✓	×	No commercial fishing for abalone north of Moore River (zone 8 of the managed fishery) has taken place since 2011–2012 (Strain et al. 2020). Therefore, there is no potential for interaction with the fishery within the Activity Area.
Broome Prawn	✓	✓	×	The Broome Prawn managed fishery primarily targets western king prawns with a total catch of 55–260 t in 2021–2022 (Newman et al. 2023). Although the Activity Area intersects a small section of the Broome Prawn licence, interaction with this fishery is highly unlikely as commercial fishing is prohibited across most of the licence area, including the Activity Area (Kangas et al. 2023).
Kimberley Crab Fishery	✓	✓	×	The Kimberley Crab Fishery operates off the north-west coast of WA in WA waters. Fishing effort is concentrated in nearshore waters and targets brown mud crab species between April and September (Johnson et al. 2023). The total catch in 2021–2022 was 0.8 t (Johnson et al. 2023). Interaction with this fishery is highly unlikely, given the very low fishing effort concentrated in nearshore waters.
South West Coast Salmon	✓	✓	×	The South West Coast Salmon Managed Fishery licence expands across WA waters and therefore overlaps the Activity Area. Total catch for West Coast Estuarine and Nearshore Scalefish and Invertebrates (includes South West Coast Salmon Managed Fishery) in the 2021-2022 season was <25 t (Newman et al. 2023). However, fishing effort is concentrated in the south-west coast of WA; therefore, there is no potential for interaction with this fishery within the Activity Area.
Kimberley Prawn	✓	✓	×	The Kimberley Prawn managed fishery primarily targets banana prawns with a total catch of ~204 t in 2021 (Newman et al. 2023). There are two fishing periods for the season (April to mid-June; August to end of November). Although the Activity

Fishery Name	Planning Area	Activity Area	Potential for Interaction within Activity Area	
				Area intersects a small section of the Kimberley Prawn licence, no fishing effort occurs within or near the Activity Area, hence there is no potential for interaction with this fishery within the Activity Area.
Pilbara Crab	✓	×	×	The Activity Area does not overlap with the Pilbara Crab Fishery management area. Therefore, there is no potential for interaction with this fishery within the Activity Area.
North Coast Prawn Fishery	✓	×	×	The Activity Area does not overlap with the North Coast Prawn Fishery management area. Therefore, there is no potential for interaction with this fishery within the Activity Area.
Kimberley Gillnet and Barramundi	✓	×	×	The extent of the fishery is ~213 km east (near to the shoreline) of the Activity Area. Therefore, there is no potential for interaction with the fishery within the Activity Area.
Pilbara Trap	✓	×	×	The extent of the Pilbara Trap Managed Fishery is ~477 km south-west of the Activity Area. Therefore, there is no potential for interaction with the fishery within the Activity Area.
Pilbara Trawl	✓	×	×	The extent of the Pilbara Fish Trawl (Interim) Managed Fishery is ~560 km south-west of the Activity Area. Therefore, there is no potential for interaction with the fishery within the Activity Area.
Pilbara Line	✓	×	×	The Activity Area does not overlap with the Pilbara Line Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
West Coast Rock Lobster	✓	×	×	The Activity Area does not overlap with the West Coast Rock Lobster Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
WA Sea Cucumber Fishery (formerly Beche-de-mer Fishery)	✓	×	×	The Activity Area does not overlap with the Sea Cucumber Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Northern Shark Fishery	✓	×	×	No catch effort has been recorded since the 2008–2009 season (DPIRD 2021); therefore, there is considered no potential for interaction with this fishery within the Activity Area.
NT-managed Fisheries				
Aquarium Fishery	✓	×	×	The Activity Area does not overlap with the Aquarium Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Offshore Net and Line Fishery	✓	×	×	The Activity Area does not overlap with the Offshore Net and Line Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Spanish Mackerel Fishery	✓	×	×	The Activity Area does not overlap with the Spanish Mackerel Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Demersal Fishery	✓	×	×	The Activity Area does not overlap with the Demersal Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.

Fishery Name	Planning Area	Activity Area	Potential for Interaction within Activity Area	
Timor Reef Fishery	✓	×	×	The Activity Area does not overlap with the Timor Reef Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Pearl Oyster Fishery	✓	×	×	The Activity Area does not overlap with the Pearl Oyster Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Coastal Line Fishery	✓	×	×	The Activity Area does not overlap with the Coastal Line Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Jigging Fishery	✓	×	×	The Activity Area does not overlap with the Jigging Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Coastal Net Fishery	✓	×	×	The Activity Area does not overlap with the Coastal Net Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Barramundi Fishery	✓	×	×	The Activity Area does not overlap with the Barramundi Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Trepang Fishery	✓	×	×	The Activity Area does not overlap with the Trepang Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Development Fishery (Small Pelagic)	✓	×	×	The Activity Area does not overlap with the Development Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Mud Crab Fishery	✓	×	×	The Activity Area does not overlap with the Mud Crab Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Bait Net Fishery	✓	×	×	The Activity Area does not overlap with the Bait Net Fishery management area; therefore, there is no potential for interaction with this fishery within the Activity Area.
Mollusc Fishery	✓	×	×	The Activity Area does not overlap with the Coastal Line Fishery management area; therefore there is no potential for interaction with this fishery within the Activity Area.

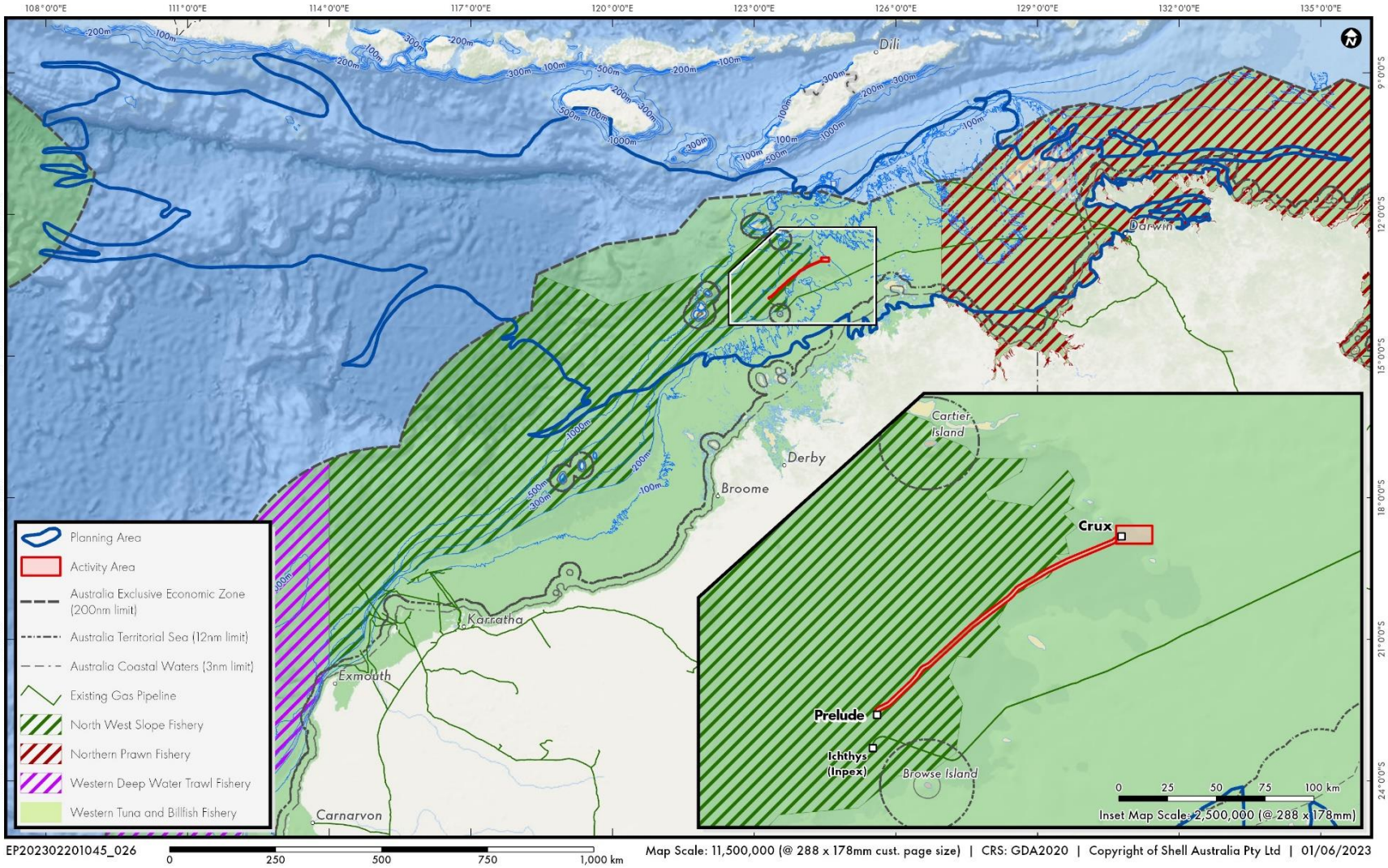


Figure 7-30: Commonwealth-managed Fisheries Management Areas within the Planning Area

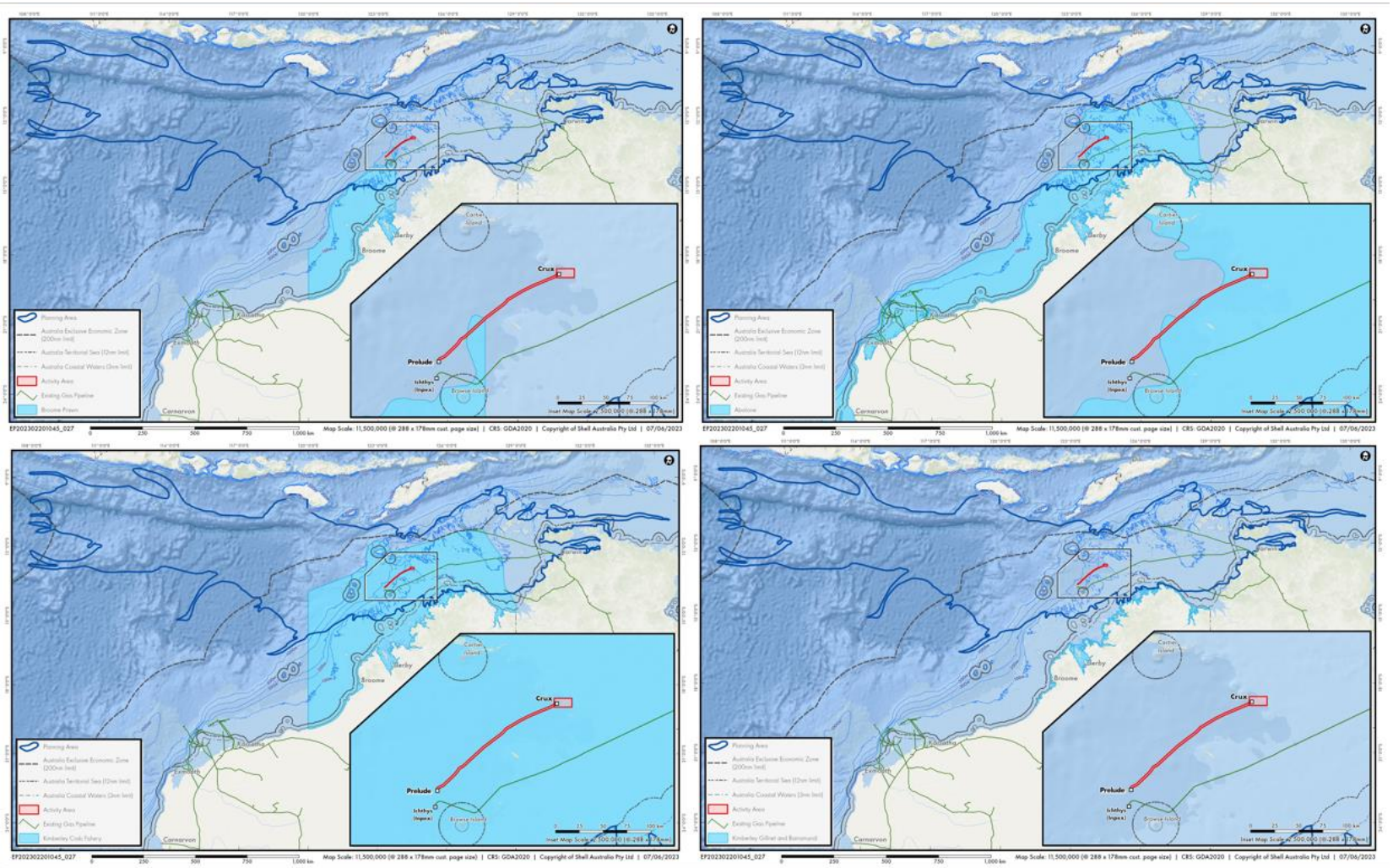


Figure 7-31: WA-managed Fisheries Management Areas within the Planning Area (1)

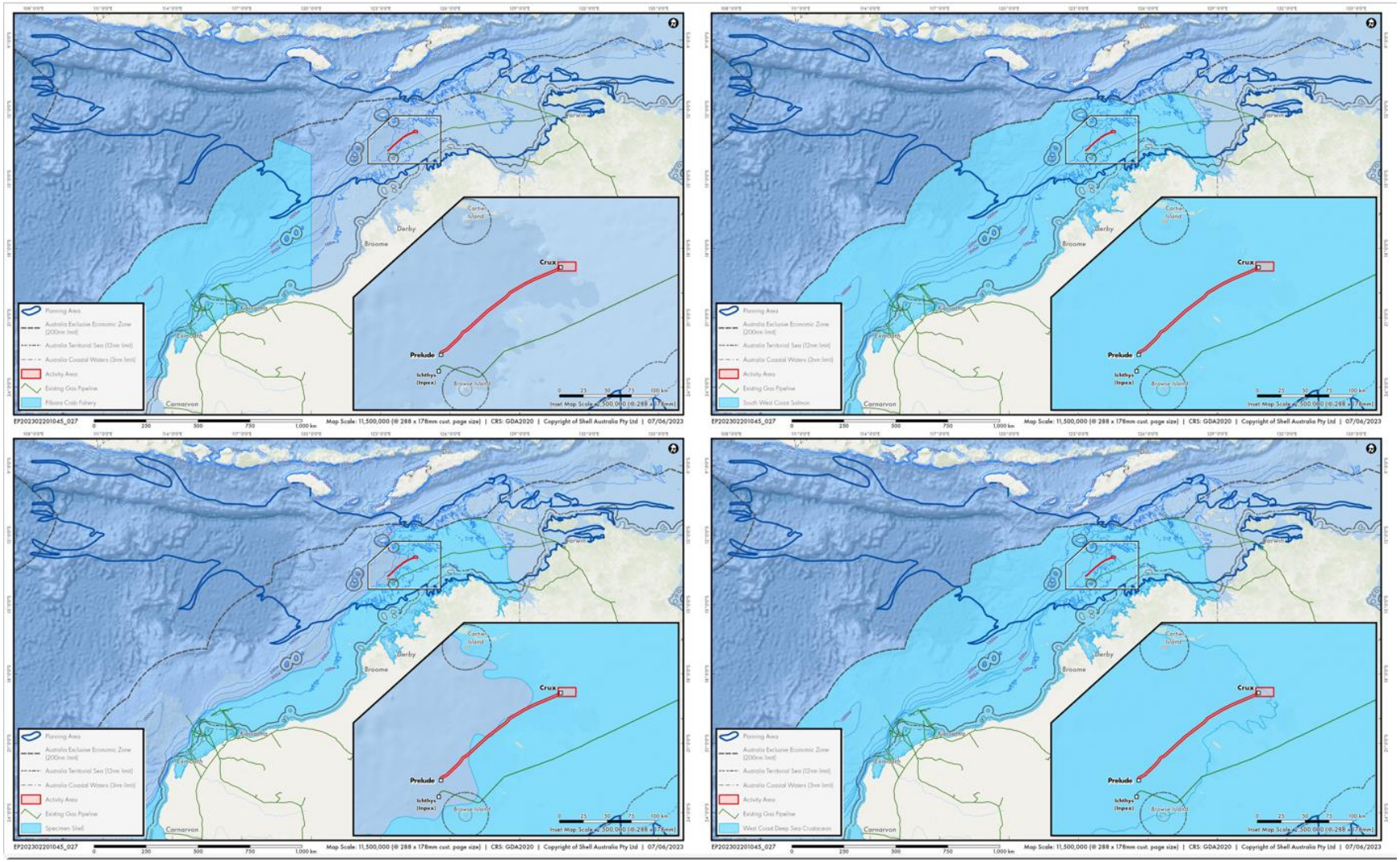


Figure 7-32: WA-managed Fisheries Management Areas within the Planning Area (2)

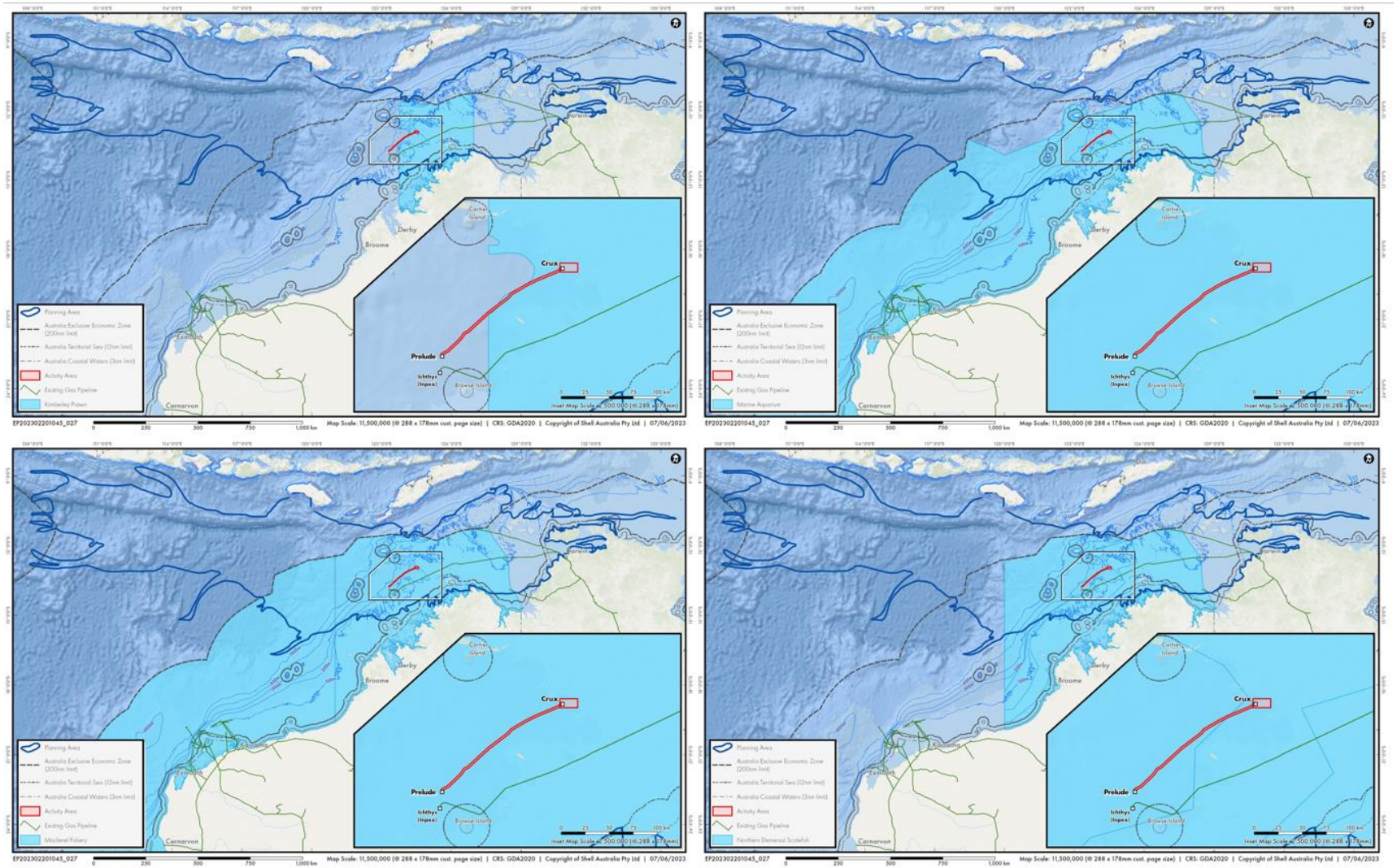


Figure 7-33: WA-managed Fisheries Management Areas within the Planning Area (3)

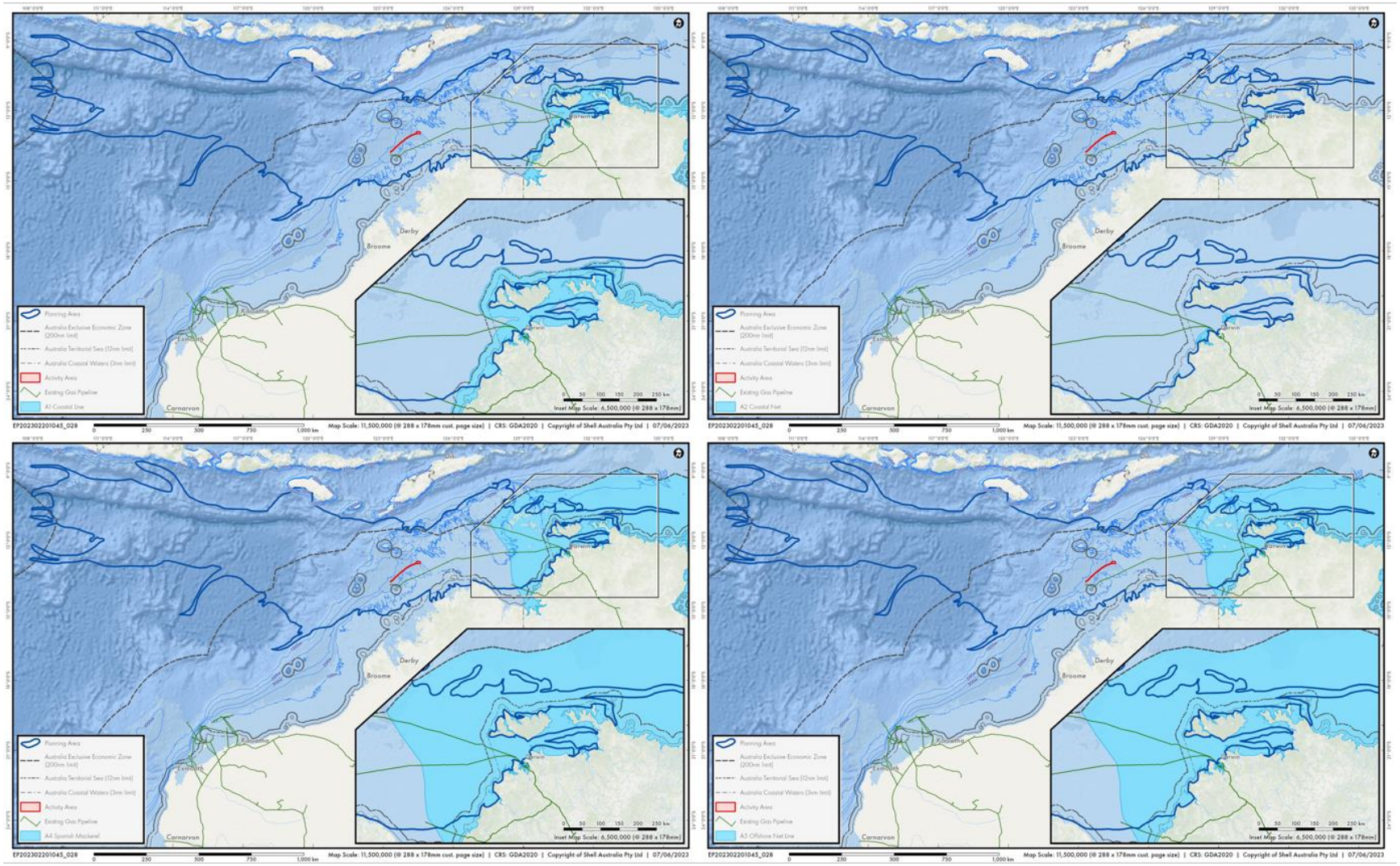


Figure 7-34: NT-managed Fisheries Management Areas within the Planning Area (1)

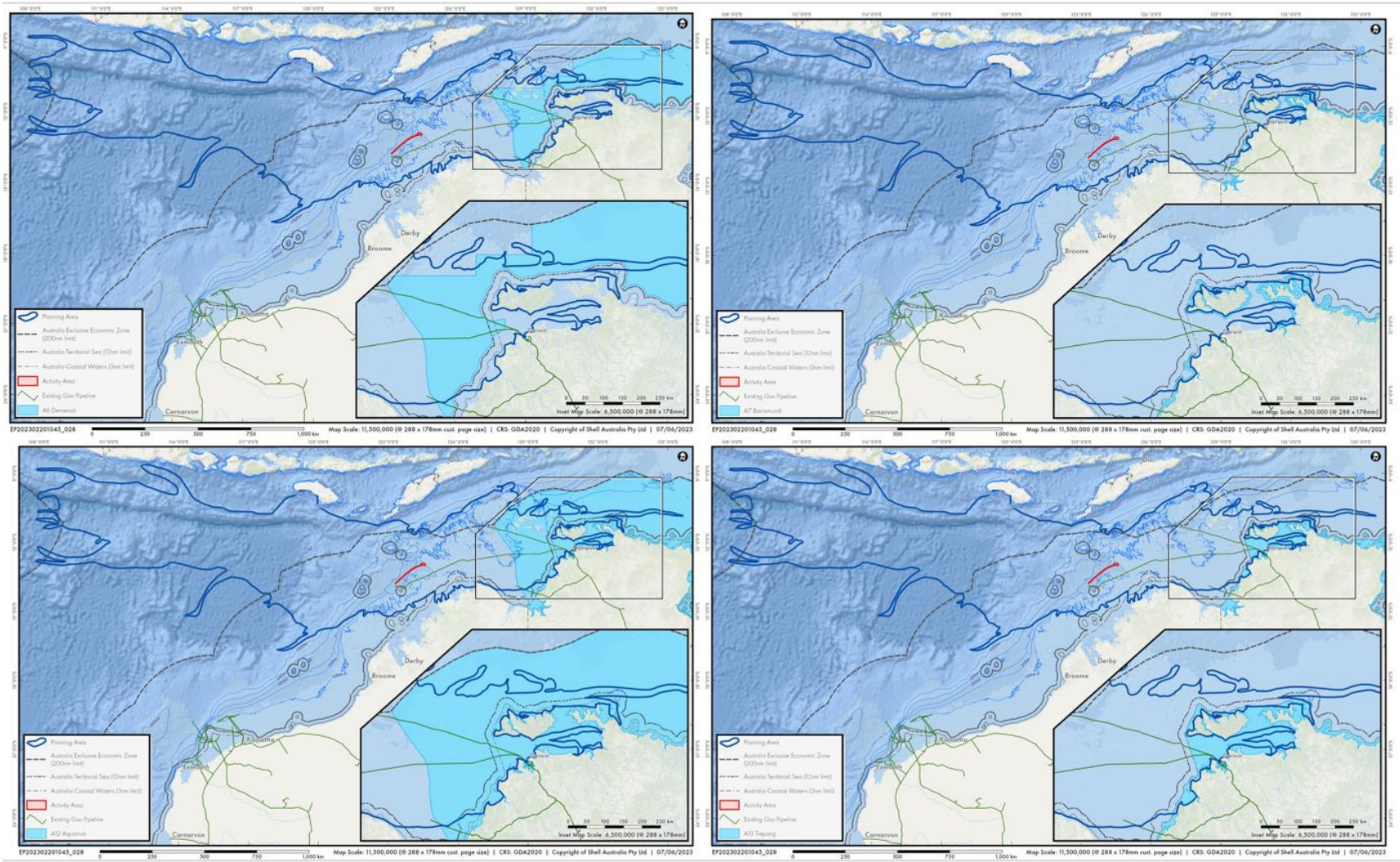


Figure 7-35: NT-managed Fisheries Management Areas within the Planning Area (2)

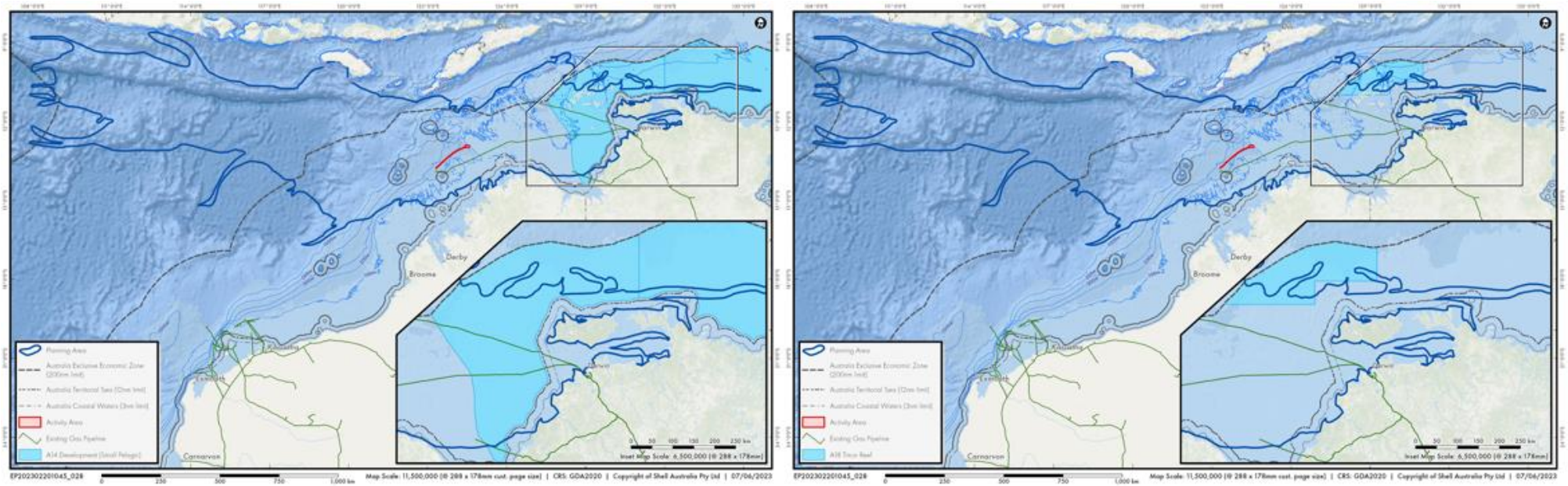


Figure 7-36: NT-managed Fisheries Management Areas within the Planning Area (3)

7.4.4.4 Aquaculture

No aquaculture operations occur within the Activity Area; typically, aquaculture is restricted to shallow coastal waters. Aquaculture in the region primarily comprises culturing hatchery-reared and wild-caught oysters (*Pinctada maxima*) for pearl production. The Kimberley region is important to the WA pearling industry, which is the world's top producer of silver-white south sea pearls (Hart et al. 2016). WA pearling activities are mostly near Broome and Eighty Mile Beach, and leases are typically in shallow coastal waters <20 m deep (Fletcher et al. 2006). In the NT, pearl farm leases are limited to the coastal waters around Bynoe Harbour and Beagle Gulf near Darwin, as well as Cobourg Peninsula and Nhulunbuy (NT Government 2021).

Other aquaculture activities in the Kimberley region and in the NT are understood to be limited to land-based projects (e.g. the Darwin Aquaculture Centre and Project Sea Dragon prawn hatchery development near Darwin), barramundi farming, and other activities in shallow coastal waters (NT Government 2021).

7.4.5 Tourism and Recreation

No tourism activities are known to occur within the Activity Area, but they do occur widely in the Planning Area. Most tourism in the Planning Area is nature-based and is typically associated with outstanding natural features such as the Kimberley coastline and the offshore reefs and islands (e.g. Rowley Shoals). Because of the remoteness of the region, most offshore tourism activities are organised expeditions, which use larger vessels.

Tourism is more common along the coast from Exmouth to Darwin, and is largely confined to coastal waters and inshore islands, with Cape Leveque, Beagle Bay, Cockatoo Island and the Buccaneer Archipelago all popular destinations for coastal cruises. Fishing and diving charters operate out of Broome and Derby and the occasional charter vessel may visit Scott Reef, Ashmore Reef, Browse and Adele islands. A search of recreational fishing charters in the north-west region of WA did not reveal any recreational fishing in the marine waters of the Activity Area. Birdwatching tours operate occasionally out of Broome, with annual expeditions visiting Ashmore Reef and associated offshore islands such as the Lacepede Islands, Adele Island, Browse Island, and Scott Reef. Tourism makes a significant contribution to the regional economy, with Broome (beyond the Planning Area) being a central node for many tourism-related activities in the region.

Most recreational and tourism activities in the NT are adjacent to population centres such as Darwin. Peak times are during the dry season (May to October), and activities include recreational fishing, diving, snorkelling, wildlife watching and boating (NT Tourism 2023).

7.4.6 Defence

Australian Border Force (ABF) Maritime Border Command (MBC) undertakes civil and maritime surveillance (and enforcement) in and around the Activity Area (Department of Home Affairs [DHA] 2018a, 2018b). Their primary purpose is to monitor the passage of suspected illegal entry vessels and illegal foreign fishing activity within and beyond Australia's EEZ, which extends to ~200 nm from the mainland (DHA 2018a).

There are no designated military/defence exercise areas in the Activity Area. However, regionally relevant activities include the North Australian Exercise Area (NAXA) offshore training area and the Browse Basin and Northern Carnarvon Basin offshore air-to-air weapons ranges, which are maritime military zones administered by the Department of Defence. The NAXA extends ~300 km north and west from just east of Darwin into the Arafura Sea and is used for offshore naval exercises and onshore weapons-firing training (Department of Defence 2015). The Browse Basin (Curtin) and Northern Carnarvon (Learmonth) air-to-air weapons ranges are 513 km and 1,500 km from the Activity Area, respectively. The Learmonth RAAF base on North West Cape is within the Planning Area but ~1,262 km from the Activity Area. A search of the Department of Defence's Unexploded Ordnance (UXO) map indicated that no UXOs are known to occur within the Activity Area (Department of Defence n.d.) with the nearest known UXO >220 km from the Activity Area.

7.4.7 Ports and Commercial Shipping

Shipping activity in the vicinity of the Activity Area is considered high. However, most shipping movements in the Activity Area are associated with the operation of the Prelude FLNG facility and Ichthys facilities (e.g. offtake tankers, support vessels etc.). Given the distances between the Activity Area and commercial shipping channels, Shell expects minimal navigational impacts to commercial shipping from the Activity.

Coastal ships may potentially traverse the Activity Area from the major state and territory ports (Broome, Derby, Wyndham, Darwin), and MBC may conduct civil and maritime surveillance in and around the Activity Area to monitor the passage of illegal entry vessels and illegal foreign fishing activity (DHA 2018b).

Figure 7-37 summarises the regional shipping movements and port areas within the Planning Area.

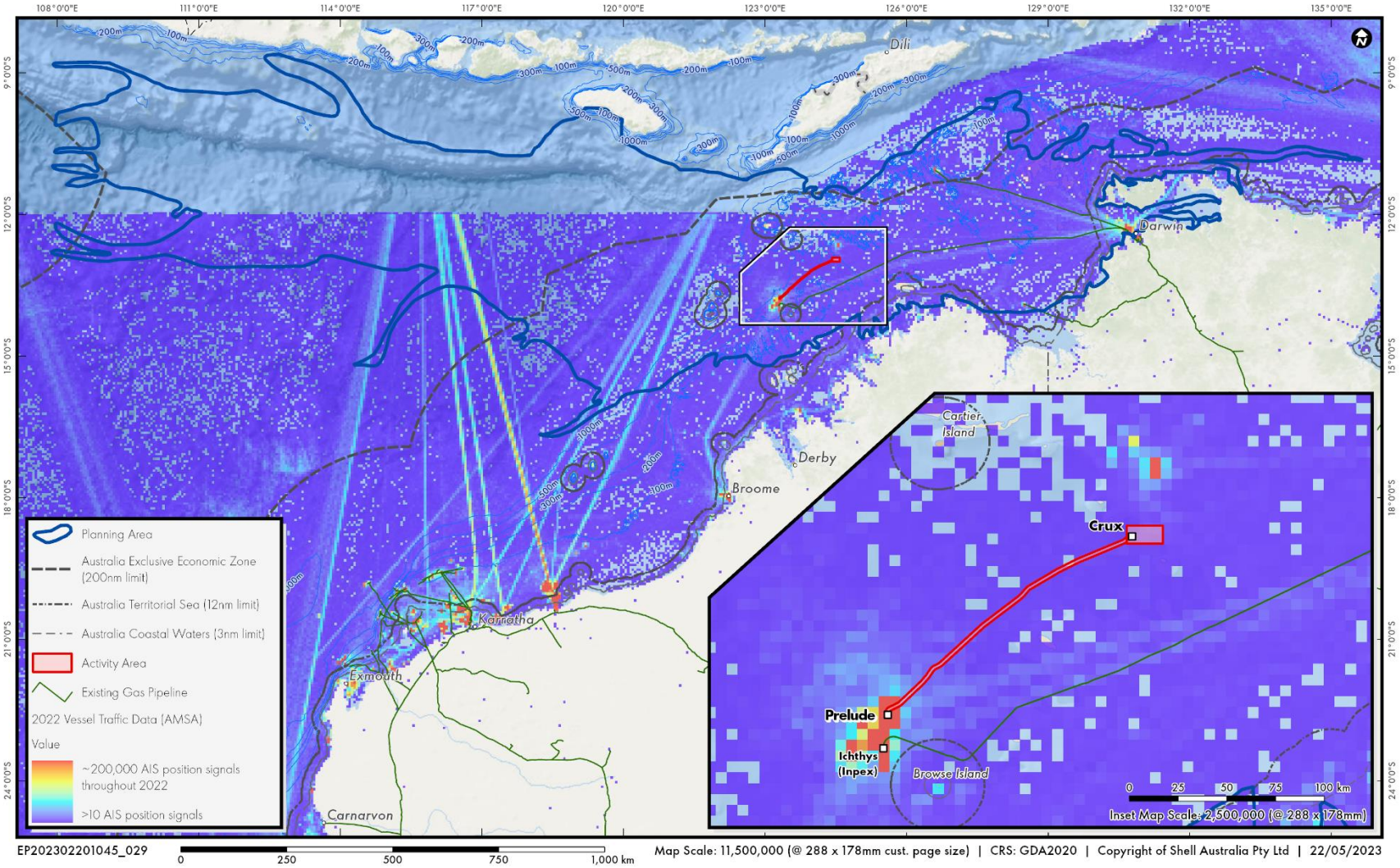


Figure 7-37: Shipping Levels within the Activity and Planning Areas

7.4.8 Indonesian Coastline

Although the Planning Area does not contact the Indonesian coastline (RPS 2018), a description has been provided due to the proximity to the southern coastline of Sumba, an Indonesian island. Sumba is greater than 580 km NW from the Activity Area. The Sumba coastal area provides important habitat (e.g. feeding, migratory corridors etc) to marine mammal species (IUCN-MMPATF 2022). The Sumba coastal area also has numerous seagrass meadows supporting dugong populations and seaweed harvesting.

7.4.9 Oil and Gas Industry

Oil exploration activities in the Timor Sea commenced in the late 1960s. Since this time numerous wells have been drilled throughout the region. Petroleum exploration has been active in the Browse Basin since the 1980s, with several commercial discoveries since that time. It is expected that petroleum exploration and development activities will continue in the region into the future.

The Ichthys FPSO and Montara FPSO are approximately 20 km south and approximately 30 km north of the Activity Area respectively.

8 Acceptable Levels of Impact and Risk

The OPGGS(E) Regulations require the titleholder to include an evaluation of all the impacts and risks that determined whether these will be of an 'acceptable' or 'unacceptable' level. To comply with this requirement, Shell has determined acceptable levels of impact to the environmental receptors that may credibly be impacted by the petroleum activities considered within this EP. Shell's process for determining the acceptability of risks and impacts is detailed below.

8.1 Considerations in Developing Defined Acceptable Levels of Impact and Risk

Shell has established defined acceptable levels of impacts and risks for the petroleum activities considered in this EP relating to all the environmental receptors that were identified as being credibly impacted, or at risk of being impacted. The outcomes of the evaluation of environmental impacts and risks were assessed against these defined acceptable levels to determine if the impacts or risks were acceptable. Shell considered these aspects to establish the acceptable levels of impacts and risks:

- Principles of ESD (Section 8.1.1)
- Other requirements (Section 8.1.2)
- Significant impacts[32] to MNES (Section 8.1.2.1)
- Internal context (Section 8.1.3)
- External context (Section 8.1.4).

8.1.1 Principles of ESD

Shell has considered the principles of ESD to define the acceptable levels of impacts and risks, as defined in Section 3A of the EPBC Act. The principles of ESD are summarised as:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The principles of inter-generational equity—the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
- Improved valuation, pricing and incentive mechanisms should be promoted.

8.1.2 Other Relevant Requirements

Shell considered other relevant requirements that apply to define acceptable levels of impacts and risks including:

- Commonwealth Policy (Section 3.1)
- Commonwealth Legislation (Section 3.2)
- Other Legislation (Table 3-4)
- Standards and Guidelines (Section 3.3)
- International Agreements and Conventions (Section 3.4)
- Significant Impacts to MNES (Section 8.1.2.1)
- EPBC Management Publications (Section 3.2.2.1)

[32] Significant impacts refer specifically to the levels of impacts defined in the MNES – Significant Impact Guidelines 1.1 (DoE 2013). Any subsequent reference in this EP to significant impacts refers to these levels unless stated otherwise.

- Protected Areas (Section 7.3.4)

8.1.2.1 Significant Impacts to MNES

This EP forms the basis for NOPSEMA's assessment of matters protected under Part 3 of the EPBC Act in Commonwealth waters. Therefore, Shell has given specific attention to define the acceptability of impacts and risks to MNES. Shell used the criteria listed in Table 8-1—consistent with the MNES – Significant Impact Guidelines 1.1 (DoE 2013)—where a potential interaction was identified between the relevant MNES and an aspect of the Activity.

Potential impacts and risks to MNES from aspects of the Activity were deemed inherently acceptable if:

- the significant impact criteria in relation to the MNES are not anticipated to be exceeded
- the management of the aspect aligns with EPBC management publications from the DCCEEW, including threat abatement plans, recovery plans (RPs) and conservation advice (CA).

Table 8-1: MNES Significant Impact Criteria Applied to the Petroleum Activities Considered in this EP

Category	Significant Impact Criteria
Listed Critically Endangered and Endangered species	An action is likely to have a significant impact on critically endangered or endangered species if there is likelihood that it will: • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • introduce disease that may cause the species to decline, or interfere with the recovery of the species.
Listed Vulnerable Species	An action is likely to have a significant impact on vulnerable species if there is a likelihood that it will: • lead to a long-term decrease in the size of an important population • reduce the area of occupancy of and important population • fragment an existing important population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • introduce disease that may cause the species to decline • interfere substantially with the recovery of the species.
Listed Migratory Species	An action is likely to have a significant impact on migratory species if there is likelihood that it will: • substantially modify, destroy or isolate an area of important habitat for a migratory species • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species • seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

Category	Significant Impact Criteria
Wetlands of International Importance	An action is likely to have a significant impact on a wetland of international importance if there is likelihood that it will result in: • areas of wetland being destroyed or substantially modified • a substantial and measurable change in the hydrological regime of the wetland • the habitat or lifecycle of native species dependent upon the wetland being seriously affected • a substantial and measurable change in the water quality of the wetland which may adversely impact biodiversity, ecological integrity, social amenity or human health • an invasive species that is harmful to the ecological character of the wetland being established in the wetland.
Commonwealth marine area	An action is likely to have a significant impact on the environment in the Commonwealth marine area if there is likelihood that it will: • result in a known or potential pest species becoming established in the Commonwealth marine area • modify, destroy, fragment, isolate or disturb an important or substantial area of habitat that results in an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area • have a substantial adverse effect on a population of a marine species or cetacean including its lifecycle and spatial distribution • result in a substantial change in air quality or water quality, which may adversely impact biodiversity, ecological integrity[33], social amenity or human health • result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity[33], social amenity or human health may be adversely affected • have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

8.1.3 Internal Context

Shell considered internal requirements to define acceptable levels of impacts and risks. The internal context included Shell's environment policy, environmental risk management framework, internal standards, procedures, technical guidance material and opinions of internal stakeholders.

Shell's internal impact and risk assessment defined acceptable levels as:

- Residual planned impacts that are ranked as minor or less (i.e. minor, slight, no effect or positive effect) and residual risks for unplanned events ranked light or dark blue, are inherently 'acceptable', if they meet legislative and Shell requirements and the established acceptable levels of impacts and risks.
- Moderate residual impacts, and yellow and red residual risks, are 'acceptable' with appropriate controls in place and if good industry practice can be demonstrated.
- Major and massive residual impacts from planned activities, and massive residual risks from unplanned events, are 'unacceptable'. The activity (or element of) should not be undertaken as the impact or risk is serious and does not meet the principles of ESD, legal requirements, Shell requirements or regulator and stakeholder expectations. The activity requires further assessment to reduce the risk to an acceptable level.

Table 8-2 summarises the acceptability statements, as correlated to the rankings presented in the environmental impact and risk assessments in Section 8.3.

[33] In the context of the petroleum activity, a change to ecological integrity is considered to take into account broadscale, long-term impacts to the ecosystem. With regards to the Commonwealth marine environment, the Activity Area is located in open offshore waters and the seabed is generally characterised by soft sediments and typical of the region.

Table 8-2: Acceptability Categories

Acceptability Statement	Residual Impact (Planned)	Residual Risk (Unplanned)
Inherently acceptable: Manage for continuous improvement by effectively implementing the HSSE & SP-MS	Positive Impact Consequence No Impact Consequence Slight Impact Consequence Minor Impact Consequence	Light Blue Dark Blue
Acceptable with controls: Apply the hierarchy of control to reduce the risks to ALARP	Moderate Impact Consequence	Yellow Red
Unacceptable	Major Impact Consequence Massive Impact Consequence	Red – X

8.1.4 External Content

Shell considered the external context to establish the acceptable levels of impacts and risks, including information provided by relevant persons during the preparation of this EP and the Crux OPP. Shell routinely implements an ongoing consultation program managed by Shell's Corporate Relations team (see Section 5.8). Reference is made to Section 5 for further information on the stakeholder engagement process and Appendix C summarises the responses and objections/claims made by Relevant Persons.

8.1.5 Indigenous Cultural Features and Values Impact Criteria

A key objective for the relevant persons consultation process is to seek information regarding Indigenous cultural heritage features and values that could potentially be exposed to impacts or risks from Shell's activities. An overview of Indigenous cultural heritage features and values within the Planning Area is also provided in Section 7.4.1 and Section 7.4.2 respectively. Shell used the criteria listed in Table 8-3—consistent with the MNES – Significant Impact Guidelines 1.1 (DoE 2013)—where a potential interaction was identified between the Indigenous cultural heritage feature and an aspect of the Activity to define acceptable levels of impacts and risks. Potential impacts and risks to Indigenous cultural heritage features from aspects of the Activity were deemed inherently acceptable if the significant impact criteria is not anticipated to be exceeded.

Table 8-3:Acceptability Categories for Indigenous Cultural Heritage Features and Values

Category	Significant Impact Criteria
Indigenous Cultural and Social Values	An action is likely to have a significant impact on Indigenous Cultural Heritage Features or values if there is likelihood that it will: Restrict or inhibit the continuing use of a cultural or ceremonial site causing its values to notably diminish over time Permanently diminish the cultural value of a place for an Indigenous group to which its values relate Alter the setting of a place in a manner which is inconsistent with relevant values Remove, destroy, damage or substantially disturb archaeological deposits or cultural artifacts Destroy, damage or permanently obscure cultural or ceremonial, artifacts, features, or objects Notably diminish the value of a place in demonstrating creative or technical achievement

	Permanently remove, destroy, damage or substantially alter Indigenous built structures

8.2 Defined Acceptable Levels of Impact and Risk

Table 8-4 summarises the acceptable levels of impacts and risks to environmental receptors from the petroleum activities considered in this EP.

In accordance with section 56(1) of the Environment Regulations, reference to the Project Area is defined in Section 5.3.1 of the accepted Crux OPP has been made throughout this EP. The Project Area is defined as the in-field development area (30 km radius around the proposed Crux topsides) and export pipeline corridor (1 km buffer either side of the route with a 2 km radius around the Prelude-end) encompassing approximately 314,000 ha. The accepted OPP (NOPSEMA ID: A742335) is available on the NOPSEMA website.

Table 8-4: Summary of Acceptable Levels for Environmental and Socioeconomic Receptors that may be Affected by the Activity

Receptor		Acceptable Level of Impact	Justification
Category	**Subcategory**		
Physical Environment	Water quality	No significant impacts to water quality.	Planned discharges may result in reduced water quality above impact threshold levels within 1 km of the discharge location. The potential magnitude of impacts to water quality is expected to be very low. Given the short duration of discharge activities, offshore location and absence of particularly sensitive marine ecosystems within the Activity Area, potential impacts are considered acceptable.
	Sediment quality	No significant impacts to sediment quality.	Sediment quality within the Activity Area is characteristic of the region. Planned discharges may result in changes to sediment quality above impact threshold levels within 1 km of the discharge location, however, elevated toxicity is considered unlikely to occur and the impact magnitude very low. This level of impact is considered acceptable.
	Air quality	No significant impacts to air quality.	Planned atmospheric emissions from the Activity consist primarily of combustion engine exhaust emissions (e.g. vessel engines and generators etc). These emissions will be in accordance with relevant requirements, such as MARPOL air pollution requirements. The Activity is located in the open ocean and is well-removed from nearest residential or sensitive populations of the WA coast, with limited interaction with regional airsheds.
	Australian environment	No significant impacts to the Australian environment.	Planned GHG emissions from the Activity consist primarily of combustion engine exhaust emissions (e.g. vessel engines and generators etc.). It is important to recognise that potential climate change impacts cannot be directly attributed to a single project. Therefore, there is no direct connection between GHG emissions from the Activity and potential impacts to specific receptors. Impacts to the Australian environment are concluded to be low with a low level of certainty. Shell recognises that Scope 1 emissions must be reduced to ALARP by implementing control measures and achievement of the associated EPO to be acceptable. These emissions will be in accordance with relevant requirements, such as Australian GHG emissions reporting, where required by the *National Greenhouse and Energy Reporting Act 2007* (Cth). GHG emissions attributable to the Activity are not likely to have a significant impact on MNES.

Receptor			Acceptable Level of Impact	Justification
Category	**Subcategory**			
Biological Environment	Habitats and communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	With the exception of banks and shoals, the benthic habitats and communities within the Crux Project Area are widely represented in the Timor Sea, with millions of hectares of broad soft benthic habitats occurring in the region and they are not of high environmental value. Impacts to non-sensitive benthic communities limited to <5% of the Project Area (as defined in the OPP).
		Shoals and banks	No direct impacts to named banks and shoals. No loss of coral communities at named banks or shoals as a result of indirect/offsite impacts[34].	The shoals and banks of the Timor Sea are considered of high environmental value. Shell considers direct impacts to these features unacceptable. No direct impacts to shoals and banks are expected as a result of the Activity.
		Offshore reefs and islands	No impacts to offshore reefs and islands.	Offshore reefs and islands would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision. Oil spill modelling (RPS 2018) predicted a low probability (<6%) of shoreline accumulation above impact exposure thresholds at several offshore islands and reefs, including Bathurst Island and Browse Island. Shell considers any large-scale hydrocarbon spill to be unacceptable.
		WA and NT mainland coastline	No impacts to WA and NT mainland coastline.	The WA and NT mainland coastline would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision. Oil spill modelling (RPS 2018) predicted a very low probability (<3%) of shoreline accumulation above impact exposure thresholds along mainline coastlines. Shell considers any large-scale hydrocarbon spill to be unacceptable.
	KEFs		No significant impacts to environmental values of KEFs.	The export pipeline corridor intersects one KEF—Continental slope demersal fish communities at a water depth of ~200–300 m. This KEF is valued for high diversity of demersal fish assemblages at depths between 225 m and 1,000 m. The pipelay activities in the vicinity of this KEF will likely be limited to a very short duration of 3 days (pipelay vessel travels at ~2-3 km per day) and will disturb <0.05% of the total KEF area. Given the nature and scale of the planned activities, impacts to the KEF will be below the significant impact threshold. Shell considers impacts to KEF below this threshold to be acceptable. Two KEFs—Ashmore Reef and Cartier Islands and surrounding Commonwealth waters, and Seringapatam Reef and Commonwealth waters in the Scott Reef

[34] As defined in the Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE 2013).

Receptor			Acceptable Level of Impact	Justification
Category	Subcategory			
				complex—would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision. Oil spill modelling (RPS 2018) predicted a low probability (<6%) of shoreline accumulation above impact exposure thresholds along mainline coastlines. Shell considers any large-scale hydrocarbon spill to be unacceptable.
	Threatened and migratory species	Marine mammals Marine reptiles Sharks, rays and other fish Birds	No mortality or injury of threatened MNES fauna. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Shell considers any mortality or injury of threatened species that are MNES to be unacceptable. Impacts that are below the significant impact thresholds are considered acceptable. Shell considers significant impacts to MNES to be unacceptable. Impacts that are below the significant impact threshold defined in Table 8-1 are considered as acceptable.
	Protected areas	Commonwealth Marine Area	No significant planned impacts to the Commonwealth marine area.	Planned discharges may result in impacts to water and sediment quality above impact threshold levels, both of which are components of the Commonwealth marine area, within 1 km of discharge locations. Impacts to water and sediment quality are considered acceptable as the potential impacts to the marine ecosystem (functioning and integrity) is very low from a spatial and temporal extent and the nature of the receiving environment due to the open offshore waters, and with seabed characterised to be smooth and bare of hard substrates, with predominantly sandy sediments observed). Impacts beyond this range are unacceptable.
		Marine parks	No impacts to the values of marine parks.	The environmental values within Australian marine parks would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision. In a regional environmental context, the nearest Marine Park is 95 km away. Shell considers any large-scale hydrocarbon spill to be unacceptable.
		Wetlands of international and national importance	No impacts to the ecological values of wetlands of international and national importance.	The environmental values within wetlands of international and national importance would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision. However, these wetlands are very distant and are highly unlikely to be contacted (<2.5%). Shell considers any large-scale hydrocarbon spill to be unacceptable.
		World, Commonwealth or	No impacts to world heritage properties, Commonwealth	No world heritage property value is likely to be impacted. The environmental values within Commonwealth or national heritage places values would only be impacted by a large-scale hydrocarbon spill, such as a vessel collision.

Receptor			Acceptable Level of Impact	Justification
Category	**Subcategory**			
		National heritage listed places	heritage. places or national heritage places values.	However, these places are very distant and are unlikely to be contacted at low thresholds (<9%). Shell considers any large-scale hydrocarbon spill to be unacceptable.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Consistent with the criteria defined by DCCEEW for Indigenous cultural heritage of National Heritage places, Shell does not accept impacts to cultural heritage features. In August 2023, DAC commented that no impacts from a spill to their sea Country are acceptable.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Consistent with the criteria defined by DCCEEW for Indigenous cultural heritage of National Heritage places (see Table 8-3), Shell does not accept significant impacts to cultural values of a place for an Indigenous group to which its values relate. Consistent with the acceptable criteria for the physical and biological environment, Shell recognises that impacts to the environment may also impact cultural values. Shell considers that no significant impact to these values is acceptable. Impacts beyond this range are unacceptable.
	Marine archaeology		No disturbance to historical shipwrecks and sunken aircrafts is acceptable.	Shell considers any disturbance of historical shipwrecks and sunken aircrafts to be unacceptable. No known historical shipwrecks and sunken aircrafts will be impacted due to the Activity. In the event of an IFO spill (worst-case scenario), submerged historical shipwrecks and sunken aircrafts within the Planning Area are unlikely to be impacted as IFO tends to remain on the sea surface rather than entraining into the water column.
	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Shell considers impacts or restricted access to targeted fish stocks that measurably reduces the potential revenue for commercial fishers, charter operators or other benefits provided to traditional fishers (intersects the MoU Box) to be unacceptable. In a regional context, commercial, recreational and traditional fishing is typically concentrated mostly in coastal/shallow waters and minimum fishing effort is known to occur within the Activity Area, given its remoteness offshore. Shell considers the displacement of other users (e.g. commercial, recreational and traditional fishers) from relatively small areas of the open ocean environment in the Activity Area to be acceptable and necessary from a safety and security perspective.

Receptor		Acceptable Level of Impact	Justification
Category	**Subcategory**		
	Tourism and recreation	No negative impacts to nature-based tourism resources resulting in demonstrated loss of income. Temporary displacement of tourism activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of tourism activities from PSZs is acceptable.	Shell considers impacts to nature-based tourism resources that measurably reduces the potential revenue for tourism operators to be unacceptable. In a regional context, there are no known tourist attractions or destinations within the Activity Area or surrounding marine waters, however charter vessels may transit the broader regional waters. Shell considers the displacement of other users (e.g. tourism operators) from the Activity Area, which is a relatively small area of the open ocean environment where existing tourism and recreation use is very low, to be acceptable and necessary from a safety and security perspective.
	Defence	Temporary displacement of defence activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of defence activities from PSZs is acceptable.	Shell considers the displacement of other users (e.g. defence vessels and aircraft) from relatively small areas of the open ocean environment within the Activity Area to be acceptable. In a regional context, there are no designated military/defence exercise areas in the Activity Area, however there are regional defence exercise areas with large geographic extents.
	Ports and commercial shipping	Temporary displacement of commercial shipping within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of commercial shipping from PSZs is acceptable.	Shell considers the displacement of other users (e.g. commercial shipping) from relatively small areas of the open ocean environment in the Activity Area to be acceptable and necessary from a safety and security perspective. In a regional context, the major shipping routes traversing the Activity Area are associated with the Prelude FLNG and Ichthys facilities.
	Oil and gas industry	Temporary displacement of petroleum exploration activities and operations within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of petroleum exploration activities from PSZs is acceptable.	Shell considers the displacement of other users (e.g. petroleum exploration and operations) from relatively small areas of the open ocean environment in the Activity Area to be acceptable. In a regional context, the Prelude FLNG facility is interconnected to the Activity, and outside of Shell operations the nearest operational facility is Ichthys, ~20 km away.
	Indonesian and Timor-Leste coastlines	No impacts to Indonesian and Timor-Leste coastlines are acceptable.	Oil spill modelling predicts that there would be no shoreline contact with Indonesian or Timor-Leste coastlines at low thresholds (RPS 2018). Shell considers any large-scale hydrocarbon spill to be unacceptable.

8.3 Linking Significant Impact Definitions for Values to Matters of National Environmental Significance - Significant Impact Guidelines 1.1

Shell has carried forward relevant content and requirements from the Crux OPP into this EP. One such core approach taken forward is the approach to defined acceptable levels established for the Crux Project in the Crux OPP and associated EPOs established to ensure acceptable levels of impact are not exceeded. An important component of defined acceptable levels, and associated EPOs, is the basis for the definition significant impacts, where the term is used, which is taken from the Matters of National Environmental Significance - Significant impact guidelines 1.1 (DoE 2013).

Table 8-5 below shows, in chronological sequence, a comparison of key content illustrating how it is appropriate to set defined acceptable levels taken from the Matters of National Environmental Significance - Significant impact guidelines 1.1 and then apply this to specific related receptors defined acceptable levels, and then subsequently having associated EPO's which relate back to the defined acceptable levels for the receptors (including use of the term significant impact with EPOs). It is particularly relevant when considering the MNES commonwealth marine environment, which is made up of important resources including water quality, air quality and sediment quality and how defined acceptable levels and EPO's which ensure these are met are applied throughout the EP.

Table 8-5 shows key terms and definitions, in bold, and how they make their way into how Shell clearly defines acceptable levels of impact to water, sediment and air quality, linking to the Matters of National Environmental Significance - Significant impact guidelines 1.1, and how this then appropriately relates to the establishment of EPO's, which use the term 'significant impacts' for these values linking back to defined acceptable levels in relevant aspects of Section 9 of this EP. Noting where the term 'significant impact' is used throughout the EP without a footnote, it is referring to the definition provided in the first row of Table 8-5.This approach assures high levels of protection to MNES for the Crux Project which are measurable and achievable.

Table 8-5: Linking Significant Impact Definitions for Values to Matters of National Environmental Significance - Significant impact guidelines 1.1

Crux OPP content	This EPs content
Significant impacts refer specifically to the levels of impacts defined in the Matters of National Environmental Significance - Significant impact guidelines 1.1 (DoE 2013a). Any subsequent reference in this OPP to significant impacts refers to these levels unless stated otherwise.	**Significant impacts refer specifically to the levels of impacts defined in the MNES – Significant Impact Guidelines 1.1 (DoE 2013). Any subsequent reference in this EP to significant impacts refers to these levels unless stated otherwise**.
MNES Commonwealth marine environment Significant Impact Definition: An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that it will: • Result in a substantial change in **air quality** or **water quality** which may adversely impact on biodiversity, **ecological integrity**, social amenity or human health. • Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals **accumulating in the marine environment** such that biodiversity, **ecological integrity**, social amenity or human health may be adversely affected.	**MNES Commonwealth marine environment Significant Impact Definition**: An action is likely to have a significant impact on the environment in the Commonwealth marine area if there is likelihood that it will: • result in a substantial change in **air quality** or **water quality**, which may adversely impact biodiversity, **ecological integrity**, social amenity or human health • result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, **ecological integrity**, social amenity or human health may be adversely affected
Ecological Integrity Definition: In the context of the Crux project, **a change to ecological integrity is considered to take into account broadscale, long term impacts to the ecosystem**. With regards to the Commonwealth marine environment, the Crux project area is located in open offshore waters and the seabed is generally characterised by smooth predominantly sandy	**Ecological Integrity Definition**: In the context of the petroleum activity, a **change to ecological integrity is considered to take into account broadscale, long-term impacts to the ecosystem**. With regards to the Commonwealth marine environment, the Activity Area is located in open offshore waters and the seabed is generally characterised by soft sediments and typical of the region.

Crux OPP content	This EPs content
sediments and is bare of hard substrates. These characteristics are typical of the offshore Browse Basin.	
Acceptable level for commonwealth marine environment: No significant impacts to the Commonwealth marine area beyond 1 km from the Crux platform or drilling locations. - supporting justification: Discharges at the Crux platform may result in impacts to water and sediment quality, both of which are components of the Commonwealth marine environment, within 1 km of the Crux platform or drilling locations. As outlined above in the Water Quality and Sediment Quality sub-categories, routine impacts to water and sediment quality are expected to be limited to within 1 km and are considered acceptable as the **potential impacts to the marine ecosystem (**functioning **and integrity) is very low when considering the discharge location and the nature of the receiving environment** (open offshore waters, and with seabed characterised to be smooth and bare of hard substrates, with predominantly sandy sediments observed). Impacts beyond this range are unacceptable.	**Acceptable level for commonwealth marine environment**: No significant planned impacts to the Commonwealth marine area. supporting justification: Planned discharges may result in impacts to water and sediment quality above impact threshold levels, both of which are components of the Commonwealth marine area, **within 1 km of discharge locations. Impacts to water and sediment quality are considered acceptable as the potential impacts to the marine ecosystem (**functioning **and integrity) is very low** from a spatial and temporal extent and the nature of the receiving environment due to the open offshore waters, and with seabed characterised to be smooth and bare of hard substrates, with predominantly sandy sediments observed). Impacts beyond this range are unacceptable.
Acceptable level of impact for water quality: No significant impacts to water quality during the Crux project. **Impact magnitude very low.**	**Acceptable level of impact for water quality:** No significant impacts to water quality during the Crux project. **Impact magnitude very low.**
Acceptable level of impact for sediment quality: No significant impacts to sediment quality during the Crux project. **Impact magnitude very low.**	**Acceptable level of impact for sediment quality:** No significant impacts to sediment quality during the Crux project. **Impact magnitude very low.**
Acceptable level of impact for air quality: No significant impacts to air quality during the Crux project. **Limited interaction with regional airsheds.**	Acceptable level of impact for air quality: No significant impacts to air quality during the Crux project. **Limited interaction with regional airsheds.**

9 Evaluation of Environmental Impacts and Risks

9.1 Introduction

This section documents the process for evaluating environmental (including socioeconomic and cultural features and values) impacts and risks and the development of mitigation measures for the petroleum activities described

will be implemented during the Activity.

9.1.1 Risk Assessment Methodology

At a corporate level, Shell has a standardised Hazards and Effects Management Process (HEMP), as the process by which Shell identifies and assesses hazards and implements measures to manage them. This process is consistent with the principles outlined in the Australian Standard AS/NZS ISO 31000:2018 Risk Management and Handbook 203:2012 Managing Environment-Related Risk. The process is summarised in Figure 9-1. The HEMP is a fundamental element of the Shell Group SEAM Standards and is a process that is applied at every phase of projects and operations.

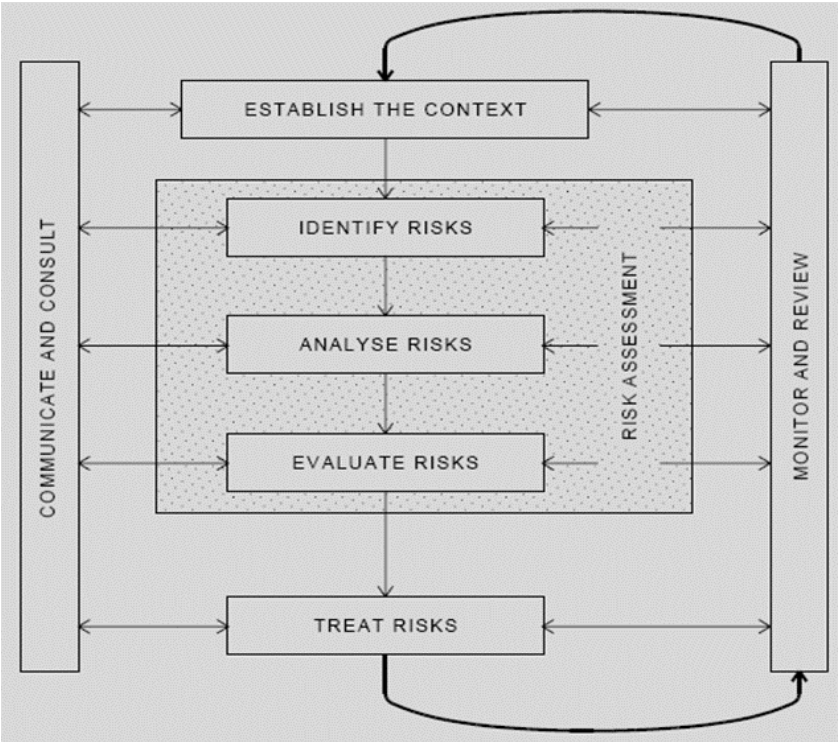


Figure 9-1: Risk Management Framework (AS/NZS 4360:2004 Risk Management)

Shell's HSSE & SP-MS is continually improving because it incorporates:

- new and amended legislative requirements
- changing community expectations
- improved available technology
- ongoing stakeholder engagement
- learnings from incidents industry wide and within Shell
- regular management review.

Shell ensures the HSSE & SP-MS is effective and continuously improving. Each Shell company ensures compliance with new Shell standards through local self-assurance and the ongoing Shell Global auditing process. This process identifies gaps and drives closure of those gaps.

Company standards are often aligned with, but in many cases more stringent than local legislation, global good industry practice benchmarks such as those published by the International Finance Corporation and World

Bank. Both legislation and company standards are continually being updated and require a higher level of performance over time. Concurrently, new technologies are becoming available and making improved performance possible and more affordable. This continual improvement is reflected in more challenging ALARP and acceptability benchmarks, leading to better environmental outcomes over time.

Section 21(5)(b) of the OPGGS(E) Regulations requires that the EP includes 'an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk'. This is further clarified by section 21(6) of the OPGGS(E) Regulations which states that: 'to avoid doubt, the evaluation mentioned in section 21(5)(b) must evaluate all 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.' Based on this, Shell has chosen to present ALARP demonstrations for all identified impacts and risks, regardless of their ranking.

Section 9.2 details the environmental, socioeconomic and cultural impacts and risks of the petroleum activities. Activities are described in terms of magnitude/sensitivity and the ranking of planned impacts and unplanned risks. Management actions proposed to reduce any effect on the environment to ALARP are also described.

Various environment professionals carried out a detailed desktop review of the impact and risks assessments when preparing this EP.

9.2 Impact Assessment Methodology

This Section describes the approach adopted by Shell for identifying and assessing impacts on the environment as relevant to the petroleum activities. Planned activities give rise to environmental impacts, while unplanned and accidental events pose a risk of environmental impact, if they occur. The risk ranking of environmental impacts resulting from unplanned or accidental events is evaluated by identifying the worst-case credible consequence (without controls) and then assessing the likelihood for the event occurring (with confirmed controls in place).

The approach aligns with Shell's methodology that enables a balanced assessment of planned impacts and unplanned risks. The methodology ties potential 'Magnitude' of a predicted impact and the 'Receptor Sensitivity' (see Table 9-4). The matrix is used for assessing impacts and consequences for both planned activities and unplanned events.

Table 9-1 defines the key terminology used in this assessment.

Table 9-1: Definition of Key Terminology for Impact Assessment

Term	Definition
Acceptable	The level of impact and risk to the environment that may be considered broadly acceptable with regard to all relevant considerations.
Activity	Components or elements of work associated with the project. All activities associated with the project have been considered at a broad level (as outlined in Section 6).
ALARP	The point at which the cost (in time, money and effort) of further risk or impact reduction is grossly disproportionate to the risk or impact reduction achieved.
Aspect	Elements of the proponent's activities or products or services that can interact with the environment. These include planned activities and unplanned (e.g. emergency) events.
Control	A measure that prevents and/or mitigates risk by reducing the overall likelihood of a worst-case credible consequence occurring. Controls include existing controls (i.e. company management controls or industry standards) or additional controls (i.e. additional measures identified during the risk assessment processes).
Event	One or more occurrences of a particular set of circumstances; can have several initiating causes.
Factor	Relevant physical, biological, socioeconomic and cultural features of the environment (also referred to as values, sensitivities and/or receptors).
Hazard	A substance, situation, process or activity that can cause harm to the environment.
Impact	Any change to the environment from a planned activity, whether adverse or beneficial, wholly or partially resulting from a proponent's environmental aspects.

Term	Definition
Impact consequence	The outcome of a planned activities or unplanned events, which can lead to a range of worst-case, credible consequences. A consequence can be certain or uncertain and can have positive or negative effects. Consequences can be expressed qualitatively or quantitatively.
Inherent risk	The potential exposure defined as the plausible worst-case event in the absence of controls.
Likelihood	Description of probability or frequency of a consequence occurring with controls in place.
Residual impact	The level of impact remaining after impact treatment, i.e. application of controls (includes unidentified impact).
Residual risk	The level of risk remaining after risk treatment, i.e. application of controls (includes unidentified risk).

9.2.1 Aspects and Impact/Risk Identification

Environmental receptors (including socioeconomic and Indigenous heritage cultural features and values) with the potential to be exposed to an aspect and subsequent impacts or risks were also identified, based on the features, values and sensitivities described in Section 7. This initial identification of aspects and potentially associated impacts/risks is carried out before the relative importance of each issue, the sensitivity of the existing environmental and socioeconomic values, or the magnitude of the potential impact is assessed in detail, and does not take into account potential control measures.

The key aspects arising from the petroleum activities were identified as:

- physical presence (Section 9.3)
- lighting (Section 9.4)
- noise (Section 9.5)
- seabed disturbance (Section 9.6)
- vessel movements (unplanned) (Section 9.7)
- introduction of IMS (unplanned) (Section 9.8)
- discharges of liquid effluent (Section 9.9)
- activity discharges (includes contingency activities) (Section 9.10)
- atmospheric emissions (Section 9.11)
- GHG emissions (Section 9.12)
- unplanned minor releases (unplanned, includes accidental release of solid objects and spills) (Section 9.13)
- emergency events (unplanned, includes vessel collision and bunkering spills) (Section 9.14)
- Oil spill response strategies (Section 9.15).

9.2.2 Evaluation of Impacts

9.2.2.1 Impact Consequence Assessment

The ranking of environmental impact consequence is assessed in terms of:

- magnitude based on the size, extent and duration/frequency of the impact (Section 9.2.2.2)
- sensitivity of the receiving receptors (Section 9.2.2.3).

9.2.2.2 Magnitude

Table 9-2 outlines the levels of magnitude of environmental impacts. The magnitude of an impact or predicted change (as illustrated in Figure 9-2) takes into account:

- nature of the impact and its reversibility
- duration and frequency of an impact
- extent of the change

- potential for cumulative impacts.

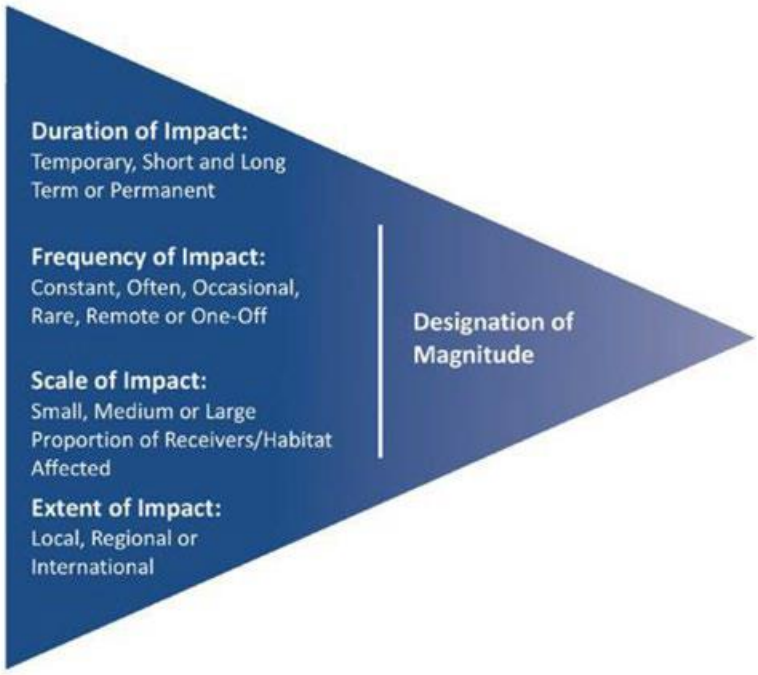


Figure 9-2: Magnitude Considerations in the Context of Impact Identification

Magnitude is defined differently depending on the type of impact—numerals can be used for readily quantifiable impacts (e.g. noise, liquid discharge plume extent), but for others (e.g. communities, habitats) a more qualitative definition applies. The criteria listed in Table 9-2 capture high-level definitions, adapted as appropriate to the offshore context of the Crux Project.

Table 9-2: Magnitude Criteria

Definition	Environmental Impact
Positive effect +1	Net positive effect arising from a proposed aspect of the petroleum activity
No effect 0	No environmental damage or effects
Slight effect -1	Slight environmental damage contained within the Activity Area Effects unlikely to be discernible or measurable No contribution to transboundary or cumulative effects Short-term or localised decrease in the availability or quality of a resource, not effecting usage
Minor effect -2	Minor environmental damage, no lasting effects (or persistent effects are highly localised) Minor change in habitats or species Unlikely to contribute to transboundary or cumulative effects Short-term or localised decrease in the availability or quality of a resource, likely to be noticed by users
Moderate effect -3	Moderate environmental damage that will persist or require cleaning up Widespread change in habitats or species beyond natural variability

	Observed off-site effects or damage (e.g. fish kill, damaged habitats) Decrease in the short-term (1–2 years) availability or quality of a resource affecting usage Local or regional stakeholders' concerns leading to complaints Minor transboundary and cumulative effects
Major effect -4	Severe environmental damage that will require extensive measures to restore beneficial uses of the environment Widespread degradation to the quality or availability of habitats and/or wildlife requiring significant long-term restoration effort Major oil spill over a wide area leading to campaigns and major stakeholders' concerns Transboundary effects or major contribution to cumulative effects Mid-term (2–5 years) decrease in the availability or quality of a resource affecting usage National stakeholders' concern leading to campaigns affecting Shell's reputation
Massive effect -5 (to be used only for unplanned events)	Persistent severe environmental damage resulting in loss of use or loss of natural resources over a wide area Widespread long-term degradation (not readily rectified) to the quality or availability of habitats Major impact on the conservation objectives of internationally/nationally protected sites Major transboundary or cumulative effects Long-term (>5 years) decrease in the availability or quality of a resource affecting usage International public concern

9.2.2.3 Receptor Sensitivity

For this EP, receptors are grouped into these primary categories (described and subcategorised further in Section 7):

- physical environment
- biological environment
- socioeconomic and cultural environment.

Receptor sensitivity criteria are based on these key factors:

- Importance of the receptor at local, national or international level

  For example, a receptor will be of high importance at international level if it is categorised as a designated protected area (e.g. a Ramsar site). Areas that may potentially contain high value habitats are of medium importance if their presence/extent has not yet been confirmed.

- Sensitivity/vulnerability of a receptor and its ability to recovery

  For example, certain species can adapt to changes easily or recover from an impact within a short time. Thus, as part of the receptor sensitivity criteria (Table 9-3), recovery time of a receptor from identified impacts is considered, as well as if the receptor was already under stress.

- Sensitivity of the receptor to certain impacts

For example, vessel emissions will potentially affect air quality but not affect other receptors (e.g. seabed).

Table 9-3: Receptor Sensitivity Criteria

Sensitivity	Environmental Impact
Low (L)	Receptor with *low* value or importance (e.g. habitat or species is abundant and not of conservation significance, exhibits immediate to short-term recovery, and/or easily adapts to change).
Medium (M)	Receptor of *medium* importance (e.g. recognised as an area/species of potential conservation significance, such as KEF or listed threatened species), or Recovery likely within 1–2 years following cessation of activities, or localised medium-term degradation with recovery in 2–5 years.
High (H)	Receptor of *high* importance (e.g. recognised as an area/species of potential conservation significance with development restrictions, such as marine parks or conservation reserves, or habitat critical to the survival of a species), or Recovery not expected for an extended period (>5 years following cessation of activity) or cannot be readily rectified.

9.2.2.4 Impact Consequence Ranking

The magnitude of the impact and sensitivity of receptor are combined to determine the impact consequence ranking (see Table 9-4). Key management controls are then identified to reduce the magnitude of such an event occurring in order to determine the final residual impact ranking.

Table 9-4: Impact Consequence Ranking Matrix

Magnitude	Sensitivity: L	Sensitivity: M	Sensitivity: H
+1			
0			
-1			
-2			
-3			
-4			
-5			

Residual Impact Consequence Ranking	Residual Impact Acceptability Categories
Positive Impact Consequence	Inherently acceptable - Manage for continuous improvement through effective implementation of the HSSE and SP management system
No Impact Consequence	
Slight Impact Consequence	
Minor Impact Consequence	
Moderate Impact Consequence	Acceptable with controls - Apply the hierarchy of control to reduce the risks to ALARP
Major Impact Consequence	Unacceptable
Massive Impact Consequence	

9.2.3 Evaluation of Risks (Addition of Likelihood Criteria)

To determine the risk ranking of unplanned/emergency events, the likelihood of such an event occurring must be assessed along with the impact consequence. For example, based on magnitude and sensitivity alone a hydrocarbon spill associated with a long-term vessel collision would be classed as having a major impact consequence; however, the inherent likelihood of such an event occurring would typically be in the range of unlikely to remote. In addition, the mitigation measures for such impacts focus on reducing the likelihood of the impact occurring not reducing the magnitude of the impact itself. Thus, unplanned events must be assessed in terms of residual risk.

As with planned activities, the potential impacts of unplanned events are identified, and the impact consequence ranking is determined—this takes into account the magnitude of the event and sensitivity of the relevant receptor(s). The impact consequence ranking is then combined with the likelihood of the event

occurring (Table 9-5) to determine the overall environmental risk ranking (using Table 9-6). To determine the residual risk, controls are then identified to reduce the risk of such an event occurring.

Table 9-5: Likelihood Criteria

A	Never heard of in the industry – extremely remote $<10^{-5}$ per year Has never occurred within the industry or similar industry but theoretically possible
B	Heard of in the industry – remote 10^{-5}–10^{-3} per year Similar event has occurred somewhere in the industry or similar industry but not likely to occur with current practices and procedures
C	Has happened in the Shell Group or more than once per year in the industry – unlikely 10^{-3}–10^{-2} per year Event could occur within the lifetime of similar facilities; has occurred at similar facilities
D	Has happened at the location or more than once per year in the Shell Group – possible 10^{-2}–10^{-1} per year Could occur within the lifetime of the development
E	Has happened more than once per year at the location – likely 10^{-1} – >1 per year Event likely to occur more than once at the facility

Table 9-6: Environmental Risk Matrix (Unplanned Events)

Residual Impact Consequence	Likelihood A	Likelihood B	Likelihood C	Likelihood D	Likelihood E
No Impact Consequence					
Slight Impact Consequence					
Minor Impact Consequence					
Moderate Impact Consequence					
Major Impact Consequence					
Massive Impact Consequence			X	X	X

	Residual Risk Acceptability Categories
Light Blue	Inherently Acceptable - Manage for continuous improvement through effective implementation of the HSSE and SP management system
Dark Blue	
Yellow	Acceptable with Controls - Apply the hierarchy of control to reduce the risks to ALARP
Red	
Red - X	Unacceptable

For the petroleum activities, these key risks were assessed using this risk-based approach:

- vessel movements, in the context of unplanned interactions with marine fauna
- introduction of IMS
- unplanned release of wastes
- emergency (spill) events.

9.2.4 Assessment of Residual Impacts and Risks

The risk assessment methodology applied ensured these key steps were completed throughout scenario development:

1. hazards identified

2. initiating causes determined
3. worst-case credible scenarios agreed (without controls in place)
4. release of hazards understood (i.e. top events)
5. preventive controls listed
6. mitigative controls listed
7. likelihood determined (with confirmed controls in place)
8. risk ranking attributed.

When evaluating residual impacts and risks (see Table 9-4 and Table 9-6), Shell assumed all controls were implemented effectively and functioning as intended.

The residual rankings displayed in the summary tables in each subsection represent the highest residual impact or risk (where relevant) for each primary receptor category (i.e. physical environment, biological environment, and socioeconomic values and sensitivities), and therefore are considered a conservative assessment for individual environmental values/sensitivities. These residual rankings were then compared to the acceptability categories outlined in Section 8 to determine a final ALARP and acceptability statement.

Cumulative environmental impacts and risks are also considered and discussed, where relevant, through the impact and risk assessment process and take into account current and foreseeable pressures on the environment (e.g. other petroleum activities, other marine industries and users, other ecosystem pressures).

9.2.5 Acceptability of Impacts

Table 9-7: Acceptability of Impacts – Physical Presence

Receptor		Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**			
Socio-economic and Cultural Environment	Indigenous Cultural Heritage Features	No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that could be credibly impacted by the physical presence of project vessels or the installed infrastructure covered under this EP.
	Indigenous Cultural Heritage Values	No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from physical presence, given that no significant impacts to culturally significant marine species are expected.
	Fishing	No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Yes	Temporary exclusions of other marine users from the Activity Area are considered to be acceptable and necessary from a safety, security and oil spill prevention (collision) perspective. Permanent exclusion of marine users from gazetted PSZs is acceptable.
	Tourism and recreation	No negative impacts to nature-based tourism resources resulting in	Yes	

Receptor		Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory			
		demonstrated loss of income. Temporary displacement of tourism activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of tourism activities from PSZs is acceptable.		
	Defence	Temporary displacement of defence activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of defence activities from PSZs is acceptable.	Yes	
	Ports and commercial shipping	Temporary displacement of commercial shipping within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of commercial shipping from PSZs is acceptable.	Yes	
	Offshore petroleum exploration and operations	Temporary displacement of petroleum exploration activities and operations within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of petroleum exploration activities and operations from PSZs is acceptable.	Yes	

The assessment of impacts from physical presence determined a Minor residual worst-case impact consequence (Table 9-8). As outlined above, the acceptability of the potential impacts from physical presence associated with the Activity has been considered in the following context.

Principles of ESD

The potential impacts from physical presence are consistent with the principles of ESD because:

- The physical presence aspect does not degrade the biological diversity or ecological integrity of the Commonwealth marine area in the northern Browse Basin.
- Significant impacts to MNES will not occur.
- The health, diversity and productivity of the marine environment will be maintained for future generations.
- The project does not significantly impinge upon the rights of other parties to access environmental resources (e.g. commercial and traditional fishers).
- The precautionary principle has been applied, and studies have been undertaken where knowledge gaps were identified. This knowledge was applied when evaluating environmental impacts and risks.

Relevant Requirements

Managing the potential impacts from physical presence is consistent with relevant legislative requirements, including:

- Part 6.6 of the OPGGS Act
- Compliance with international maritime conventions, including:
  - STCW Convention
  - SOLAS Convention
  - COLREGS
- Compliance with Australian legislation and requirements, including:
  - *Navigation Act 2012* (Cth) and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth):
    - Marine Order 21 (Safety of Navigation and Emergency Procedures)
    - Marine Order 27 (Radio Equipment)
    - Marine Order 30 (Prevention of Collisions)
    - Marine Order 71 (Masters and Deck Officers).

Matters of National Environmental Significance

Physical presence will have no impact on MNES.

External Context

To date, no objections or claims about physical presence have been raised by relevant persons. Shell's ongoing consultation program will consider feedback and claims or objections made by Relevant Persons throughout the life of this EP (Section 5.8). Where new impacts or risks are established, these will be subject to the MOC process described in Section 10.1.3.

Internal Context

Shell also considered the internal context, including Shell's environmental policy and Environmental, Social and Health Impact Assessment (ESHIA) requirements. The EPOs and the controls that will be implemented for the Activity are consistent with Shell's internal requirements.

Acceptability Summary

The assessment of impacts and risks from physical presence determined the residual impact rankings were Minor or lower (Table 9-8). Shell considers residual impacts of Minor or lower to be inherently acceptable if they meet legislative and Shell requirements. As outlined above, the acceptability of impacts from physical presence have been considered in the context of:

- the established acceptability criteria for the seabed disturbance aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant person claims)
- internal context (i.e. Shell requirements).

Shell considers the potential impacts from physical presence associated with the Activity to be ALARP and acceptable.

9.2.6 ALARP Assessment

For Shell, ALARP means the point at which the cost (in time, money and effort) of further risk or impact reduction is grossly disproportionate to the risk or impact reduction achieved.

ALARP can be demonstrated using various mechanisms:

- quantitative methods, such as technical assessments (e.g. modelling studies) or where the costs of the various options can be compared with the respective impact/risk reduction
- semi-quantitative methods, where impacts/risks within a certain level require a predefined number of barriers of a certain effectiveness in place to prevent the hazard being realised
- qualitative analysis, where ALARP is established using standards, legislative requirements and judgement based on experience.

Shell applies a hierarchy of control process to demonstrate ALARP, as shown in Figure 9-3.

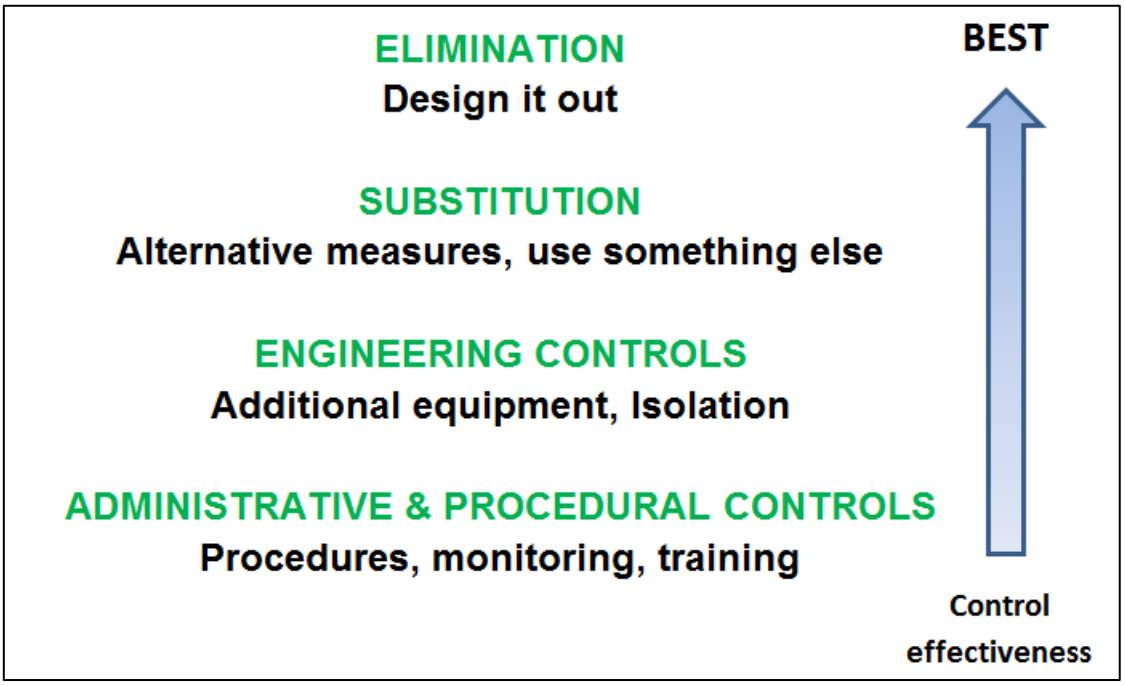


Figure 9-3: Hierarchy of Controls

9.2.7 Environmental Performance Outcomes

Environmental Performance Outcomes (EPOs) have been developed for all aspects of the Activity. The purpose of the EPOs is to provide specific, measurable levels of environmental performance that are:

- consistent with the principles of ESD; and
- demonstrate that the environmental impacts and risks are of an acceptable level.

Note that the consideration of acceptability for each aspect is provided in the relevant **Acceptability** sections in the evaluation of environmental impacts and risks. Consequently, these acceptability considerations are a component of the EPO.

EPOs associated with planned impacts will generally be demonstrated through successful implementation of controls, environmental performance standards and associated measurement criteria. Note that controls may include environmental monitoring programs, however these are not required where there is high confidence in the effectiveness of controls and the potential for environmental impact is low. Where an unplanned event (e.g. accidental discharge) results in the potential for environmental harm, the incident reporting and investigation process will identify if there is the potential for environmental impacts. This process will provide sufficient information to determine if the EPO has been achieved.

9.3 Physical Presence

9.3.1 Aspect Context

Physical presence relates to the Activity (Sections 6.9 to 6.14) and the associated infrastructure. The infrastructure and equipment will be present at the sea surface (e.g. topsides), within the water column (e.g. substructure, umbilicals, risers) or on the seabed (e.g. export pipeline, foundations). Section 6.5 describes the various project vessels and helicopters and Table 6-6 lists the project vessel durations within the Activity Area.

PSZs are a key safety measure to reduce potential interactions between other marine users, some installation activities, and specified wells, infrastructure and equipment. There is an existing PSZ for the Prelude FLNG and a proposed 500 m PSZ that will extend around the substructure drilling template (outside the scope of this EP). These PSZs will prohibit unauthorised marine users from entering throughout the Crux Project life. Outside of the PSZs, there will be temporary displacement from the Activity Area (e.g. within the vicinity of project vessels (e.g. during pipelay activities and IMR activities).

Cumulative impacts have been considered in this assessment for concurrent and proximal activities. The Prelude FLNG activities (covered under the Prelude FLNG EP 2020 [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002] are planned to occur concurrently with the Prelude-end flexible riser and umbilical installation activities (see Section 6.9.6) for a duration of approximately six weeks. The export pipeline installation activities (see Section 6.9.5)—limited to ~5 km of the export pipeline route—will occur in the vicinity of the Prelude FLNG for a duration of approximately three weeks. The two Crux installation activities are unlikely to coincide. These concurrent and proximal activities will result in cumulative impacts to other marine users (e.g. access and movement restrictions) due to additional project vessels (covered under this EP), Prelude FLNG facility PSZ and Prelude FLNG supporting vessels (out of scope for this EP).

The physical presence of long–term and temporary infrastructure, and project vessels has the potential to displace other marine users from the Activity Area, and may affect activities and access to areas associated with fishing, tourism and recreation, defence, commercial shipping and other oil and gas activities within the region.

9.3.2 Description and Evaluation of Impacts

9.3.2.1 Socioeconomic and Cultural Environment

9.3.2.1.1 Indigenous Cultural Features and Values

There are no known Indigenous cultural heritage features or values that could be credibly impacted by the physical presence of vessels or the installed infrastructure (covered under this EP) within the Activity Area. No specific feedback or concerns were raised during consultation for this EP regarding potential impacts on Indigenous cultural heritage features or values from this aspect.

9.3.2.1.2 Fishing

The potential impacts of physical presence include minor interference (navigational hazard), localised displacement/avoidance by commercial fishing vessels, damage or loss of fishing equipment, and loss of commercial fish catches within the immediate vicinity of the infrastructure.

Table 7-25 summarises the fisheries and fishing effort. Three managed fisheries (one Commonwealth and two WA) have the potential for interaction within the Activity Area. However, such interaction is considered unlikely because:

- low fishing effort occurs within the Activity Area
- the area other marine users will have restricted access to is small compared to the area available for their use (Section 7.4.4.3)
- PSZs (outside the scope of this EP) already exist—the fisheries are aware of these locations and avoid these areas.

Some traditional and recreational fishers may traverse the Activity Area but significant disruption to these fishers is considered unlikely, given the typical water depths they operate in, the lack of any geographic features such as shoals, banks or reefs, and the distance offshore (Sections 7.4.4.1 and 7.4.4.2). The seabed within the Activity Area is predominately bare and unconsolidated sediment, which supports relatively low diversity and low abundance fish assemblages compared to more complex habitats (e.g. reefs and shoals). The installed Crux infrastructure will provide a substrate for the attachment of organisms such as sponges and

gorgonians. The resulting habitat will be relatively complex compared to much of the pre-existing habitat and will serve as an artificial reef. Recent survey work on the North West Shelf has highlighted the increased fish species richness and abundance associated with offshore oil and gas infrastructure, and subsea pipelines (Bond et al. 2018; McLean et al. 2017). These studies noted that the fish assemblages associated with pipelines tended to have a relatively high portion of commercially targeted fish species that preferred complex habitats (Bond et al. 2018; McLean et al. 2017). Therefore, it can reasonably be expected that the Crux infrastructure may support an increase in fish diversity and abundance, therefore potentially improving fishing activities, particularly along the export pipeline.

9.3.2.1.3 Tourism and Recreation

No known tourism-based activities occur within the Activity Area (Section 7.4.5), given the typical water depths they operate in, the lack of any geographic or UCH features such as shoals, banks, reefs or shipwrecks, and the distance offshore. Tourism operators may occasionally transit the Activity Area, but disruption to tourism-based activities is expected to be unlikely.

9.3.2.1.4 Defence

No designated defence exercise areas or planned activities occur within the Activity Area (Section 7.4.6). Therefore, no impacts to defence are expected.

9.3.2.1.5 Ports and Commercial Shipping

Shipping activity in the vicinity of the Activity Area is considered high (Section 7.4.7). However, most shipping movements in the Activity Area are associated with the operation of the Prelude FLNG and Ichthys facilities (e.g. offtake tankers, support vessels etc.). Given the distances between the Activity Area and commercial shipping channels, Shell expects minimal navigational impacts to commercial shipping.

9.3.2.1.6 Oil and Gas Industry

The closest permanent petroleum infrastructure (excluding Prelude FLNG) are the Ichthys FPSO and Montara FPSO, approximately 20 km south and approximately 30 km north of the Activity Area respectively (Section 7.4.9). Exploration activities undertaken by other operators in the region within other permit areas is considered possible. No impacts to non–Shell operated oil and gas activities within the region are expected.

The residual impact ranking of physical presence is assessed as Minor (Magnitude: −2, Sensitivity: M).

9.3.2.2 Cumulative Impacts

On the basis that concurrent activities (see Section 9.3.1) will occur, the potential for cumulative impacts is acknowledged. The existing Prelude FLNG PSZ prohibits unauthorised marine users from entering and the Crux activities conducted within the vicinity of the Prelude FLNG PSZ will further restrict other marine user movements. Due to the low activity intensity of fishers and other marine users (excluding Prelude related operations), and the short duration (approximately two months) of concurrent activities, the additive or cumulative effects to marine users can reasonably be expected to be negligible. Therefore, no change to the overall consequence level is expected.

9.3.3 Impact Assessment Summary

Table 9-8 lists the highest impact consequence rating in the relevant environmental receptor group.

Table 9-8: Physical Presence Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	N/A	N/A	N/A
Biological Environment	N/A	N/A	N/A
Socioeconomic and Cultural Values and Sensitivities	−2	M	Minor

9.3.4 ALARP Assessment and Environmental Performance Standards

Table 9-9: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard (EPS)	Measurement Criteria
ALARP Assessment						
Elimination	N/A	N/A	The physical presence of the vessels and infrastructure cannot be eliminated.	N/A	N/A	N/A
Substitution	N/A	N/A	The physical presence of the vessels and infrastructure cannot be substituted.	N/A	N/A	N/A
Engineering	N/A	N/A	No additional engineering control measures have been identified to reduce the impact from physical presence.	N/A	N/A	N/A
Administrative and Procedural Controls	For specific vessel-based campaigns, give advance notice to the AHO before the vessel arrives on location to enable a 'Notice to Mariners' to be issued before petroleum activities occur within the Activity Area.	Yes	Allows notifications to be made to other marine users in the area to minimise disruption to their activities. A 'Notice to Mariners' may be issued by the relevant authority before the petroleum activity. This control is also consistent with the relevant persons consultation outcomes. The benefits outweigh the costs associated with implementing this control and are considered to reduce risks to an acceptable level.	1.1	AHO is notified, at least four weeks prior, to enable a 'Notice to Mariners' to be issued before petroleum activities occur.	Consultation records provide sufficient information to generate 'Notice to Mariners' at least four weeks prior to the relevant petroleum activity.
Administrative and Procedural Controls	Project vessels equipped and crewed in accordance with Australian maritime requirements.	Yes	The project vessels within the Activity Area will adhere to the navigation safety requirements contained within the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), SOLAS Convention, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), the *Navigation Act 2012* (Cth) and any subsequent Marine Orders, which specify standards for crew training and	1.2	Vessels will be equipped and crewed in accordance with the *Navigation Act 2012* (Cth) (as applicable for vessel size, type and class), including implementing: Marine Order 21 (Safety and emergency procedures), including:	Inspection records demonstrate compliance with navigation safety requirements including: A Minimum Safe Manning Certificate is in place and identifies minimum crew qualifications to meet the STCW Convention requirement. Records of vessel crew STCW Convention qualifications align with the Minimum Safe Manning Certificate (as

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard (EPS)	Measurement Criteria
			competency, navigation, communication, and safety measures. Implementing this control is required under the legislative requirements; hence, it must be adopted.		• safety measures such as manning and watchkeeping. Marine Order 27 (Safety of navigation and radio equipment), including: • radio equipment and communications • navigation safety measures and equipment • danger, urgency and distress signals and messages. Marine Order 30 (Prevention of Collisions), including: • lights and signals as applicable to vessel class per COLREGS requirements. Marine Order 71 (Masters and Deck Officers), including: • all master, mate and watchkeeper officer duties undertaken by crew certified as applicable to vessel class per International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW) requirements.	applicable for vessel size, type and class). A Vessel Cargo Ship Safety Equipment Certificate demonstrates the vessel has lights, shapes and means of making sound signals and distress signals in accordance with COLREGS requirements (as applicable for vessel size, type and class). Records of Shell's marine vessel assurance process (as applicable for vessel size, type and class).
Administrative and Procedural Controls	Installed infrastructure locations provided to AHO for inclusion on nautical charts	Yes	Allows infrastructure to be marked on nautical charts so other marine users in the area are aware of its presence and can navigate to avoid interactions. Standard industry practice. The benefits outweigh the costs associated with implementing this	1.3	Australian Hydrographic Service notified of location of installed infrastructure to facilitate inclusion on nautical charts.	Record of communication of installed infrastructure locations to AHO

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard (EPS)	Measurement Criteria
			control and are considered to reduce risks to an acceptable level.			
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity physical presence. No additional or alternative controls were identified. Therefore, the impacts are considered to be reduced to ALARP.						

9.3.5 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No adverse interactions between the Activity and other marine users within the Activity Area. Displacement of other marine users within the Activity Area is restricted to: • temporary displacement within the Activity Area • exclusion from gazetted PSZs.	No supported claims reported that demonstrate direct loss of income or other impacts to marine users as a result of undertaking the Activity.

9.4 Lighting

9.4.1 Aspect Context

Light emissions will occur from project vessels, substructure (including temporary work platforms, scaffolding, drilling rig set-up etc.) and topsides (including platform deck and modules)—to support safe navigation and safe operations. Project vessel lighting will occur on a 24-hour basis for the duration of each work package (excluding preservation period), as described in Section 6 and Table 6-6 lists the vessel durations. The Crux facility and ASV lighting will also occur on an ongoing 24-hour basis after the Crux substructure and topsides are installed.

Cumulative impacts have been considered in this assessment for concurrent and proximal activities. The Prelude FLNG activities (covered under the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002] are planned to occur concurrently with the Prelude flexible riser and umbilical installation activities for approximately six weeks (see Section 6.9.6). The export pipeline installation activities—limited to ~27 km of export pipeline route is the spatial extent of Prelude FLNG light impacts—for approximately eight weeks (see Section 6.9.5). Note that the two Crux installation activities are unlikely to coincide. These concurrent and proximal activities will generate light from the project vessels (covered under this EP) and the operational activities on the Prelude FLNG facility and associated supporting vessels (out of scope for this EP) resulting in cumulative light impacts. The PMCT works occurring on Prelude FLNG will not emit material additional light emissions to that which already occurs from the Prelude FLNG facility (Refer Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002]).

All offshore facilities and vessels must meet maritime and operational safety lighting requirements, as specified by Safety Case assessments under the OPGGS Act and relevant legislation, such as the *Navigation Act 2012* (Cth). Spot lighting may be used as needed (e.g. when deploying or retrieving equipment). ROVs may emit light when underwater. Artificial light from the Activity will result in light spill to the surrounding marine environment. Typically, this lighting is either bright white (i.e. metal halide, halogen, fluorescent) or yellow/red (high-pressure sodium) and is not dissimilar to lighting used for other offshore activities, including fishing and shipping. To the human eye, light falls within the visible range of ~380–780 nanometres, spanning from violet to red in the electromagnetic spectrum. In fauna, light perception ranges from 300–>700 nanometres, depending on the species. Some fauna cannot perceive long-wavelength red light, whereas others can detect light beyond the blue-violet range and into the ultraviolet (UV) spectrum (CoA 2020). Therefore, impact from light sources not only relates to the amount of artificial light, but also the types of light and the wavelengths that the different light types emit.

Imbricata (2018) characterised the sources of light emissions (topsides and project vessels) from the Activity and assessed the predicted impact of light on identified sensitive receptors. The report determined the extent of light spill (line-of-sight modelling) to identify potential receptors and intensity of luminance from the light sources relative to ambient light conditions (light intensity modelling). The results from this modelling report were used to inform the impact assessment.

Line-of-Sight Assessment

The study determined the light from a project vessel (assuming a maximum height of light source at 30 m above sea level) may be visible on the horizon up to 19.6 km. Once installed, the substructure (temporary lighting to support installation activities [Section 6.9]) and the topsides have a maximum height of light source at ~25 m and ~75 m above sea level, respectively. The light from the substructure may be visible on the horizon up to 17.9 km and from topsides may be visible up to 30.9 km. Therefore, light emitted from project vessels within the Activity Area, the substructure and the topsides may be seen from Goeree Shoal, Eugene McDermott Shoal and Vulcan Shoal.

Light Intensity Assessment

Although the line-of-sight may extend tens of kilometres from the source, the light intensity (measured in Lux) rapidly decreases as distance from the light source increases. Table 9-10 summarises the light intensity modelling results (Imbricata 2018). Light intensity represents the intensity of light that arrives at or leaves a surface, as perceived by the human eye. The total amount of light, as it arrives at a surface, is referred to as illuminance and is the parameter that was modelled in this assessment.

The results can be compared with typical ambient light conditions, as summarised below:

- >1 Lux (daylight)
- 0.1–1.0 Lux (full moon to twilight)

- 0.01–0.1 Lux (quarter moon to full moon)
- 0.001–0.01 Lux (moonless clear night to quarter moon).

The results of light intensity modelling show low levels of light influence. The functional lighting from project vessels, substructure and topsides to ambient conditions is predicted to be 9 km (Table 9-10). Therefore, the project vessels' light may reach Goeree Shoal and Eugene McDermott Shoal (~8 km distant from the Activity Area). The lighting from the substructure and topsides are not predicted to reach any key habitat at intensities >0.001 Lux.

Table 9-10: Extent of Horizontal and Vertical Light Propagation at Ambient Light Conditions and Key Habitats within this Range

Location of Light Source	Modelling Analogues (max. luminance at 100 m) (Lux)	Horizontal Light Propagation (km)	Key habitats reached
Project vessels within the Activity Area	8.9	9	Eugene McDermott Shoal and Goeree Shoal
Substructure	8.9	9	None[35]
Topsides	8.9	9	None[35]

Note: Luminance = 0.001 Lux

Source: Imbricata 2018

9.4.2 Description and Evaluation of Impacts

Artificial lighting can create light spill, which has the potential to affect marine fauna that use light as cues for navigation or behaviour. The impacts of artificial light on these animals may include:

- disorientation, misorientation, attraction or repulsion
- disruption to natural behavioural patterns and cycles
- indirect impacts such as increased predation and reduced fitness.

Potential impacts of changes to ambient light are included in several recovery plans and conservation advice, including the Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA 2017b) and the Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a).

The National Light Pollution Guidelines for Wildlife (DCCEEW 2023b) address potential impacts from artificial light to marine turtles, seabirds and migratory shorebirds. These guidelines recommend a specific artificial light impact assessment process is undertaken where important habitat exists within 20 km of a project for listed species that are known to be affected by artificial light. This 20 km threshold provides a precautionary limit and is based on observed effects of sky glow on marine turtle hatchlings (demonstrated to occur at 15–18 km; Kamrowski et al. 2014; Hodge et al. 2007) and fledgling seabirds grounded in response to artificial light 15 km away (Rodríguez et al. 2014). The Activity Area is >20 km from any emergent features and outside known BIAs for turtles, seabirds, and migratory shorebirds; therefore, the precautionary principle has been applied in the assessment of potential impacts of artificial lighting to these sensitive light receptors. The assessment of impacts in the subsections below is supported by the light modelling presented in Imbricata (2018) and other published sources.

9.4.2.1 Biological Environment

9.4.2.1.1 Habitats and Communities

Benthic Communities

No light-generating activities will credibly impact benthic communities as the infrastructure (e.g. Crux substructure and export pipeline) is to be installed in waters exceeding 160 m deep.

Shoals and Banks

Some coral species use moonlight cues to trigger reproductive spawning events; significant light pollution can prevent these corals from detecting moonlight, resulting in their failure to spawn. Light modelling (see Section 9.4.1) predicts that in the outer extent of the Activity Area visible lighting from project vessels may

[35] Closest key habitat to the substructure and topsides is Goree Shoal (>13 km distant).

reach the nearest submergent receptors of Goeree Shoal and Eugene McDermott Shoals above ambient intensity (equivalent to a moonless clear night to quarter moon). However, given the low levels of light reaching these submergent shoals, these shoals are considered unlikely to be impacted. Visible lighting sources from substructure or topsides installation are not predicted to reach any key habitat at ambient intensity (Imbricata 2018). Therefore, no discernible residual impact consequence is expected (Magnitude: 0, Sensitivity: H).

Offshore Reefs and Islands

No light-generating activities will credibly impact offshore reefs and islands because of the distance to these features. The closest receptor (when operating in the Prelude-end vicinity of the Prelude FLNG facility) is Browse Island, ~42 km south-east of the facility. Cartier Island (~80 km from the Activity Area) is the closest receptor when operating within the export pipeline corridor and at the substructure location.

WA and NT Mainland Coastline

No light-generating activities will credibly impact the WA and NT mainland because of the distance to these features—the closest part of the mainland is ~200 km south-east of the Activity Area.

9.4.2.1.2 Key Ecological Features

The Activity Area intersects one KEF—Continental Slope Demersal Fish Communities. The values associated with the KEF are at water depths greater than 225 m (see Section 7.3.2) and hence are unlikely to be impacted by light from the Activity. Based on the assessment of impacts to fish (see below), only a localised range of attraction for fish and invertebrates to lighting from a project vessel is expected, with no discernible residual impact consequence (Magnitude: 0, Sensitivity: L) and lighting is considered unlikely to attract individuals away from any named shoals/banks, offshore reefs/islands or KEFs. Considering a low receptor sensitivity to such impacts, there are no credible residual impacts at a population level.

Other KEFs are too distant to be credibly impacted by Activity lighting.

9.4.2.1.3 Threatened and Migratory Species

An EPBC protected matters search was undertaken for the 20 km Light Assessment Area (refer to Table 7-1), as recommended in the National Light Pollution Guidelines for Wildlife (DCCEEW 2023b). No additional species were identified within the Light Assessment Area compared to the Activity Area (Appendix F.2).

Marine Mammals

Activity lighting has the potential to affect marine fauna by altering use of visual cues for orientation, navigation or other purposes, resulting in behavioural responses that can alter foraging and breeding activity, create competitive advantage to some species and reduce reproductive success and/or survival in others. Cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea, and therefore disturbances to behaviour are unlikely to occur. There is no evidence to suggest that artificial light sources affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly use acoustic senses to survey their environment, rather than visual cues (Simmonds et al. 2004). However, light glow may act as an attractant to light-sensitive prey species (e.g. squid, fish) that may alter predator–prey dynamics, particularly in dolphins. Therefore, a Slight residual impact consequence from lighting on marine mammals is expected (Magnitude: −1, Sensitivity: L).

Marine Reptiles – Turtles

Of the turtle species identified as protected under the EPBC Act (see Table 7-7), only green turtles are known to nest on Cartier Island (~80 km north-west of the Activity Area) and Browse Island (~42 km south-east of the Prelude FLNG facility) (CoA 2017b).

Light can affect the behaviour of adults and hatchling turtles. On nesting beaches, light pollution can alter critical nocturnal behaviours in adult and hatchling turtles (CoA 2020). Research suggests that artificial lighting can disrupt or affect the choice of nesting location by female turtles, particularly light visible on the landward side of nesting beaches (Salmon et al. 1992). Turtle hatchlings leaving nesting beaches are particularly sensitive to artificial lighting because they use celestial cues to orientate (Limpus 2008; Salmon et al. 1992).

Marine turtle hatchlings may use celestial lights as navigational markers during oceanic migrations and are attracted towards bright lights. Hatchlings can become disorientated and trapped within light spill around platforms and vessels, resulting in increased energy expenditure, increased predation and decreased survival rates (Witherington and Martin 1996, CoA 2020). However, as hatchlings swim offshore from their natal beach,

they become less influenced by light cue and rely predominantly on wave motion, currents and the earth's magnetic field (Lohmann and Lohmann 1992).

Extensive light attraction studies have been conducted on turtle hatchlings, including at Barrow Island (Pendoley 2005), ~1,000 km south-west of the Activity Area. These studies demonstrated that hatchlings crawl away from tall, dark horizons (sand dunes and vegetation) towards lower and lighter horizons (the sea and stars), and that artificial lighting can alter this response.

Although artificial lighting from the Activity may be visible up to tens of kilometres away from the project vessels, substructure and topsides (as outlined in the modelling above), the light intensity will be low beyond several hundred metres from the light sources.

No important habitat for listed turtle species that are known to be affected by artificial light occurs within the Light Assessment Area. Important habitats are those areas necessary for an ecologically significant proportion of a listed species to undertake important activities such as foraging, breeding, or dispersal. The closest internesting buffer and nesting BIAs to the Activity Area are at Browse Island (~23 km and ~42 km south-east of the Prelude FLNG facility respectively) (Table 7-8). The closest internesting buffer and nesting BIAs to the Crux field is Cartier Island and Ashmore Reef (~65 km and ~80 km north-west of the Activity Area respectively).

Turtles may transit through the Light Assessment Area, but in the absence of BIAs (e.g. foraging or nesting habitat), turtles are unlikely to be present in significant numbers (Figure 7-16). Turtles in the nearshore or on the turtle nesting beaches of Cartier and Browse Islands are unlikely to be affected by the Activity given the distance. Furthermore, hatchlings will likely be widely dispersed and are not expected to be influenced by light from the Activity.

Given the large distance between the Light Assessment Area and the closest critical habitat for turtles, there is expected to be a Minor residual impact consequence of light spill from the Activity on hatchling and adult turtles (Magnitude: −2, Sensitivity: M).

Marine Reptiles – Sea snakes

Sea snakes must come to the surface to breathe at intervals anywhere between 30 minutes and two hours. Of the three EPBC Act listed threatened species of sea snake that may occur within the Planning Area (*Aipysurus fuscus, Aipysurus foliosquama* and *Aipysurus apraefrontalis*) all are expected to occur in habitats of 0-20m (TSSC 2010a, TSSC 2010b and DCCEEW 2024n) associated with reefs, shoals and banks. The closest islands/reefs that recorded sea snakes are at Ashmore Reef and Cartier Island, ~80 km north-west of the Activity Area. Of the three EPBC Act listed threatened species of sea snake that may occur within the Planning Area, the nearest area where they (or their habitat) may occur is approximately ~8km outside of the Activity Area, where the nearest Shoals occur.

Sea snakes from the Aipysurus genus are not attracted to night lights on vessels (DCCEEW 2024n). The closely related olive sea snake is active for equal periods of time in the daylight and at night (Burns & Heatwole 1998), indicating that the moon cycle and sex are all likely to influence the level of activity (Lynch et al. 2023) more than light.

Although some individual sea snakes may occur in the Activity Area, sea snakes are unlikely to remain in the area due to the water depth and preference habitat (e.g. shallow reefs, shoals and banks) or be attracted by lights on vessels.

Birds

Studies conducted in the North Sea between 1992 and 2002 confirmed that artificial light was the reason that birds were attracted to and accumulated around lit offshore infrastructure (Marquenie et al. 2008) and that lights can attract birds from large catchment areas (Wiese et al. 2001). Birds may be directly attracted by the light source or indirectly—structures in deepwater environments tend to attract marine life at all trophic levels, creating food sources and shelter for birds (Surnam 2002). Negative potential impacts to birds attracted by artificial lighting are limited but include collisions with infrastructure and alteration of normal behaviours (CoA 2020).

When considering line-of-sight with respect to light assessment for birds, the factors that need to be considered include:

- the distance between the light source and the receptor
- the potential elevation of the receptor.

If migratory birds rely on visual cues (e.g. ambient light, moonlight, starlight) to navigate, in addition to their magnetic compass, then artificial light could alter their natural migratory patterns, particularly in the absence of terrestrial landmarks. Light emissions from offshore platforms in the North Sea have been shown to attract migrating birds, with those that migrate during the night especially affected (Verheijen 1985). During other studies conducted in the North Sea (Marquenie et al. 2008), it was noted that birds travelling within a 5 km radius of illuminated offshore platforms may deviate from their intended route and either circle or land on the platform. Beyond this distance, it is assumed that light source strengths were not sufficient to attract birds away from their preferred migration route.

Bird injuries and mortalities from direct collisions with infrastructure are inferred from the literature, the collision rate appears to be related to weather conditions, the cross-sectional area of the obstacle, amount of light and number of birds travelling through an area. Where bird collision incidents have been reported, low visibility weather conditions (cloudy, overcast and foggy nights) have usually been implicated as the major contributing factor; by contrast, few collisions occur on clear nights (Avery 1976; Elkins 1988; Weise et al. 2001). Conditions in the Activity Area are not conducive to significant fog formation. However, most rainfall in the Activity Area is seasonal and associated with the summer monsoon and cyclones in November to April, which does overlap with the peak migratory period for birds (see Section 7.3.3.4).

According to Bamford et al. (2008), 33 species of migratory birds that use the EAAF are regularly present in Australia. Migratory shorebird species are mostly present during the non-breeding period, from as early as August each year to as late as April/May the following year (DoEE 2017b). According to Marquenie et al. (2008), the change in behaviour of migratory birds is expected to be significantly smaller, about two orders of magnitude, than the visibility limit within a 5 km radius from an artificial light source.

No important habitats for listed bird species that are known to be affected by artificial light occur within the Light Assessment Area. Important habitats are those areas necessary for an ecologically significant proportion of a listed species to undertake important activities such as breeding and roosting. The applied 20 km threshold provides a precautionary limit based on observed effects of sky glow on fledgling seabirds grounded in response to artificial light 15 km away (CoA 2020). On this basis, any light generated from within the Light Assessment Area is not predicted to result in any environmental damage or effects given the distance to the nearest sensitive habitats, which are:

- 30 km to known breeding BIA for greater frigatebird and the red-footed booby
- 33 km to known breeding BIA for wedge-tailed shearwaters and lesser frigatebirds
- 40 km to known breeding BIA for tropicbirds.

Although it is possible that small numbers of birds may be attracted to the project vessels, substructure or topsides lighting, impacts from any such attraction are not predicted to be significant at a local population level, based on fauna observations at the adjacent Prelude FLNG facility and the short duration of installation activities. Therefore, it is concluded that under the worst-case conditions, there is expected to be a Minor residual impact consequence (Magnitude: −2, Sensitivity: M).

Other Fish

Fish and zooplankton may be directly or indirectly attracted to lights. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan et al. 2001), with traps drawing catches from up to 90 m (Milicich et al. 1992). Lindquist et al. (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by light fields emanating from platforms.

Marine predators are known to aggregate at the edges of artificial light halos where the concentration of marine organisms attracted to light (and potentially the light intensity) increases the food source for these predatory species. Shaw et al. (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have preyed on concentrations of zooplankton attracted to platforms' light fields. This behaviour could potentially lead to increased predation rates in lit areas compared to unlit areas.

The potential for increased predator activity is considered unlikely to result in a significant impact on plankton or fish populations. The closest known fish aggregation site is Goeree Shoal ~8 km away from the Activity Area. Given the relatively small impact area surrounding the petroleum activities in respect to zooplankton and fish habitat, any potential impacts would be expected to be highly localised and unlikely to have discernible

consequences at the population level. Therefore, it is considered unlikely that artificial lighting will impede or disturb fish aggregation sites.

The attraction of fish and invertebrates to vessel lighting is expected to be localised with no discernible residual impact consequence (Magnitude: 0, Sensitivity: L) and is considered unlikely to attract individuals away from any named shoals/banks, offshore reefs/islands or KEFs. Considering fish have a low receptor sensitivity to such impacts, there are no credible residual impacts at a population level.

Sharks and Rays

A whale shark BIA for foraging intersects the Light Assessment Area, and migration behaviours may occur within this area (Section 7.3.3.3). However, it is expected that whale shark presence near the Activity would be transitory and of short duration. This is consistent with tagging studies of whale shark movements that show continual movement of whale sharks in deeper, open offshore waters (Meekan and Radford 2010). The conservation advice for the whale shark does not identify light emissions as a threat (DoE 2015e).

No other sensitive species of sharks or rays are expected to be impacted by project vessel lighting during the activity due to their highly transient nature, low likelihood of vessel encounter and general limited sensitivity to light (Magnitude: 0, Sensitivity: L).

9.4.2.2 Socioeconomic and Cultural Environment

Light is not expected to impact socioeconomic receptors, including fishing due to the remote location and low socioeconomic activity levels within the Light Assessment Area.

Impacts to fauna from light, including fish and marine species of cultural significance (identified in Sections 7.4.1.2.1 and 7.4.1.2.2), is likely to be limited to localised, temporary behavioural impacts and is unlikely to result in significant impacts to marine species at the individual or population level. For an assessment of potential impacts to marine species that may be of cultural significance, refer to Section 9.4.2.1.3.

No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to socioeconomic receptors or Indigenous cultural heritage features and values from this aspect. The overall impact consequence is considered to be no impact (Magnitude: 0, Sensitivity: L).

9.4.2.3 Cumulative Impacts

Light emissions from the Activity will result in a temporary and transient change to ambient light. The Activity Area is a significant distance from coastal sources of light emissions, and existing anthropogenic lighting in the region is limited to offshore facilities and shipping traffic. The contribution of light emissions from the Activity is predicted to be comparable with existing vessels in the region and is not predicted to result in a notable increase.

On the basis that concurrent and proximal activities (see Section 9.4.1) will occur, the potential for cumulative light impacts is acknowledged. The Prelude FLNG EP and this EP assessed potential light impacts. Light modelling predicted a line-of-sight for turtles is within 9 km of project vessels, 27 km from the Prelude FLNG (51 km during flaring activities, noting flaring is very unlikely to occur during concurrent activities) (Shell 2020). The line of sight for seabirds is 127 km from the Prelude FLNG (151 km during flaring activities) (Shell 2020). The project vessels have lower deck height than the FLNG facility; therefore, the line-of-sight assessment undertaken for the FLNG facility is sufficient for the impact assessment (Shell 2020). In accordance with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023b) sensitive receptors within 20 km of the light source should be considered. There is no important habitat for listed turtle and bird species that are known to be affected by artificial light within 20 km of the Prelude FLNG. Important habitats are those areas necessary for an ecologically significant proportion of a listed species to undertake important activities such as foraging, breeding, roosting or dispersal. The applied 20 km threshold is in alignment and provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings and fledgling seabirds grounded in response demonstrated to occur 15-18 km away (DCCEEW 2023b). Therefore, any light generated from concurrent or proximal activities will not result in any environmental damage or effects given the separation distance from the Prelude FLNG to the nearest sensitive habitats as follows:

- ~23 km to the Green Turtle critical internesting habitat
- ~42 km to Browse Island – Turtle nesting and hatchlings
- ~59 km to the nearest bird breeding BIA.

Notwithstanding the potential overlap of the extent of light effects from concurrent activities, due to the absence of significant feeding, breeding or aggregations of light-sensitive fauna and the very short duration of these concurrent and proximal activities (approximately 3.5 months), additive and cumulative light effects can reasonably be expected to be negligible. Therefore, no changes are warranted to the overall consequence level from cumulative light impacts to the Activity.

9.4.3 Impact Assessment Summary

Table 9-11 lists the highest impact consequence rating in the relevant environmental receptor groups.

Table 9-11: Light Emissions Evaluation of Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	N/A	N/A	N/A
Biological Environment	−2	M	Minor
Socioeconomic and Cultural Environment	0	L	No impact

9.4.4 ALARP Assessment and Environmental Performance Standards

Table 9-12: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard	Measurement Criteria
ALARP Assessment						
Elimination	No lighting and avoidance of night work.	No	No additional or alternative control measures were identified for this impact for the activities, given the requirement for a well-lit work area. Not conducting installation activities at night would require the vessels to remain on standby during the night, either using DP or station keeping using thruster. This would lead to increases in: • Project duration • Project costs • Vessel discharges and emissions. Hence this control is not considered feasible.	N/A	N/A	N/A
Substitution	Use different wavelength lights.	No	Given the low densities of marine turtles and migratory birds and seabirds expected to occur within the Light Assessment Area, and that the lighting impact assessment predicts that any impacts to birds and turtles would be minor, installation of different spectrum lighting is considered disproportionate in both cost and effort in comparison to the negligible environmental benefit gained from adopting this control.	N/A	N/A	N/A
Engineering	Use filtered lighting on the platform topsides facilities LED lights.	No	Whilst LED lights can be filtered, if required, by filtering the light the overall light emitted per bulb is reduced, which results in an increased number of light fittings throughout the facility, increasing energy consumption and waste generation for spent bulbs, as well as the increased cost for purchase and maintenance, which is not in line with the NNM philosophy. Given there are no	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard	Measurement Criteria
			environmental to provide a select wavelength, due to the remote, offshore location away from sensitive areas, filtered lights were not adopted.			
Engineering	Project vessels designed to minimise light spill via: shielding low spill/ directional lighting low-reflective paints directing luminaires inwards onto the project vessels, substructure and topsides and away from the ocean.	No	As a conservative management measure, the project vessels working at night during the activity within the Activity Area will be required to reduce external lighting to the minimum required for safe operations, and where practicable, direct lighting downwards (refer to EPS 2.2). Additionally, the pipelay vessel welding deck will have shielding measures (refer to EPS 2.1). Given the distance to from any known light sensitive BIA and coastlines, the anticipated low densities of marine turtles, migratory birds and seabirds that may transit the Light Assessment Area, and that the lighting impact assessment predicting minor impacts to these light sensitive species, the adoption of EPS 2.1 and EPS 2.2 is considered adequate. Implementing additional light management controls is considered disproportionate in both cost and effort in comparison to the negligible environmental benefit gained from adopting this control.	N/A	N/A	N/A
Engineering	The pipelay vessel will have an enclosed pipe welding deck.	Yes	An enclosed pipe welding deck is effective in preventing light emissions from a highly lit working zone. The adoption of this control measure is justified as it leverages the existing infrastructure on the pipelay vessel, is technically feasible and aligns with safety and environmental best practice.	2.1	The pipelay vessel shall have an enclosed pipe welding deck to shield light emissions.	Pipelay vessel specification records verify an enclosed pipe welding deck present.
Administrative and Procedural controls	Implement light management actions recommended in the National Light Pollution Guidelines for Wildlife	No	Given the distance from the Light Assessment Area to an important habitat, potential activity light emissions are unlikely to prevent sensitive fauna from undertaking	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard	Measurement Criteria
	(DCCEEW 2023b), including: switch off outdoor/deck lights when not in use use existing block-out blinds on portholes and windows that are not necessary for safety or navigation at night manage and report seabird interactions.		critical behaviours such as foraging, reproduction, or dispersal. Given the distance from any known light–sensitive BIA and coastline, the expected low densities of light–sensitive species that may transit the Light Assessment Area, and the lighting assessment predicting minor impacts to these light–sensitive species, the adoption of EPS 2.2 is considered adequate to reduce the potential impacts. Implementing additional light management controls is considered disproportionate in both cost and effort in comparison to the negligible environmental benefit gained from adopting this control.			
Administrative and Procedural controls	Project vessel lighting will be used as required for safe work conditions and navigational purposes.	Yes	Safety and maritime regulations require a well-lit work area to support 24-hour operations and the minor residual consequence associated with impacts. Light spill from unnecessary lighting reduced, even further lowering the likelihood of potential impacts to transiting fauna from project vessel lighting. As a conservative management measure, project vessels working at night within the Activity Area will be required to reduce external lighting to the minimum necessary for safe operations and, where practicable, direct the lighting downwards (refer to EPS 2.2). Lighting is assessed to only provide necessary lighting for safety and navigation during the Activity. Reducing the potential for additional light pollution to the environment, thus reducing the potential impacts to transiting marine fauna to ALARP.	2.2	Vessel navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, Marine Orders 21: Safety of Navigation and Emergency Procedures, *Navigation Act 2012* (Cth) and Chapter 5 of the SOLAS Convention.	Vessel certification confirms compliance with applicable regulations.
				2.3	Light spill to the ocean is avoided where practical.	Contractor vessel light inspection record within a week of mobilisation to site and follow-up inspections every quarter, confirm light spill to ocean is avoided where practicable.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	Environmental Performance Standard	Measurement Criteria
Administrative and Procedural controls	External lighting on the platform topsides minimised through design to that required for navigation, safety of deck operations and security considerations.	Yes	Designing lighting to meet navigation, safety requirements and security requirements is inherent for all offshore facilities. Given this there are no additional cost with adopting this control, even in the absence of sensitive receptors for lighting.	2.4	Lighting limited to that required for safe work/navigation and security requirements.	Contractor vessel light inspection record within a week of mobilisation to site and follow-up inspections every month, where relevant, confirm lighting limited to that required for safe work/navigation and security requirements
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity light emissions. No additional or alternative controls were identified that could further reduce the impacts—beyond negligible environmental benefits if any—without disproportionate effort and cost. Therefore, the impacts are considered to be reduced to ALARP.						

9.4.5 Acceptability of Impacts

Table 9-13: Acceptability of Impacts – Lighting

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Biological Environment	Habitats and Communities	Shoals and banks	No direct impacts to named banks and shoals. No loss of coral communities at named banks or shoals as a result of indirect/offsite[34] impacts.	Yes	Modelling predicted that lighting from project vessels that was above ambient conditions (moonless clear night to quarter moon) may occur at the two closest shoals. Given the low levels of light reaching these submergent shoals and that they are located within the outer extent of light propagation at ambient light conditions, these shoals are unlikely to be impacted.
	Key Ecological Features		No significant impacts to environmental values of KEFs.	Yes	The pipelay activities in the vicinity of this Continental slope demersal fish communities KEF will likely be limited to a very short duration of ~3 days and values associated with the KEF are unlikely to be impacted from lighting.
	Threatened and migratory species	Marine mammals Marine reptiles Sharks, rays and other fish Birds	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	Light from the Activity may attract threatened and migratory birds, which may roost on the structures. Because there are no important bird habitats within 20 km of the Activity Area (20 km is a conservative threshold distance for impacts; Light Assessment Area), light emissions are not expected to result in significant impacts at a population level and residual lighting consequences are expected to be Minor. Light emissions are not anticipated to have a significant impact on marine turtle species given the lack of sensitive habitat within the Light Assessment Area, hence are not inconsistent with the requirements of the relevant recovery plans. Given the location of the activities and short duration of Activity it is expected that the residual consequences on marine reptiles are Minor. Other fish and invertebrates may be attracted to lighting associated with the Activity; however, the lack of fish aggregation sites within the Light Assessment Area means that impacts are unlikely. There is a known whale shark foraging

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
					BIA, but it is considered that there is a negligible risk of impacts to whale sharks that may transit the area and restricted to individuals transiting the area. Given this, there are no predicted significant impacts to threatened or migratory MNES.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that could be credibly impacted by light emissions from the Activity.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from light emissions, given that no significant impacts to culturally significant marine species are expected.
	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Yes	No impacts that could result in demonstrated loss of income is expected to occur.

The assessment of impacts from light emissions determined a Minor residual worst-case impact (Table 9-11). As outlined above, the acceptability of the potential impacts from light emissions associated with the Activity has been considered in the following context.

Principles of ESD

The potential impacts from light emissions are consistent with the principles of ESD because:

- The light emissions aspect does not degrade the biological diversity or ecological integrity of the Commonwealth Marine Area and significant impacts to MNES are not anticipated to occur.
- The precautionary principle has been applied, and studies/reviews were undertaken (Environmental Resources Management 2009; Imbricata 2018) where knowledge gaps were identified. This knowledge was applied when evaluating environmental impacts.

Relevant Requirements

Managing the potential impacts from light emissions is consistent with relevant legislative requirements (Table 9-14), including:

- National Light Pollution Guidelines for Wildlife (DCCEEW 2023b)
- policies, strategies, guidelines, conservation advice, and recovery plans for threatened species.

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation of lighting impacts indicates that no credible significant impacts to threatened and migratory species are predicted to occur from the Activity. Table 9-14 demonstrates alignment between the Activity and management plans, recovery plans and conservation advice.

Commonwealth Marine Area

The lighting impacts from the Activity are predicted to not exceed any of the significant impact criteria for the Commonwealth marine area listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-14: Summary of Alignment of the Potential Impacts from Light Emissions Aspect of the Petroleum Activities with Relevant Requirements for EPBC Threatened Fauna

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory species – Birds	Significant impact criteria for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The evaluation of environmental impacts indicates that any impacts from artificial light emissions on threatened or migratory bird species that may occur are likely to be Minor and would not constitute a significant impact to populations. As such, residual impacts from artificial light associated with the Activity do not exceed any of the significant impact criteria for threatened and migratory bird species, as listed in Table 8-1.
	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a)	Managing the light aspect of the Activity has been aligned to 'Objective 4' of the Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a) by ensuring that anthropogenic disturbance was considered in the assessment processes. Migratory birds were considered as an environmental receptor when evaluating lighting impacts.
	National Light Pollution Guidelines for Wildlife (DCCEEW 2023b)	The National Light Pollution Guidelines for Wildlife (DCCEEW 2023b) identify seabirds and migratory birds likely to be affected by artificial light sources and outlines light management actions. Shell's proposed light management actions and the impact assessment/thresholds are based on the precautionary limits referenced in these guidelines (Section 9.4.2.3).
Threatened and Migratory species – Marine Reptiles	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The evaluation of environmental impacts indicates that any impacts from artificial light emissions on threatened or migratory marine reptiles are Minor and would not constitute a significant impact. As such, residual impacts from artificial light associated with the Activity do not exceed any of the significant impact criteria for threatened and migratory marine reptile species, as listed in Table 8-1.
	Recovery Plan for Marine Turtles 2017–2027 (CoA 2017b)	Light pollution has been identified as a threat in the Recovery Plan for Marine Turtles (CoA 2017b). Nesting females and hatchling turtles are at greatest risk of light impacts; however, the nearest potential nesting habitat is Cartier Island (~80 km from the Activity Area). Potential light-related impacts to turtles on nesting beaches is considered to be slight.

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
		Actions in the Recovery Plan for Marine Turtles (CoA 2017b) relating to the threat of artificial light include: manage artificial light within or adjacent to habitat critical to the survival of marine turtles such that marine turtles are not displaced from these habitats develop and implement best practice light management guidelines for existing and future developments adjacent to marine turtle nesting beaches identify the cumulative impacts on turtles from multiple sources of onshore and offshore light pollution. Because the Activity Area is beyond any BIAs or habitat critical for the survival of marine turtles (e.g. nesting, internesting, foraging areas) and the light modelling and other studies predicted that any impacts to marine turtles would be Minor, the actions listed above are not applicable to the Activity.
	National Light Pollution Guidelines for Wildlife (DCCEEW 2023b)	Marine turtles were identified in the National Light Pollution Guidelines for Wildlife (DCCEEW 2023b) as species that can be affected by artificial light sources. Light emissions management for the Activity considered the light management actions described in the guidelines and based the impact assessment/thresholds on the precautionary limits referenced in the guidelines (Section 9.4.2).
Commonwealth marine area	Significant impact guidelines for the Commonwealth marine environment (Table 8-1)	The evaluation of environmental impacts indicates that the any impacts from light emissions from the Activity are not predicted to exceed the Commonwealth marine environment significant impact criteria, as listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

External Context

To date, no objections or claims about lighting have been raised by relevant persons. Shell's ongoing consultation program will consider feedback and claims or objections made by Relevant Persons throughout the life of this EP (refer to Section 5.8). Where new impacts or risks are established, these will be subject to the MOC process described in Section 10.1.3.

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of impacts and risks from light emissions determined the residual impact ratings were Minor (Table 9-11) given that any visible light (including sky glow) will not displace or disrupt any EPBC Act listed species from important habitat, nor will it prevent these species from being able to undertake critical behaviours such as foraging, reproduction and dispersal. Shell considers Minor residual impacts to be acceptable if they meet legislative and Shell requirements. The acceptability of these impacts was considered in the context of:

- established acceptability criteria for the light emissions aspect
- ESD
- relevant requirements

- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

Shell considers impacts from light emissions associated with the Activity to be ALARP and acceptable.

9.4.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No injury or mortality of listed threatened or migratory MNES species as a result of artificial light emissions from the Activity.	Incident reports demonstrate no mortality of EPBC Act listed threatened or migratory MNES species as a result of artificial light emissions.

9.5 Noise

9.5.1 Aspect Context

There are two types of underwater noise emissions from the Activity:

- impulsive noise: typically discrete, short-duration noises punctuated by periods of low/no noise, characterised by high peak sound pressure levels with relatively rapid rise and decay times
- continuous (e.g. non-impulsive noise): noises that do not have rapid rise and decay times with a typically longer duration (e.g. continuous).

Underwater noise emissions are primarily generated from these sources and activities:

- Impulsive:
  - survey methods
  - acoustic positioning equipment
  - pile driving operations
- Continuous:
  - project vessel operations (including DP thrusters)
  - temporary power generation and equipment operations on the substructure and topsides
  - DTH drilling operations
  - aviation operations
  - ROV operations.

Acoustic modelling assumes static animals; however, the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) combines modelled sound fields with realistic animal movements to predict how animals may be impacted through sound exposure. JASMINE provides a framework for understanding and predicting sound exposure for species of interest and calculating ranges to relevant thresholds. The distribution of distances to the source of animats predicted to be exposed to the sound levels above relevant thresholds were used to calculate the horizontal distance that includes 95% of the animat distances that exceeded a given effect threshold ($ER_{95\%}$) (Connell et al. 2023, Appendix G).

Connell et al. (2023) conducted modelling to assess distances at which underwater sound levels from the Activity (such as installation of the substructure foundation including project vessel, DTH drilling and pile driving operations) reach noise effect thresholds and criteria. The study also provided an acoustic exposure analysis for migrating pygmy blue whales, which describes the modelled predictions of sound levels that individual pygmy blue whales may receive during the activities. Simulations with animats (simulated animals) restricted to the BIA for pygmy blue whales can provide an understanding of how animats will be exposed given the location and environment-specific context where they are most likely to occur. Scenarios in which pygmy blue whales are seeded in an unrestricted manner allowed exposure ranges for effect thresholds to be calculated across the entire Activity Area, including any relevant areas beyond that. These ranges may then be interpreted to determine appropriate buffer zones (such as the noise impact assessment area) for the Activity (refer to Table 7-1 for the definition of the Noise Assessment Area). The unrestricted seeding approach is particularly informative for projects that do not intersect the pygmy blue whale BIA, such as this Activity. The substructure location—where the pile driving and DTH drilling operations will occur—is 120 km away from the closest pygmy blue whale BIA.

9.5.1.1 Sound Terminology

Table 9-15**Error! Reference source not found.** summarises the terminology relevant to the underwater noise impact assessment.

Table 9-15: Sound Terminology

Term	Definition
Auditory injury (AUD INJ)	Damage to the inner ear that can result in destruction of tissue, such as the loss of cochlear neuron synapses or auditory neuropathy. Auditory injury includes, but is not limited to, Permanent Threshold Shift (PTS).

Term	Definition
Peak sound pressure level (PK) or 0-to-peak.	The peak pressure, also called the 0-to-peak pressure, is the range in pressure between zero and the greatest pressure of the signal. It is represented by PK and the unit dB re 1 µPa and summarised as dB PK.
Peak-to-peak sound pressure level (PK-PK)	The peak-to-peak pressure is the range in pressure between the most negative pressure and the most positive pressure of the signal. It is represented by PK-PK and the unit dB re 1 µPa or dB re 1 μPa^2m^2 and summarised as dB PK-PK.
Permanent threshold shift (PTS)	Permanent loss of hearing sensitivity caused by excessive noise exposure.
Received sound levels	The sound level measured at a receiver.
Root mean square (RMS) sound pressure	The root-mean-square pressure is the square root of the average of the square of the pressure of the sound signal over a given duration and if applicable, frequency band. It is commonly represented as sound pressure level (SPL).
Sound Pressure Level (SPL)	The level of the time-mean-square sound pressure in a stated frequency band and time window the units are dB re 1 µPa (equivalent to dB re 1 μPa^2) and summarised as dB SPL.
Sound exposure level (SEL)	A measure of the sound energy that considers both received level and duration of exposure. It is the time integrated squared pressure over a given time interval and if applicable, frequency band. The time interval can be a specific duration (e.g. 24 hours) or from the start to end of an event like an airgun pulse, pile strike etc. For this assessment 24 hours has been used for the time interval (e.g. accumulation period) and is shown as SEL_{24h}. Units are dB re 1 μPa^2s or dB re 1 μPa^2m^2s.
Source sound level	The sound pressure level or sound exposure level measured 1 m from a theoretical point source.
Temporary threshold shift (TTS)	Temporary loss of hearing sensitivity caused by excessive noise exposure.

9.5.1.2 Underwater Noise from Project Vessel Operations

The underwater noise produced by project vessels mainly comes from two continuous sources—propeller and thruster cavitation (when propulsion systems are engaged)—and low noise levels produced by sound transmitting through the hull (e.g. engines, gearing, other mechanical systems). Section 6.5 describes the various project vessels and Table 6-6 lists the project vessels activities and estimated durations.

Table 9-16 summarises modelled source levels for project vessels (construction and support vessels). A vessel's sound signature depends on its size, power output, propulsion system, and the design characteristics of particular systems (e.g. blade shape and size). A vessel produces broadband acoustic energy with most of the energy emitted below a few kilohertz (kHz). Sound from onboard machinery, particularly sound <200 Hz, dominates the sound spectrum before cavitation begins (Connell et al. 2023). Noise levels are highest when project vessels are holding station using thrusters to maintain position.

All project vessels must comply with EPBC Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of colliding with cetaceans (see Section 9.7). Implementing this control may reduce the noise generated by vessels when they are near cetaceans because they will be travelling slower—slower vessel speeds may, depending upon vessel class, reduce underwater noise from machinery noise (main engines) and propeller cavitation (MacGillivray et al. 2019).

Table 9-16: Modelled Broadband Source Levels of Project Vessels (continuous sources)

Source	Frequency	Source Level (dB re 1 μPa^2m^2s)
DLV2000 (construction vessel)	10 Hz to 25 kHz	194.5
AHT 150 MT BP (support vessel)	10 Hz to 25 kHz	191.0
AHT 75 MT BP (support vessel)	10 Hz to 25 kHz	188.0

Cumulative impacts have been considered in this assessment for concurrent and proximal activities (see Section 9.5.2.4). The Prelude FLNG activities (covered under the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002] are planned to occur concurrently with the Prelude flexible riser and umbilical installation activities for a duration of approximately six weeks (see Section 6.9.6). The

export pipeline installation activities (see Section 6.9.5)—limited to ~5 km of the export pipeline route—will occur in the vicinity of the Prelude FLNG for a duration of approximately three weeks. Note that these two Crux installation activities are unlikely to coincide. These concurrent activities will generate noise from the project vessels (covered under this EP) and Prelude FLNG facility (and supporting vessels) resulting in cumulative noise impacts.

9.5.1.3 Underwater Noise from Survey Methods

Section 6.9.1 describes the survey methods. Table 9-17 summarises indicative source levels for survey methods. MBES and SSS systems operate at high-frequency to offer high resolution images of the seabed. They produce short pulses of sound at frequencies in the tens or hundreds of kilohertz. Sound from the high-frequency pulses produced by MBESs are focused within highly directional and narrow beams, which form a fan shape directed at the seabed (Salgado Kent et al. 2016; Jiménez-Arranz et al. 2017). SSSs also produces sound in a focused swathe directed at the seabed. Due to the high frequency of pulses produced by these instruments, sound rapidly attenuates outside the beam (Zykov 2013). Despite relatively high source levels, the operating frequencies of most MBESs and SSSs places the dominant sound energy at frequencies above the principal auditory range of most marine fauna species, although HF and VHF cetaceans that may occur in the Activity Area (e.g. odontocetes) can hear some of the sound energy at the lower end of the operating frequency ranges. SBPs are typically small, low-frequency, high-resolution and shallow-penetrating systems, producing pulses across a range of low frequencies (Jiménez-Arranz et al. 2017).

Sound levels associated with CPT have been measured in waters off WA (Erbe and McPherson 2017). The broadband (20 Hz to 24 kHz) source levels for penetration testing were 151–160 dB re 1 μPa^{2}s SEL at 1 m (equivalent to ~160–170 dB re 1 μPa at 1 m), with received levels reducing to ~141–146 dB re 1 μPa SPL within 20 m from the source (Erbe and McPherson 2017).

The other survey methods (described in Section 6.9.1) are not likely to be audible above the propeller or DP noise from the vessel as it maintains position. Therefore, these noise sources are not considered further in this assessment.

Table 9-17: Typical Source Levels for Survey Methods and Acoustic Positioning (impulsive sources)

Activity		Frequency	Source Level (dB re 1 μPa·1 m)	Reference
Impulsive sound				
Survey methods	MBES	Frequency range 200–400 kHz Operational frequency 300 kHz	~218	MacGillivray et al. 2013
	SSS	Operational frequency 300–675 kHz	~229	Geoscience Australia n.d.; Tritech 2023.
	SBP	Operational frequency range 500 Hz to 16 kHz	~200	MacGillivray et al. 2013
	CPT	20 Hz–24 kHz	~160–170	Erbe and McPherson 2017
Acoustic positioning equipment (LBL/USBL)		Operational frequency 300–600 kHz	~229	Geoscience Australia n.d.; Tritech n.d. MacGillivray et al. 2013

9.5.1.4 Underwater Noise from Acoustic Positioning Equipment

Acoustic positioning equipment may be used to support the accurate and safe positioning of infrastructure (see Section 6.9.2). Acoustic positioning equipment may use Long Baseline (LBL) and/or Ultra Short Baseline (USBL) systems. LBL and USBL positioning equipment uses transponders that are typically fixed to seabed frames (LBL) or subsea equipment (USBL) and recovered once the infrastructure is correctly positioned.

Table 9-17 summarises indicative source levels for acoustic positioning equipment. USBL and transponders typically emit pulses of medium to high frequency sound. The estimated SPL would be 180 to 206 dB re 1 μPa

at 1 m (Jiménez-Arranz et al. 2017). Transmissions are not continuous—they are short 'chirps' that last from 3–40 milliseconds. The frequency of chirps depends on the activity:

- general positioning (duration approximately four hours at a time): about one chirp every five seconds
- precise positioning (duration approximately two hours at a time): about one chirp every second.

Transponders will only be active when infrastructure positioning is required and will not emit any sound when on standby.

9.5.1.5 Underwater Noise from Substructure and Topsides

Once the substructure and topsides have been installed, temporary power generators, equipment, and tools (including cutting tools) may be operated. These noise sources have been determined to have no significant impact and fall within acceptable levels. Therefore, they are not further assessed further in this EP.

9.5.1.6 Underwater Noise from DTH Drilling Operations

The DTH drilling operations is expected to be conducted over a short duration (~30–35 days), where two drill rigs will be used to drill the required primary piles, one at a time, to allow for setting and grouting of the insert piles (Section 6.9.7.3). Connell et al. (2023) adapted the proxy source levels and characterisation for DTH drilling from Guan et al. (2022). DTH drilling is a percussive, rotating drilling technique primarily used for hard rock or cemented horizons within sub-bottom formations. The acoustic energy generated during DTH drilling operations as discussed in Guan et al. (2022) generally occur within the frequency range of 40–500 Hz, with an estimated broadband sound energy level of 170.1 dB re 1 μPa^2m^2s.

9.5.1.7 Underwater Noise from Pile Driving Operations

The pile driving operations is expected to be conducted over a short duration (approximately 19 days). Installing the substructure requires pile driving (16 primary piles; see Section 6.9.7.2). The nature of the soil at the Crux substructure location means that the primary pile is likely to penetrate through most of the soil profile under its own weight (Fugro 2019). The primary piles will be driven further into the seabed, one at a time using a single hydraulic hammer (likely options include the MHU 500T, MHU 800S or IHC 800S). The pile-driving rate is expected to be ~38 strikes per minute, with a target depth of ~120 m.

The specific characteristics of the sounds generated from pile driving depends on the pile and hammer characteristics. The propagation of these sounds depends on several factors, including bottom type, seafloor penetration depth,

, and oceanographic conditions. Impact pile driving produces impulsive, intense broadband sounds that propagate out from the pile driving location. At close range the sounds are characterised by a short rise time to maximum pressure followed by a rapid decrease to minimum pressure.

The broadband sound energy at 10 m for each penetration depth modelled (33.5 m, 68.0 m and 102.5 m respectively) ranged from 190.7 to 193.4 dB re 1 μPa^2s. The maximum sound energy concentrated in the frequency range 100–400 Hz.

The frequency characteristics close to the pile are dominated by relatively broadband signals (~10Hz to >3,000 Hz) whereas further from the activity sound signals are dominated by low-frequency components, generally <1 kHz. Table 9-18 lists the modelled broadband near source levels from the pile driving scenarios.

Table 9-18: Modelled Received Levels of Pile Driving (impulsive source)

Pile type	Hammer	Full penetration depth (m)	Modelled penetration depth (m)	Received Levels at 10 m (dB re 1μPa²)
Primary pile	MHU 500T / MHU 800S*	120	33.5	193.2 / ~194.2
			68.0	193.3 / ~194.3
			102.5	193.4 / 194.4
Primary pile	IHC 800S	120	33.5	190.7
			68.0	190.8
			102.5	191.2

*The MHU 800S potential noise levels have been estimated, using similar parameters to those applied for the IHC 800S and MHU 500T, approximately 0.5–1 dB re 1µPa^2 at 10 m above that modelled for the MHU 500T.

9.5.1.8 Underwater Noise from Aviation Operations

Helicopters, which are used to transfer personnel, may enter the Activity Area for short periods. The main acoustic source associated with helicopters is the impulsive noise from the main rotor. Dominant tones in noise spectra from helicopters are generally <500 Hz (Richardson et al. 1995). The level of underwater sound from helicopters depends on helicopter altitude, aspect and strength of noise emitted, and the receiver depth, water depth and other variables (Richardson et al. 1995).

The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles >13° from the vertical, much of the sound is reflected and does not penetrate the water (Richardson et al. 1995). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. Richardson et al. (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. The maximum received level was 109 dB re 1µPa^{2}s. Due to their short duration and near-surface impacts only, helicopter noise emissions are not considered a credible source of noise impact/risk and are not considered further.

9.5.1.9 Underwater Noise from ROV Operations

ROVs may be deployed from project vessels and would be used for the activities outlined in Table 6-6. Typically, the noise generated from an ROV will have a considerably lower intensity than that from a project vessel.

Underwater sound levels depend on the primary (noisiest) sound source rather than being strictly additive. ROV operations will be undertaken from a vessel and thus are expected to negligibly contribute to the overall noise emissions associated with project vessel operations, as described in Section 9.5.1.1. Noise related to ROV operations is not considered further.

9.5.1.10 Underwater Noise Impact Levels

Marine species with the greatest sensitivity to underwater noise are marine mammals (whales and dolphins), turtles and fish (including larvae). Other species that could be affected by underwater noise include sea snakes, sharks and rays, and invertebrates.

Impacts to marine fauna can be grouped in the decreasing order of effect:

- mortality or potential mortal injury: physical injury that may result in the death of an animal
- impairment:
  - PTS: a permanent reduction in the ability of an animal to perceive sound. Recovery is not expected to occur.
  - Auditory injury: damage to the inner ear that can result in destruction of tissue. Auditory injury may or may not result in PTS.
  - TTS: a temporary reduction in the ability of an animal to perceive sound. Recovery to pre-exposure levels is expected to occur.
  - masking: no change in the ability for an animal to perceive sound, but biologically meaningful sounds may be ‘drowned out’ by anthropogenic noise.
- behavioural impacts: typically short-term behavioural responses such as avoidance, surfacing etc. Behaviour will return to normal following cessation of the anthropogenic noise.

Impact thresholds for the fauna groups were derived from scientific literature and published guidelines, including:

- sound exposure guidelines for fishes and sea turtles (Popper et al. 2014).
- 2018 update to technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (National Marine Fisheries Service [NMFS] 2018) and updated noise exposure criteria and cetacean hearing groupings (Southall et al. 2019).

- sound criteria and thresholds for U.S. Navy acoustic and explosive effects analysis (Finneran et al. 2017).
- 2024 update to technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (National Marine Fisheries Service [NMFS] 2024) including the updated Finneran technical report (Finneran 2024).

Table 9-19 to Table 9-22 summarise the thresholds that could result in PTS, TTS and behavioural disturbance as a result of continuous and impulsive noise sources for cetaceans, sirenians, turtles and fish.

Marine Mammals

The vulnerability of marine mammals to underwater noise is linked to their ability to perceive sound. Marine mammals can be grouped based on similarities in their hearing range. Underwater noise exposure thresholds can then be weighted for each group to emphasise noise frequencies to which a group may be particularly vulnerable. This approach is described in Southall et al. (2007) and has been applied to a range of underwater noise guidelines and impact assessments on cetaceans. Southall et al. (2019) updated the nomenclature to describe three cetacean hearing groups as 'Low-frequency' (LF) (e.g. baleen whales), 'High-frequency' (HF) (e.g. dolphins), 'Very high-frequency' (VHF) (e.g. kogia) as well as a separate group for sirenians (dugongs) to better reflect their hearing sensitivities in marine bioacoustics terms. These groupings, along with updated hearing ranges, have been adopted in the recent update to NMFS technical guidance (NMFS 2024).

Most of the noise associated with the Activity involves continuous noise sources, such as project vessel noise. Pile driving, survey methods and acoustic positioning equipment would involve impulsive noise for intermittent and short durations. Table 9-19 to Table 9-22 summarise the impact thresholds for continuous and impulsive underwater noise. The thresholds are derived primarily from technical guidelines and exposure criteria published by NMFS (2018 and 2024) and Southall et al. (2019).

Table 9-19: Thresholds for PTS, TTS and Behavioural Response Onset for LF, HF, VHF Cetaceans and Sirenians for Impulsive and Continuous Noise

Receptor	Impulsive				Continuous			
	PTS onset: SEL_{24h} (dB re 1 µPa².s)	AUD INJ onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset thresholds: SEL_{24h} (dB re 1 µPa².s)	Behavioural response (dB re 1 µPa)	PTS onset thresholds: SEL_{24h} (dB re 1 µPa².s)	AUD INJ onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset thresholds: SEL_{24h} (dB re 1 µPa².s)	Behavioural response (dB re 1 µPa)
LF cetaceans	183	183	168	160	199	197	177	120
HF cetaceans	185	193	178		198	201	181	
VHF cetaceans	155	159	144		173	181	161	
Sirenians	190	186	171		206	200	180	

Source: NOAA (2018, 2024); Southall et al. 2019

Marine Turtles, Fish and Other Fauna

Table 9-20 summarises the sound exposure guidelines for marine turtles for continuous and impulsive sounds based on Popper et al. (2014) and Finneran et al. (2017). Table 9-21 and Table 9-22 provide similar guidelines for fish. Sharks and rays (including whale sharks) were grouped with fish (no swim bladder) for this assessment of impacts. In accordance with the Conservation advice for the dusky sea snake (*Aipysurus fuscus)*, the dusky sea snake has been grouped with fish with a swim bladder involved with hearing for this assessment of impacts. Notably, the dusky sea snake is proposed by the Conservation advice to be grouped with a subset of fish with a swim bladder involved with hearing that includes oral gulping fish, also known as phystostomous fish. Oral gulping fish have the capacity to gulp or expel air to change the volume of gas in their swim bladder. Being able to expel air in response to loud sounds may reduce the mass of gas and subsequent range of motion of the swim bladder, in turn likely reducing injuries to the swim bladder and surrounding organs (Casper et al 2013).

There is a paucity in knowledge on noise impacts to sea snakes. A study by Chapuis *et. al*. (2019) demonstrated that *Hydrophis stokesii* (stokes' sea snake), are sensitive to low-frequency sounds, and have relatively low sensitivity compared with bony fishes and marine turtles and are likely to have a peak sensitivity

to sound at 60 Hz (163.5 dB re. 1 µPa or 123 dB re. 1 µm s^{-2}). Conversely, the recently released Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n), suggests that the hearing sensitivity for fish with a swim bladder involved with hearing could be used as a proxy for the dusky sea snake. It is noted that reef-dependent sea snakes, such as the dusky sea snake, have little capacity to relocate to avoid noise. The species are generally confined to their habitat of shallow banks and shoals (DCCEEW 2024n).

Although there are reputable published studies indicating the potential for underwater noise to impact invertebrates, currently there is insufficient evidence for setting interim quantitative impact assessment criteria for these species. No published studies or guidelines on the potential invertebrate response to continuous noise sources (e.g. drilling) have been identified. Invertebrates have not been considered in the assessment of risks and impacts from underwater noise based on these grounds.

Table 9-20: Thresholds for PTS, TTS and Behavioural Response Onset in Marine Turtles for Impulsive and Continuous Noise

Receptor	Impulsive			Continuous		
	PTS onset thresholds: SEL_{24h} (dB re 1 µPa²s)	TTS onset thresholds: SEL_{24h} (dB re 1 µPa².s)	Behavioural response (dB re 1 µPa)	PTS onset thresholds: SEL_{24h} (dB re 1 µPa²s)	TTS onset thresholds: SEL_{24h} (dB re 1 µPa²s)	Behavioural response (dB re 1 µPa)
Marine turtles	204	189	166+ 175+	220	200	(N) High (I) Moderate (F) Low#

Source: PTS and TTS thresholds (Finneran et al. 2017), + behavioural disturbance threshold (impulsive) (McCauley et al. 2000), # behavioural response threshold (continuous) (Popper et al. 2014),

Note: The sound units for continuous noise include: relative risk (high, moderate and low) is given for marine turtles 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) (after Popper et al. 2014).

Table 9-21: Thresholds for Impulsive Sounds Applicable to Sharks, Rays, Other Fish and Dusky Sea Snakes

Type of animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	>219 dB SEL_{24h} or >213 dB PK	>216 dB SEL_{24h} or >213 dB PK	>>186 dB SEL_{24h}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	>186 dB SEL_{24h}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection) Dusky Sea Snakes	207 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	186 dB SEL_{24h}	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate

Note: Popper et al. 2014 do not define an accumulation period. For this assessment 24 hours was used based on the independent, expert peer review by Popper (Santos 2018) that concluded that a 24-hour period to assess SELcum and any associated effects is likely to be conservative for assessing the potential effects to fish.

Note: The sound units include relative risk (high, moderate and low) is given for fish (all types) 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) (after Popper et al. 2014).

Table 9-22: Thresholds for Continuous Sounds Applicable to Sharks, Rays, Other Fish and Dusky Sea Snakes

Receptor	Mortality and Potential Mortal Injury	PTS	TTS	Masking	Behaviour
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involving hearing Dusky Sea snakes	(N) Low (I) Low (F) Low	170 dB rms SPL for 48-hours	158 dB rms SPL for 12-hours	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low

Note: The sound units include relative risk (high, moderate and low) is given for fish (all types) 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) (after Popper et al. 2014).

9.5.1.11 Modelling Results vs Threshold Levels

Connell et al. (2023) conducted an underwater noise modelling study for expected noise levels from project vessels, DTH drilling operations and pile driving activities associated with the project (refer to Appendix G).

The modelling identified distances at which underwater sound levels from the activity would reach defined noise effect thresholds and parameters. The modelling incorporated the auditory weighting parameters, exposure function parameters and effect thresholds (PTS, TTS and behavioural) that were current at the time (refer to Table 9-23 and Table 9-24). NMFS (2024) has recently published guidelines that amended the auditory weighting and exposure function parameters based on current state of scientific knowledge regarding the characteristics of sound that have the potential to impact marine mammal hearing sensitivity. Amendments resulted in an increase in the lower and upper frequency ranges compared to modelled parameters (refer to Table 9-23). In addition, the NMFS (2024) guidelines recommend applying a lower weighting function parameter compared to the modelled parameters for all receptors, except sirenians (refer to Table 9-23). While the weighting value for sirenians may suggest a larger impact distance than previously modelled, the existing results are still considered to provide a sufficient representation of the likely scale and intensity of effects to support robust evaluation of potential impacts.

NMFS (2024) guidelines also provide slightly different marine mammal threshold values for auditory injury (which may or may not result in PTS) and TTS than what was used in the modelling (refer to Table 9-24), including:

- HF and VHF cetaceans: higher AUD INJ (compared to PTS) and TTS threshold levels for impulsive and continuous noise.
- Sirenians: slightly lower AUD INJ (compared to PTS) and TTS threshold levels for impulsive and continuous noise.
- LF cetaceans:
  - Slightly lower AUD INJ (compared to PTS) and TTS threshold levels for continuous noise.
  - No change to AUD INJ (compared to PTS) and TTS threshold levels for impulsive noise.

While application of these updated thresholds would slightly increase or decrease the distances at which the impact criteria would be reached for marine mammals from those indicated by the modelling, the modelling is considered to provide a sufficiently representative indication of the likely scale and intensity of effects to support robust evaluation of impacts. Notably, the NMFS technical guidance (NMFS 2024) do not alter the behavioural impact thresholds for marine mammals, or any of the thresholds for other marine fauna groups.

Table 9-23: Marine Mammal Auditory Weighting Function – Modelled Compared to NMFS (2024) Parameters

Receptor	Lower–Frequency Cutoff (kHz) [Modelled parameters]	Lower–Frequency Cutoff (kHz) [NMFS 2024]	Upper–Frequency Cutoff (kHz) [Modelled parameters]	Upper–Frequency Cutoff (kHz) [NMFS 2024]	Weighting Function (dB) [Modelled parameters]	Weighting Function (dB) [NMFS 2024]
LF cetaceans	0.2	0.168	19	26.6	0.13	0.12
HF cetaceans	8.8	1.73	110	129	1.20	0.32
VHF cetaceans	12	5.93	140	186	1.36	0.91
Sirenians	12	5.91	140	37.6	1.36	3.61

Table 9-24: Marine Mammal Thresholds – Modelled Criteria (PTS, TTS) Compared to NMFS (2024) Criteria (Auditory Injury, TTS) for Impulsive and Continuous Noise

Receptor	Impulsive				Continuous			
	Model Threshold		NMFS 2024 threshold		Model Threshold		NMFS 2024 Threshold	
	PTS onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset: SEL_{24h} (dB re 1 µPa².s)	AUD INJ onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset: SEL24h (dB re 1 µPa².s)	PTS onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset: SEL_{24h} (dB re 1 µPa².s)	AUD INJ onset: SEL_{24h} (dB re 1 µPa².s)	TTS onset: SEL_{24h} (dB re 1 µPa².s)
LF cetaceans	183	168	183	168	199	179	197	177
HF cetaceans	185	170	193	178	198	178	201	181
VHF cetaceans	155	140	159	144	173	153	181	161
Sirenians	190	175	186	171	206	186	200	180

Project Vessel Noise

Modelling of underwater noise for project vessel operations (see Section 6.5 for project vessel specifications) included:

- construction vessel, based on the *DLV2000*
- support vessels based on:
  - *Pacific Centurion* (150 MT BP AHT)
  - *Posh Antares* (75 MT BP AHT)

Although the exact vessel specifications or operational scenarios are yet to be determined, the two classes considered allow for similar vessels to be used as surrogates for modelling purposes (Connell et al. 2023).

Four vessel scenarios were modelled:

- 1: DLV2000
- 2: Pacific Centurion
- 3: Posh Antares
- 4: all vessels (*DLV2000* plus four AHTs).

The most conservative scenario (all vessels) was considered in this assessment. Modelling of this combined vessel scenario showed:

- the 24-hour threshold for PTS for LF cetaceans may be met if animals remain within 0.46 km of the activity, based on acoustic modelling results. However, the more accurate exposure modelling predicted this threshold may only be met if animals remain within 10 m of the vessel activity (see Table 9-25)
- the 48-hour threshold for recoverable injury for fish with a swim bladder involved in hearing and dusky sea snakes (Popper et al. 2014) may be reached if the animals remain within 80 m of the activity
- the 12-hour threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014) and dusky sea snakes may be met if the animals remain within 200 m of the activity
- the proposed threshold for fish without a swim bladder is proposed to be Low for any distance to continuous underwater noise (Table 9-22) and as such has not been considered further
- the threshold for marine mammal behavioural response to continuous noise (NOAA 2019) was reached at 43.1 km based on acoustic modelling results; however, the more accurate exposure modelling predicted this threshold would only be met within a maximum distance of 36.80 km from the vessel activity (see Table 9-25).

Table 9-25: Modelled Maximum Horizontal Distances (R_{max}) and 95th Percentile ($ER_{95\%}$) Exposure Ranges for Pygmy Blue Whales from Project Vessels

Modelling Approach	Parameter	PTS[36]	TTS[36]	Behavioural[37]
Acoustic modelling	R_{max}	SEL_{24h}: 0.46 km	SEL_{24h}: 13.00 km	SPL: 43.10 km
Exposure modelling (JASMINE)	$ER_{95\%}$	SEL_{24h}: <0.01 km	SEL_{24h}: 0.19 km	SPL: 36.80 km
	Probability	SEL_{24h}: 30%	SEL_{24h}: 79%	SPL: 93%

DTH Drilling Noise

Based on the thresholds outlined in the tables above and hearing ranges for different fauna, no marine permanent injury criteria were exceeded for the DTH (construction) drilling scenario modelled by Connell et al. (2023) at the platform location. The modelling predicted the behavioural response threshold to marine mammals for continuous noise (NOAA 2019) may be reached at distances of up to 0.94 km, with the potential for TTS within 60 m of the platform.

Pile Driving Noise

Pile driving activities have the potential to result in noise impacts on marine fauna. Final selection of the type of hammer is yet to be undertaken; therefore, modelling was undertaken for operations using two different types and sizes of hammers (IHC 800S and MHU 500T). Additionally, a third hammer has been considered for use, the MHU800S. This hammer is estimated to generate noise emissions similar to that modelled for the MHU 500T, but marginally louder (received levels approximately 0.5–1 dB re 1µPa^2 at 10 m above that modelled for the MHU 500T). Indicatively, this may extend the distance to received levels of behavioural response by low frequency cetaceans by 1.5–2 km.

Modelling of maximum horizontal distances to maximum-over-depth peak pressure level thresholds (PK) based on Southall et al. (2019) (cetaceans) and Popper et al. (2014) (fish) and Finneran et al. (2017) (marine turtles) showed:

- VHF cetaceans: the threshold for PTS may be exceeded at a maximum horizontal distance of 1.3 km (MHU 500T) or 0.76 km (IHC 800S) and the threshold for TTS may be exceeded at a maximum horizontal distance of up to 3.2 km (MHU 500T) or 1.8 km (IHC 800S)

[36] Southall et al. (2019) criteria for marine fauna (frequency weighted SEL_{24h})

[37] SPL (120 dB re 1 µPa) NOAA (2019) recommended unweighted behavioural threshold for marine mammals for non-impulsive noise

- LF cetaceans: the threshold for PTS may be exceeded at 30 m (MHU 500T) and the threshold for PTS was not predicted to be exceeded for IHC 800S hammer operations. The threshold for TTS may be exceeded for at a maximum horizontal distance of up to 230 m (MHU 500T) or 130 m (IHC 800S)
- the threshold for TTS may be exceeded for dugongs (Sirenians) at a maximum horizontal distance of up to 30 m (MHU 500T)
- the threshold for mortality or potential mortal injury (PTS) may be exceeded at 230 m (MHU 500T) or 70 m (IHC 800S) for fish without a swim bladder (including whale sharks).
- the threshold for mortality or potential injury (PTS) may be exceeded at 700 m (MHU 500T) or 290 m (IHC 800S) for fish with a swim bladder and dusky sea snakes.

Potential cumulative exposure was also modelled based on an estimated maximum of 6,516 or 14,576 strikes in a 24-hour period for the IHC 800S and MHU 500T hammers respectively. The third hammer option (MHU800S) is likely to require similar, or lower, maximum strike numbers as compared to the estimates used for the MHU 500T hammer.

Notably, cumulative exposure assumes the receiving animal remains stationary in the area throughout the entire 24-hour period and that the pile is driven at maximum energy for the maximum number of strikes. The stationary animal assumption results in unrealistically effect ranges, as it is considered unlikely that an animal would remain within receiving ranges at which impact criteria may be exceeded for an extended period. Studies relating to fish responses to impulsive sound, such as pile driving, indicate avoidance behaviours at considerable distances (many kilometres) (Popper and Hawkins 2019, Chapuis et al. 2023, Smith and Popper 2023).

Connell et al. (2023) included an acoustic exposure analysis for migrating pygmy blue whales in their study, which describes the modelled predictions of sound levels that individual pygmy blue whales may receive during the Activity.

Sound exposure distribution estimates are determined by moving large numbers of animats through a modelled time-evolving sound field, computed using specialised sound source and sound propagation models. This approach provides the most realistic prediction of the maximum expected SPL, and the temporal accumulation of sound exposure level (SEL_{24h}) for comparison against the relevant thresholds.

JASMINE was used to model the movement of pygmy blue whales through the predicted sound field. Biologically meaningful movement rules were applied to each animat in the model to represent pygmy blue whale behaviours. This included swim speeds, direction, diving and foraging depth, dive depths (for both migratory dives near the surface and deeper exploratory or feeding dives), and time spent at or near the surface before diving again. The exposure modelling used animats to simulate the real-world movements of migrating pygmy blue whales. Animats settings used the closest migratory blue whale BIA to the Activity Area and the LF cetaceans noise effect criteria defined in Table 9-19.

The modelled 95th percentile exposure ranges ($ER_{95\%}$) from the sound source to the relevant noise effect criteria are shown in Table 9-26 (JASCO 2023). For comparison, the horizontal maximum distances (R_{max}) from the acoustic modelling are also shown in Table 9-26. Although the distances predicted to the behavioural threshold are very similar, the $ER_{95\%}$ to PTS and TTS effect criteria are substantially lower than the distances predicted by acoustic modelling. These results are significant when considering other large, mobile marine fauna and potential impacts from underwater noise. For example, the whale shark has a higher threshold for noise exposure: the predicted PTS by Popper et al. (2014): >219 dB SEL_{24} as compared with the pygmy blue whale (LF whales) 183 dB SEL_{24} (Southall et al. 2019) and the threshold levels are based on sound pressure whereas the whale sharks perceive sound via particle motion adding a further level of conservatism.

Whale sharks in the Noise Assessment Area are likely to exhibit migratory behaviours and expected to be highly mobile. Studies of tagged whale sharks have shown that although whale sharks spend most of their time in the upper 10 m of the water column, they also undertake frequent vertical oscillations within the epipelagic zone (Tyminski et al. 2015). As such, their behaviours may be considered to some degree similar to the modelled pygmy blue whale in context of potential sound exposure from pile driving. Therefore, similar to that of the pygmy blue whale, the maximum distance to potential impacts to whale sharks are likely to be substantially lower than the distances predicted by the acoustic modelling.

Table 9-26: Modelled Maximum Horizontal Distances (R_{max}) and 95th Percentile ($ER_{95\%}$) Exposure Ranges for Pygmy Blue Whales from Pile Driving Operations

Modelling approach	Parameter	PTS[38]	TTS[39]	Behavioural[40]
Acoustic modelling	R_{max}	SEL_{24h}: 35.6 km	SEL_{24h}: 98.1 km	SPL: 21.6 km
Exposure modelling (JASMINE)	$ER_{95\%}$	SEL_{24h}: 19.8 km	SEL_{24h}: 56.4 km	SPL: 18 km
	Probability	SEL_{24h}: 75%	SEL_{24h}: 58%	SPL: 72%

Modelling of potential exposures, using the daily exposure criterion (Table 9-26 and Table 9-27) showed:

- Acoustic modelling predicted the threshold for PTS may be exceeded for LF cetaceans at a maximum over-depth distance of up to 35.6 km (MHU 500T) or 19.1 km (IHC 800S) if the animal remained within that distance over 24 hours. Animat exposure modelling predicted a maximum distance of 19.8 km with a 75% probability for an animal to be exposed to this threshold within that distance (MHU 500T). Modelling for the IHC 800S hammer predicted a maximum over-depth distance of 9.1 km with a 73% probability for an animal to be exposed to the threshold level within that distance.
- Acoustic modelling predicted the threshold for TTS may be exceeded for LF cetaceans at a maximum over-depth distance of up to 98.1 km (MHU 500T) or 61.1 km (IHC 800S) if the animal remained within that distance over 24 hours. Animat exposure modelling predicted a maximum distance of 56.4 km with a 58% probability for an animal to be exposed to this threshold level within that distance.
- Acoustic modelling predicted behavioural threshold levels for LF cetaceans to be met up to 21.6 km from the pile driving operations, whereas the animat exposure modelling predicted a distance of up to 18 km with a 72% probability for an animal to be exposed to this threshold level within this distance.
- The threshold for PTS may be exceeded for HF cetaceans at a maximum over-depth distance of up to 120 m when using the MHU 500T hammer. The threshold for TTS may be exceeded at a maximum over-depth distance of up to 2.3 km (MHU 500T) or 130 m (IHC 800S).
- The threshold for PTS may be exceeded for VHF cetaceans at a maximum over-depth distance of 6.4 km (MHU500T) or 1.2 km (IHC 800S). The threshold for TTS may be exceeded at a maximum over-depth distance of up to 21.6 or 6.46 km (IHC 800S).
- The threshold for PTS may be exceeded for dugong (Sirenia) at a maximum over-depth distance of up to 0.13 km (MHU500T) and TTS may be exceeded at a maximum distance of up to 2.4 km (MHU 500T) or 0.15 km (IHC 800S).
- The threshold for PTS may be exceeded for marine turtles at a maximum over-depth distance of up to 4.92 km (MHU 500T) or 2.24 km (IHC 800S). The threshold for TTS may be exceeded at a maximum over-depth distance of up to 26.2 km (MHU 500T) or 16.6 km (IHC 800S).
- The threshold for mortality or potential mortal injury may be reached at a maximum over-depth distance of up to 700 m (MHU 500T) or 210 m (IHC 800S) for fish without a swim bladder (including whale sharks).
- The threshold for mortality or potential mortal injury may be reached at a maximum over-depth distance of up to 2.37 km (MHU 500T) or 1.15 km (IHC 800S) for fish with a swim bladder not involved with hearing.
- The range for onset of recoverable injury for fish (without a swim bladder involved in hearing) may be exceeded at a maximum over-depth distance of up to 780 m (MHU 500T) or 260 m (IHC 800S). The range for recoverable injury for fish with a swim bladder and fish eggs may be reached at a maximum over-depth distance of up to 6.4 km (MHU 500T) or 2.55 km (IHC 800S).

[38] LF-weighted SEL_{24h} (183 dB re 1 µ Pa^2s) (Southall et al. 2019)
[39] LF-weighted SEL_{24h} (168 dB re 1 µ Pa^2s) (Southall et al. 2019)
[40] SPL (160 dB re 1 µPa) (NOAA 2019)

- The threshold for TTS in fish, and dusky sea snakes[41], may be reached at a maximum over-depth distance of up to 35.1 km (MHU500S) or 23.5 km (IHC800S) assuming continuous, peak noise exposure over a period of 24 hours.

The MHU 800S is anticipated to generate comparable exposure ranges, probably leaning towards the lower estimates due to the presumption of fewer strikes required per 24 hours. Based on the modelled outcomes, a noise impact assessment area of 56.4 km around the Crux installation location was applied for the pile driving operations as a conservative approach.

Table 9-27: Cumulative Exposure Scenario with Maximum Distances to Frequency Weighted SEL_{24h} Thresholds

Hearing group	SEL_{24} threshold criteria	Project Vessels (km)	DTH Drilling (km)	Pile Driving (km)
	Impulsive / Continuous			MHU 500T / IHC 800S (animat exposure modelling)
PTS				
LF cetaceans	183 / 199	0.46	-	35.6 / 19.1 (19.8)
HF cetaceans	185 / 198	0.06	-	0.12 / -
VHF cetaceans	155 / 173	0.31	-	6.40 / 1.20
Sirenians	190 / 206	0.06	-	0.13 / -
Turtles	204 / 220	0.06	-	4.92 / 2.24
Sharks, rays, dusky sea snakes and other fish	207[42] / Low[43]	-	-	3.47 / 1.38
TTS				
LF cetaceans	168 / 179	13.0	0.06	98.1 / 61.1 (56.4)
HF cetaceans	170 / 178	0.27	-	2.3 / 0.13
VHF cetaceans	140 / 153	3.20	0.03	21.60 / 6.46
Sirenians	175 / 186	0.25	-	2.40 / 0.15
Turtles	189	0.39	-	26.2 / 16.6
Sharks, rays, dusky sea snakes and other fish	186[44] / 158[45]	0.20	-	35.1 / 23.5

A dash indicates the threshold was not reached within the limits of the modelling resolution of 20 m (Connell et al. 2023).

9.5.2 Description and Evaluation of Impacts

The Crux substructure and export pipeline is to be installed in waters exceeding 160 m deep. Fauna that may be present within the Activity Area will mainly comprise pelagic and demersal fish species, with migratory species (including cetaceans, dugongs, turtles and whale sharks) transiting the area seasonally.

An EPBC protected matters search was undertaken for the Noise Assessment Area—defined as 20 km around the Activity Area with an additional 56.4 km radius surrounding the proposed substructure location (refer to Table 7-1 for justification). Two additional migratory—Australian snubfin and Australian humpback dolphins—and no additional threatened EPBC Act listed species were identified within the Noise Assessment Area compared to the Activity Area (Appendix F). One additional BIA—white–tailed tropicbird—was identified within the Noise Assessment Area compared to the Activity Area. Within the Noise Assessment Area there are five bird BIAs (Table 7-12) and a whale shark BIA, which broadly follows the 200 m isobath (Figure 7-17).

[41] Consistent with the Conservation advice for the dusky sea snake (DCCEEW 2024n).

[42] 24-hour threshold for fish with swim bladder involved in hearing (most conservative level as compared to other PTS threshold for sharks, rays and other fish)

[43] Relative risk within tens of metres from the source for fish, fish eggs and larvae (Popper et al. 2014)

[44] Cumulative impact threshold for pile driving for fish with a swim bladder involved in hearing (Popper et al. 2014)

[45] 12-hour threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014)

Whale sharks are expected to be seasonally present, mainly from July to November, transiting through the Activity Area as part of their broad migratory movement.

9.5.2.1 Physical Environment

There are no noise impacts on the physical environment protected under the EPBC Act such as air or water quality. Noise impacts are limited to the biological environment as discussed below.

9.5.2.2 Biological Environment

9.5.2.2.1 Habitats and Communities

Benthic Communities

Benthic habitat surveys in the Activity Area indicated a very low abundance of macrobenthic fauna (Fugro 2017a; AECOM 2017). It is considered that, while the latter study was more of a general characterisation study and may not have provided an extensive and statistically robust dataset for future impact assessment comparison, it was sufficient to provide an adequate characterisation of the typical benthic communities present to conclude that the modelled noise levels would not pose a risk of significant impacts upon them.

Three shoals— Eugene McDermott, Goeree and Vulcan—and no known offshore islands are within the Noise Assessment Area. These shoals may potentially be exposed to short-term increases in underwater noise levels during pile driving operations. However, based on the predicted noise attenuation away from noise sources within the Activity Area, as demonstrated by modelling (JASCO 2023), and the relatively short duration of pile driving operations (~19 days), there is no credible potential for impacts to benthic communities at these shoals as a result of the Activity.

Pelagic Communities

Pelagic communities in the Noise Assessment Area include planktonic communities and pelagic fish and invertebrates.

Planktonic communities have a diverse range of taxa, which will differ in their potential to be impacted by underwater noise. Many species of pelagic and demersal fish have a planktonic larval stage. Modelling studies by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) indicate that planktonic communities are highly dynamic and have the potential to recover rapidly following disturbance (Richardson et al. 2017). Experiments have shown mixed results of larval stages to underwater noise. For example, experiments on several species of fish larvae and lobster larvae did not detect significant effects as a result of high-intensity impulsive noise (Bolle et al. 2012; Day et al. 2016; Payne et al. 2009).

Therefore, potential impacts to planktonic communities would be localised and of a relatively short duration during the Activity. The residual impact consequence to planktonic communities is considered to be Slight (Magnitude: −1, Sensitivity: L).

An assessment of the underwater noise generated by pile driving and project vessel operations planned in the Activity Area predicted that exposure criteria for fish, fish eggs and larvae may be exceeded for these activities. Impacts from DTH drilling activities are not predicted to exceed any relevant criteria for fish, fish eggs and larvae and therefore are not considered credible risks. The potential for injury or TTS effects to fish resulting from single impulse or accumulated exposures to SBP, MBES and SSS sound is limited to within 1–2 m beneath or to the side of the sound source (Zykov 2013; McPherson and Wood 2017). Single impulse exposures at this range are highly unlikely to occur and accumulated exposures over several hours at this range are not credible. Therefore, potential impacts to fish are considered likely to be limited to localised and temporary behavioural changes. The criteria suggested by Popper et al. (2014) in Table 9-21 are based on exploration seismic surveys, and thus are highly conservative for the proposed low-energy survey equipment.

The modelling of maximum-over depth peak pressure (PK) from the pile driving activity predicted a potential exceedance of the threshold for mortality and potential injury to fish with a swim bladder, fish eggs and larvae within 700 m (MHU 500T hammer) or 290 m (IHC 800S hammer) of the substructure location.

The worst-case modelled—combined project vessel operations scenario (*DLV2000* and three AHTs in simultaneous operations)—showed that the 12-hour threshold criteria for recoverable injury for fish with a swim bladder involved in hearing may be reached if the fish remain within 200 m of the vessel operations. The 48-hour threshold for recoverable injury for fish with a swim bladder involved in hearing may be met within 80 m of the vessel operations. The noise modelling predicted that exceedance of PTS thresholds would not occur for any category of fish within the Noise Assessment Area as a result of vessel operations.

Modelling of cumulative exposure during pile driving operations predicts the PTS threshold for fish (with a swim bladder not involved in hearing), fish eggs and larvae could occur if an individual remained within 2.37 km of the pile location throughout the 24-hour period. The same criteria may be exceeded up to 3.47 km from the pile driving operations for fish with a swim bladder involved with hearing, if the individual remains within the relevant distance from the pile throughout a 24-hour period of continuous pile driving operations. Notably, the pile driving activity is anticipated to occur over periods of up to approximately 6 hrs per pile with approximately one pile installation per day.

Recoverable injury of fish (with a swim bladder) could occur within 6.4 km.

The acoustic modelling of cumulative exposure criteria for fish without a swim bladder (including sharks and rays) predicted a potential for mortal injury if the animal remained within less than 700 m of the pile driving operations for a 24-hour period while exposed to continuous operation of the pile driving activity. The potential for recoverable injury was identified for fish (without a swim bladder) that remain within a distance of less than 780 m over a 24-hour period while exposed to continuous pile driving activity. It is predicted from modelling that TTS could occur for fish if exposed continuously over 24-hours within 35.1 km of the pile driving location. However, given the highly mobile nature of most sharks (including whale sharks) and rays, exposure over a 24-hour period within these ranges is considered unlikely.

The Noise Assessment Area is not expected to host highly abundant or diverse assemblages of fish, sharks or rays (Note: Potential impacts to whale sharks from underwater noise are addressed further in Section 9.5.2.2.3 in the assessment of impacts to threatened and migratory species).

Continuous and impulsive noise sources from the Activity are assessed to have a Minor residual impact consequence (Magnitude: −2, Sensitivity: L) on resident and transient fish populations, given the relatively short duration of the activity and lack of habitat supporting diverse fish assemblages in the vicinity of the Activity Area.

9.5.2.2.2 Key Ecological Features

Two KEFs occurs within the Noise Assessment Area. The Continental slope demersal fish communities KEF covers a vast area (~33,182 km^2) and intersects 7 km of the export pipeline corridor. This KEF is outside the pile driving operations Noise Assessment Area. The KEF has a high diversity of demersal fish assemblages featuring >500 fish species. The Ancient coastline at 125 m depth contour KEF covers ~16,190 km^2 and intersects the pile driving operations Noise Assessment Area. This KEF provides areas of hard substrate along the 125 m depth contour in an area that is dominated by soft sediments, hence has a higher species diversity and richness.

Based on the pelagic communities assessment, there is considered to be no potential for permanent, temporary or behavioural impact to demersal fish, and moderate potential for masking fish choruses only over the short duration of export pipeline installation activities within these KEFs. Therefore, potential impacts to the demersal fish communities are assessed to have a Slight residual impact consequence (Magnitude: −1, Sensitivity: L).

9.5.2.2.3 Threatened and migratory species

Marine Mammals

Most cetacean species use sound to communicate (e.g. humpback whale calls) or perceive their environment (e.g. echolocation of prey). This reliance on underwater noise, and the high conservation value of these species, makes cetaceans of concern when assessing potential impacts from underwater noise. LF cetaceans are expected to be most vulnerable to underwater noise from the Activity.

Several LF cetaceans (blue, humpback, sei, fin, Omura's and Bryde's whales) were identified as potentially occurring within the Noise Assessment Area (Section 7.3.3.1). Noise monitoring in the Timor Sea for the Barossa development indicated pygmy blue, Omura's and Bryde's whales are the most likely to occur (McPherson et al. 2016, McPherson pers. Comm. 2023). Based upon known distribution data, humpback whales are considered unlikely to occur, although they have been detected in the region previously. The closest known marine mammal BIA to the Activity Area is the migration BIA for pygmy blue whales, which is 120 km west. Thums et al. (2022) and Ferreira et al. (2024) found that pygmy blue whales demonstrate extensive use of slope habitat off the WA coastline and only limited use of shelf waters, suggesting a presence mostly in water depths >250 m. During their migratory period, pygmy blue whales predominantly travel fast, with directed travel interspersed with relatively short periods of low movement persistence, indicating foraging, resting or breeding behaviours along the WA coastline (Thums et al. 2022). The Perth Canyon, Cape Range

Canyon and Cloates Canyon (Thums et al. 2022) were identified as key areas associated with these slower behaviours, supporting the 'possible' foraging areas identified in the Blue Whale Recovery Plan (CoA 2015a). During migration periods, pygmy blue whales are more likely to travel in greater numbers through the region within the deeper, and further offshore waters within their known BIA (outside the Noise Assessment Area), therefore outside the identified areas of potential impacts from underwater noise from the Activity.

HF and VHF cetaceans are also vulnerable to underwater noise, although their hearing range means they are more vulnerable to noise frequencies overlapping their functional hearing range (~150 Hz to 165 kHz). Several species of HF and VHF cetaceans were identified as potentially occurring within the Noise Assessment Area (see Section 7.3.3.1). Noise monitoring in the Timor Sea indicates HF and VHF cetaceans are present year-round (McPherson et al. 2016, McPherson pers. Comm. 2023). Dugongs (Sirenians) have been incorporated into this assessment based on anecdotal sightings within or in close proximity to the Activity Area (pers comm Craig McPherson [JASCO] 2023).

The noise modelling (Connell et al. 2023) predicted that during pile driving the instantaneous peak thresholds (i.e. the peak SPL from a single hammer strike) for PTS and TTS will not be exceeded at any range for HF cetaceans. The PTS threshold for LF cetaceans may be exceeded at 60 m and TTS may be exceeded out to a 230 m radius from the pile. The PTS threshold for VHF cetaceans may be exceeded at a maximum distance of 1.33 km and the TTS threshold may be exceeded at a horizontal distance of up to 3.21 km. The PTS for dugongs will not be exceeded at any range and TTS may be exceeded at a maximum horizontal distance of up to 30 m. The instantaneous behavioural disturbance threshold for a single hammer strike is predicted to be met at a maximum distance of 21.6 km.

The cumulative (i.e. 24-hour) PTS and TTS thresholds for LF cetaceans were predicted by animat exposure modelling to be exceeded at 19.8 km (75% exposure probability) and 56.4 km (58% exposure probability) respectively. The cumulative (i.e. 24-hour) PTS and TTS thresholds for HF cetaceans were predicted by the modelling to be exceeded at a maximum horizontal distance of 0.12 km and 2.3 km respectively, whereas for VHF cetaceans these thresholds were predicted to be exceeded at 6.4 km (PTS) and 21.6 km (TTS). The predictions are conservative because they are based on a worst-case hammer size and number of strikes and rely on the transiting and highly mobile cetaceans remaining within the threshold radius for the entire 24-hour period. Although it is probable that cetaceans, such as pygmy blue whales, may be present within the Noise Assessment Area, this area does not overlap with any mammal BIAs, including cetaceans and as such any disturbance would not disrupt critical behaviours such as feeding, breeding or resting.

Behavioural responses of cetaceans exposed to acoustic disturbance shows typical behavioural response is to move away from unpleasant stimuli, unless motivated to remain in the area due to biologically important activities (such as feeding or breeding). Several species of cetacean, including humpback whales, have been shown to avoid high-intensity low frequency sound (Dunlop et al. 2013; Kvadsheim et al. 2017; Sivle et al. 2015). The VHF and LF cetaceans that may occur within the Noise Assessment Area are expected to be able to move away from the pile driving noise, based on the notion that the Noise Assessment Area is situated away from known BIAs and within open offshore waters (i.e. not a confined migratory pathway). Considering the expected low usage of the Noise Assessment Area by VHF and LF cetaceans, avoidance behavioural responses and the nature of the pile driving operations, no VHF or LF cetaceans are expected to be exposed to noise levels exceeding the 24-hour PTS or TTS thresholds.

The nearest known aggregation of whales is the seasonal presence of pygmy blue whales in their migratory corridor, which is ~120 km west of the Activity Area. Therefore, it is considered that there is no credible risk of blue whales being significantly impacted by pile driving noise.

The NMFS (2024) technical guidance introduces adjustments to cetacean weighting functions and consideration of AUD INJ thresholds. The cetacean AUD INJ distances are assumed to range between the modelled PTS and TTS distances. Additionally, NMFS (2024) decreased the cetacean weighting function and increased the range for lower–and upper–frequency cutoffs compared to the modelled parameters (Table 9-23). Applying the NMFS (2024) cetacean weighting function would likely indicate that the pile driving impact distances will likely remain unchanged or decrease compared to modelled distances. The pile driving modelling was based on frequencies from pile driving frequency ranging from 0.01 to 1.024 kHz, and were extrapolated to extend up to 25 kHz. Hence, only a negligible portion of the outer limits of the lower-frequency range for all cetaceans and the outer limits of the upper-frequency range for LF cetaceans were omitted from the modelled parameters. Given this, it is reasonable to assume that cetacean impact distances are unlikely to change significantly.

The modelling predicted that pile driving noise would exceed dugong PTS and TTS impact thresholds within 0.13 km and 2.40 km, respectively. The NMFS guidelines (2024) have increased the sirenian weighting

function and reduced the upper–frequency cutoff range compared to the modelled parameters (Table 9-23). The NMFS (2024) sirenian upper–frequency cutoff parameters will not affect the existing modelling (i.e. changes are outside of the revised range). However, the increase in weighting function suggests that the dugong impact distances for pile driving will likely increase compared to modelled distances. The area within 2.40 km (TTS distance) of the Crux platform does not support dugong populations and dugong individuals are not expected to transit, given the water depths, lack of suitable habitat, and the closest known dugong BIA and shoal are greater than 162 km and 13 km away. Therefore, remodelling to apply the NMFS (2024) sirenian parameters is unlikely to result in any intersection of the noise impact area with any dugong habitat.

Additionally, given that the precautionary principle has already been applied when adopted the controls, performance standards and measurement criteria listed in Table 9-29, it is reasonable to conclude that any new data obtained from additional modelling, would not result in an update to these existing measures adopted.

The modelling assessment did not predict that DTH drilling or individual vessel DP noise would exceed any of the LF or HF cetacean impact thresholds defined for continuous noise at any range. The animat exposure modelling results predicted a potential for exceedance of LF cetacean thresholds for PTS, TTS and behavioural impact threshold for animals present within 10 m, 190 m and 36.8 km respectively of simultaneous vessel operations. The frequencies detectable by marine mammals indicate that sound levels at the source could potentially cause PTS and TTS in animals that were very close (within tens of metres of the vessel for an extended duration). However, the most likely impact at these levels is a behavioural response such as avoidance. Even assuming the PTS distances were doubled if the modelling had used the updated NMFS (2024) thresholds, a mammal would need to swim within 20 metres of the vessel for more than 24 hours to experience AUD INJ, which is not a credible scenario.

The HF pulses produced by survey method equipment will rapidly attenuate outside the immediate beam (MacGillivray et al. 2013; Zykov 2013). The high operating frequencies of these instruments also places the majority of sound frequencies above the auditory range of most marine fauna species. Dolphins and other HF cetaceans have peak hearing sensitivity up to 110 kHz, with potential for some limited hearing ability up to ~165 kHz (NMFS 2018, 2024). Therefore, they may be able to detect a small amount of the sound energy from some survey method equipment instruments in the lower operating frequency ranges (MacGillivray et al. 2013; Zykov 2013). Modelling of the propagation of high-frequency sound from survey method equipment with similar source frequency characteristics to those proposed for the Crux geophysical survey has been undertaken by Zykov (2013) and MacGillivray et al. (2013). The modelling predicted that sound emissions outside the main beams would be below the threshold levels for PTS or TTS. Sound levels that may result in behavioural effects are likely limited to within tens of metres, but potentially up to a few hundred metres from the sound source for HF cetaceans (Zykov 2013; MacGillivray et al. 2013).

Acoustic modelling of SBP by Zykov (2013), MacGillivray et al. (2013) and McPherson and Wood (2017), predicts that limited horizontal sound propagation occurs outside the main directional beams of sound. The modelling studies also predict that SEL_{24h} thresholds for PTS (as outlined in Table 9-19) are not exceeded. The potential for TTS resulting from SEL_{24h} exposures is limited to a few metres from the moving sound source (Zykov 2013; McPherson and Wood 2017), which is not considered to be a credible exposure for mobile marine fauna. Exceedance of the 160 dB re 1 µPa SPL behavioural response threshold would also be limited to within hundreds of metres (Zykov 2013; McPherson and Wood 2017).

Based on the results of the noise assessment, the relatively short duration of exposure to impulsive noise sources, the cetacean species that may occur within the Noise Assessment Area and the controls Shell will implement, potential impacts are expected to be behavioural disturbance only. This behavioural disturbance is likely to involve avoidance of areas of high noise intensity, which may inhibit other behaviours such as feeding. Notably, no known BIAs or critical areas for feeding / breeding or resting for marine mammals are found within the Noise Assessment Area. Behavioural disturbance will be restricted to relatively short periods when high noise intensity activities are occurring. Once the noise stops (i.e. the activity ceases), animal behaviour is expected to return to normal. With the implementation of controls (e.g. pile driving 'soft start-up'), potential impacts such as mortality, AUD INJ, PTS and TTS are considered very unlikely to occur.

The overall impact consequence for marine mammals is considered to be Minor (Magnitude: −2, Sensitivity: M).

Marine Reptiles

The short-nosed sea snake, leaf-scaled sea snake and dusky sea snake are not expected to be present within the Activity Area, however, may be present in the shallow waters and reef habitats within the Noise Assessment Area.

Excessive marine noise, including piling and drilling has been identified by the Conservation Advice for the dusky sea snake as a threat to the species (DCCEEW 2024n). The Conservation Advice presents that the noise impacts to the dusky sea snake should be grouped with gulping fish (phystostomous fishes) for the purpose of noise impact assessment. Phystostomous fishes are fish with swim bladders that are less sensitive to noise, as compared to other fish with swim bladders, due to their ability to expel air in response to loud noise and as such reduce the likelihood of severe injury or impact to organs including the swim bladder (Casper et al 2013). A study of *Hydrophiinae stokesii* (true marine sea snakes) undertaken by Chapuis et al (2019) suggested that sea snakes show low sensitivity compared with bony fishes and marine turtles to sound and are likely to have a peak sensitivity at 60 Hz (163.5 dB re. 1 µPa or 123 dB re. 1 µm s^{-2}). Reef-dependent sea snakes, such as the dusky sea snake, have little capacity to relocate to avoid noise and may be considered indirectly vulnerable due to their habitat sensitivity. Current understanding of this species is that they generally confined to their habitat of shallow banks and shoals (DCCEEW 2024n). The platform location, where drilling and piling will occur is situated more than 13 km away from where the dusky sea snake species or species habitat may occur. There are no areas of known dusky sea snake habitat is found within the Activity area.

No impact criteria, including behavioural response, for the dusky sea snake using fish with swim bladder as a proxy, were predicted to be met or exceeded for the DTH (construction) drilling scenario modelled by Connell et al. (2023) at the platform location.

Using the threshold for fish with a swim bladder (Popper et. al 2014) as a proxy (consistent with DCCEEW 2024n), the modelling of maximum-over depth peak pressure (PK) from pile driving activity predicted a potential exceedance of the threshold for mortality and potential injury to the dusky sea snake within 700 m MHU 500T hammer) or 290 m (IHC 800S hammer) of the substructure location.

Modelling of cumulative exposure during pile driving operations predicts the PTS threshold for the dusky sea snake may be exceeded up to 3.47 km from the pile driving operations, if the individual remains within the relevant distance from the pile throughout a 24-hour period of continuous pile driving operations.

Recoverable injury of dusky sea snakes could occur within 6.4 km of the pile driving location based on modelling of single strikes (PK metric), and up to 35.1 km from the pile driving location based on the 24-hour continuous noise modelling (SEL_{24}) for the worst-case hammer scenario (MHU500T) while using fish with swim bladder as a proxy (Popper et. al. 2014). Notably, both the modelling undertaken and the threshold values applied are conservative. While the modelling was based on predictive studies for Crux, the number of strikes required were stated within these studies to be conservative (Connell et. al. 2023). Furthermore, TTS (or recoverable injury) thresholds for fish from impulsive sound were based on studies using seismic airguns, as no data on TTS or masking are available for fish exposed to pile driving (Popper et. al. 2014). Notably, these studies found that all fish that showed TTS recovered to normal hearing within 18-24 hours (Popper et. al. 2014). Studies undertaken by Casper et. al. (2013) also found that fish can recover from injuries that are not mortal, although that recovery was in a laboratory under controlled conditions (Popper et. al. 2014).

Based on the notion that the dusky sea snake and its sensitivity and response to noise could be likened to fish with a swim bladder it would be reasonable to expect recovery from sub-lethal noise exposure (TTS) to also be similar.

The inherently conservative threshold values and proxy modelling threshold levels for the dusky sea snake, together with the absence of dusky sea snake species habitat or species presence within the area of potential mortality or mortal injury indicates that the impacts to any dusky sea snakes in the noise assessment area would be minor.

Constant marine vessel noise has also been identified within the Conservation advice for the dusky sea snake as a threat to the species ((DCCEEW 2024n). The modelling undertaken for the purpose of the installation activities included several constant marine noise (vessel operations) scenarios with multiple vessels operating simultaneously (Connell et. al. 2023). The specific modelled outcomes for vessel noise scenarios predict that the 48-hour threshold for recoverable injury for fish with a swim bladder involved in hearing and dusky sea snakes (Popper et al. 2014) may be reached if the animals remain within 80 m of the activity. The 12-hour threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014) and dusky sea snakes may be met if the animals remain within 200 m of the activity. Notably, the guidelines from Popper et. al. (2014) advises that there are no direct evidence of mortality or potential mortal injury to fish from vessel noise. The risk of behavioural disturbance is predicted to be high near the source, moderate at intermediate distances and low at far distances. Vessel operations for the installation activities will be concentrated within the Activity Area. The shortest distance between the Activity Area and areas where the dusky sea snake or its habitat may occur is 4.3 km. Constant marine noise from the installation activities is predicted to be unlikely to impact the dusky sea snake.

Marine turtles are not known to be particularly sensitive to underwater noise and as such noise has not been identified as a pressure or threat for this group. Research on marine turtles suggests that functional hearing is concentrated at frequencies between 100 and 600 Hz (which is a subset of the LF cetacean range). Several turtle species were identified as likely to occur within the Noise Assessment Area (no additional species were identified compared to the Activity Area) (Section 7.3.3.2), however no critical habitat or BIAs for these species overlap the Noise Assessment Area.

The water depth and benthic habitat within the Noise Assessment Area is typically too deep for turtle foraging for several species (e.g. Hays et al. 2001; Polovina et al. 2003), although they may forage at shallow-water shoals. Species that eat primarily pelagic prey (e.g. leatherback and juvenile green turtles) may forage for pelagic prey. Because no known suitable breeding or nesting habitat occurs within the Activity Area, turtles would be expected to occur at low densities when transiting or foraging within the area.

The behavioural impact threshold for marine turtles is predicted to be met up to 10.7 km from the pile driving location. The 24-hour cumulative PTS threshold for turtles may be exceeded at a maximum horizontal distance of up to 4.92 km for pile driving noise; however, continuous pile driving operations are not likely to occur for 24 consecutive hours. PTS for marine turtles is therefore not considered credible.

Sound levels that are likely to be produced by various equipment used in different survey methods are predicted to fall below the 166 dB re 1 µPa SPL threshold (Table 9-20) within a few metres or tens of metres (Zykov 2013; McPherson and Wood 2017). The high-frequency sounds produced by the survey equipment are expected to be above the auditory range of marine turtles and so behavioural impacts are not expected to occur. Localised and short-term behavioural disturbances may result from the survey methods, affecting individuals (potentially exposed within tens of metres of the equipment for a brief period).

Continuous noise may result in behavioural disturbance in a localised area around activities. However, the potential for impairment (including recoverable injury, TTS and masking) is low.

Based on the results of the noise assessment, potential impacts to marine reptiles are considered likely to be restricted to short-term behavioural disturbance to animals close to high-intensity noise sources. Given the expected low density of marine reptiles within the Noise Assessment Area, this potential impact would only affect a relatively small portion of turtle or dusky sea snake populations in the region. Recovery from behavioural disturbance is expected to occur immediately once the noise emissions stop. The overall impact consequence for marine reptiles is considered to be Minor (Magnitude: −2, Sensitivity: M).

Whale sharks

Whale sharks occur within the Noise Assessment Area (e.g. traversing the open waters within or surrounding the Activity Area during migration to/from aggregation off Ningaloo Reef). A whale shark foraging BIA exists in the Noise Assessment Area, but it is considered unlikely that whale shark would occur in significant numbers as there is no main aggregation area within the vicinity of the Noise Assessment Area—any presence would be anticipated to be transitory and short term. This is consistent with tagging studies of whale shark movements, which show continual movement of whale sharks in deeper, open offshore waters (Meekan and Radford 2010, Ferriera et al. 2023). Given the contrast to the feeding behaviour off aggregation areas such as Ningaloo Reef, the BIA within the Noise Assessment Area is considered unlikely to be a dedicated foraging area; rather, it is likely to be a broad area within which migratory movements can be expected. This is consistent with the conservation advice (DoE 2015e) for this species, which indicates this BIA up the north-west coast is a migration corridor rather than significant foraging habitat. There are no constraints (e.g. shallow water, shorelines) that prevent whale sharks from moving away from the Noise Assessment Area and it is not considered a confined pathway.

Whale sharks forage on plankton and small fish, and high-intensity underwater noise has been shown to impact some taxa within zooplankton communities. Recent observations by McCauley et al. (2017) provides evidence of considerable mortality of crustacean zooplankton (e.g. copepods and nauplii larval stage of crustaceans) over short timeframes. However, longer-term impacts may be much less discernible due to the high turnover of planktonic communities and the movement of water masses. Modelling studies by the CSIRO indicate that planktonic communities are highly dynamic and have the potential to recover rapidly following disturbance (Richardson et al. 2017). As a result, it is considered that any impacts to zooplankton, which would be of short duration, would not have the potential to negatively affect any whale sharks moving through the area. Note: Small crustacean zooplankton comprise only part of whale shark diets, with larger plankton and nekton (e.g. krill, baitfish) forming a part of their diet (Colman 1997).

The *Conservation Advice for Whale Sharks (Rhincondon typus)* (DoE 2015e) does not identify sound emissions as a threat to the species, as such it is expected that the potential effects to whale sharks associated

with underwater noise will be the same as for other pelagic fish species. Whale sharks are not considered to be particularly vulnerable to noise-related impacts and were categorised as 'fish with no swim bladder' when determining impact thresholds (Table 9-21). There is a paucity of information on hearing abilities for whale sharks (and more generally fish without a swim bladder) and as such the threshold levels by Popper et al. (2014) were based on sound pressure levels, not particle motion. Data are available that show lack of effect from exposure to a SEL_{cum} of 216 dB re 1 $\mu Pa^2 \cdot s$ for a fish without a swim bladder, supporting the argument that the presence of a swim bladder increases vulnerability to noise (Popper et al. 2014). The guideline provided by Popper et al. (2014) was based on a study of mortality and injury observed by Halvorsen et al. (2011, 2012) during a pile driving activity with 960 sound events at 1.2s intervals and represent the lowest level where injury was found.

The noise modelling conducted for the Activity (Connell et al. 2023) predicted that pile driving noise sources from the project may exceed the instantaneous threshold for recoverable injury, potential mortal injury or mortality (>213 dB PK) for fish with no swim bladder within a 230 m radius from the pile. The cumulative TTS for pile driving noise was predicted to potentially occur out to ~35.1 km, noting that the study results are conservative (i.e. the results likely over-estimate received sound levels) and assume an individual would remain within the impact range for a 24-hour period. Studies undertaken on sharks and rays in relation to underwater noise indicate that underwater noise effects are likely to result in avoidance behaviours (Popper and Hawkins 2019, Smith and Popper 2023; Chapuis et al. 2019). As such it may be reasonably expected that underwater noise effects to whale sharks are likely to elicit avoidance behaviour and be unlikely to result in injury. The whale shark BIA within the Noise Assessment Area is known to be important for migratory behaviours rather than feeding, breeding or resting and as such potential impacts would not be expected to result in any long-term or significant impacts. Given that there is limited potential exposure to migrating Whale sharks from underwater noise it is expected that significant impacts are not credible.

The potential for injury or TTS effects to whale sharks resulting from single impulse or accumulated exposures to sound from survey method equipment is limited to within 1–2 m beneath or to the side of the sound source (Zykov 2013; McPherson and Wood 2017). Single impulse exposures at this range are highly unlikely to occur and accumulated exposures over several hours at this range are not credible. The criteria suggested by Popper et al. (2014) in Table 9-21 are based on exploration seismic surveys and therefore are highly conservative for the low-energy survey equipment proposed. Therefore, potential impacts to whale sharks are likely to be limited to localised (within tens of metres) and temporary behavioural changes close to the survey equipment.

Based on the results of the noise assessment, the potential impacts to whale sharks are expected to be limited to minor, short-term behavioural disturbance. The overall impact consequence for whale sharks is considered to be Minor (Magnitude: −2, Sensitivity: M).

9.5.2.3 Socioeconomic and Cultural Environment

Noise is not expected to significantly impact socioeconomic receptors, such as fishing and tourism, due to the low socioeconomic activity levels within the Noise Assessment Area.

Noise is unlikely to result in significant impacts to marine species of cultural significance—as established in Sections 7.4.1.2.1 and 7.4.1.2.2—with the proposed control measures in place. For the assessment of impacts to marine species that may be of cultural significance, refer to Section 9.5.2.2.3.

No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to socioeconomic receptors or Indigenous cultural heritage features and values from this aspect. The overall impact consequence to is considered to be Slight (Magnitude: −1, Sensitivity: L).

9.5.2.4 Cumulative Impacts

The remoteness of the Activity Area means that it is considered unlikely that there will be a cumulative impact above thresholds with other marine users.

Multiple project vessels may be within the vicinity of the Prelude FLNG facility during the Prelude-end flexible riser and umbilical installation and export pipeline installation activities (see Section 9.5.1.1). Therefore, the potential for cumulative sound emissions from project vessel operations is acknowledged. The Prelude FLNG EP 2020 (Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002) assessed the potential impacts to marine mammals from the operational noise sources as Slight. Noise levels from Prelude operations fall below the relevant behavioural disturbance criteria for cetaceans at ranges beyond 9 km during offtake operations (cavitation noise) and 1.3 km during normal production operations (plant noise).

Additive effects will vary depending on environmental factors such as water depth, substrate, and position of the sound source within the water column. Cumulative effects from multiple sources are likely to produce increased impacts on individuals within a confined or shallow water environment (e.g. a bay or harbour) compared to the deep ocean environment (Nienke et al. 2022). In the event that concurrent activities with multiple noise sources operate within the Noise Assessment Area (20 km assessment boundary around the Prelude FLNG), the generated overlapping sound exposure area from aggregate sound effects are considered likely to remain below thresholds for injury to marine fauna. The marine sound generated from vessel activities has the potential to cause behavioural responses, such as avoidance, to threatened or migratory marine fauna; however, it is considered unlikely that transiting individuals would remain in close proximity to the sound source due to a lack of BIAs and suitable habitat to support biologically important behaviours. The risk of impact from pipelay (flowline, umbilicals and export pipeline) activities is further reduced as the associated projects vessels will slowly travel at approximately 2–3 km per day, and the Prelude FLNG operations are limited to one location. The likelihood of an individual remaining within the distances above behavioural or impact thresholds is considered highly unlikely. It is considered that it is highly unlikely that there are any concurrent activities that have the capacity to materially change the location of the impact threshold boundaries.

Notwithstanding the potential overlap of the spatial extent of noise effects from concurrent activities, given the short duration (intermittent over ~2 months) of these activities, the absence of significant feeding, breeding or aggregations areas and marine fauna BIAs within the predicted noise ranges and the mobility of noise-sensitive fauna species that may transit through the area, the generated noise is predicted to attenuate below injury and disturbance thresholds of transiting individuals. Therefore, negligible additive and cumulative noise effects above those assessed in the Prelude FLNG facility and no change to the overall consequence level is expected to result.

9.5.3 Impact Assessment Summary

Table 9-28 lists the highest residual impact consequence ranking of the relevant environmental receptor groups.

Table 9-28: Noise Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	N/A	N/A	N/A
Biological Environment	−2	M	Minor
Socioeconomic and Cultural Environment	–1	L	Slight

9.5.4 ALARP Assessment and Environmental Performance Standards

Table 9-29: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Timing the activity to eliminate sound impacts to avoid sensitive periods such as migration (pygmy blue whales, humpback whales and whale sharks).	No	The Noise Assessment Area does not intersect any known cetacean (or noise-sensitive fauna) BIA. Consequently, it is expected that noise impacts would be limited to individuals, and it is not anticipated that there will be significant impacts on whale migratory or foraging behaviours. One BIA—whale shark migratory BIA—occurs within the Noise Assessment Area. The *Conservation Advice for Whale Sharks (Rhincondon typus)* (DoE 2015e) does not identify sound emissions as a threat to the species. Furthermore, studies undertaken on sharks in relation to underwater noise indicate that underwater noise effects are likely to result in avoidance behaviours (Popper and Hawkins 2019, Smith and Popper 2023; Chapuis et al. 2019). As such, it is reasonably expected that underwater noise effects to whale sharks are likely to elicit avoidance behaviour and be unlikely to result in injury or significant impacts. Due to the short-term nature of the pile driving operations, adoption of procedural controls (below), the migratory nature of any whale sharks within the Noise Assessment Area, the absence of any significant	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			aggregation, feeding or breeding areas and the current control measures adopted, this proposed control measure will provide negligible benefit. In addition, given the nature of commercial arrangements Shell has in place with its contractors, the likely impacts implementation of this type of control would have highly significant schedule and cost impacts, which are grossly disproportionate to any benefit gained by implementing the control. This further supports not adopting this control measure.			
Elimination	Eliminate the use of pile driving operations through the use of a FPSO.	No	The pile driving operations noise source is expected to be short-term and intermittent. However, once the topsides become operational, there will be a significant reduction in noise sources compared to an operational FPSO, including fewer vessel and aviation movements. Consequently, over the entire lifespan of the project, the platform is projected to emit less noise compared to a FPSO and thus minimise noise disturbances in the surrounding area. Hence, there is an overall environmental benefit of not adopting this control and demonstrably ALARP.	N/A	N/A	N/A
Elimination	Eliminate the use of pile driving operations through the use of suction piles.	No	The seabed soil conditions at the proposed topsides platform location were investigated extensively prior to final selection of the installation procedure and materials. The outcomes of the investigations conducted by geotechnical engineers	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			concluded that suction piles would not be a safe or viable alternative based on the soil conditions and geotechnical engineering requirements for the site conditions. Given the geotechnical conditions and engineering requirements, alternative options to pile driving operations, such as suction piles, are considered technically unfeasible. The overall pile driving noise source is expected to be short-term and intermittent.			
Substitution	N/A	N/A	No additional or alternative control measures have been identified.	N/A	N/A	N/A
Administrative and procedural control	Passive acoustic monitoring (PAM) during pile driving activities.	No	Shell evaluated the benefits and suitability of marine fauna PAM during pile driving activities. PAM can be useful in detecting the presence of vocalising marine mammals such as whales (JNCC 2023). PAM requires trained acousticians, appropriate analysis software and specialised recording equipment. Implementation may be useful to detect vocalising marine mammals prior to, and during pile driving. The detection distance for PAM can vary greatly depending on the species of whale, the frequency and loudness of their vocalizations, and the background noise levels. However, it is important to note that PAM is only effective when marine mammals vocalise frequently (noting that whale sharks do not vocalise), and when vocalisations are not masked by vessel or other background noise. During the piling	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			campaign, support vessels will be in attendance. Hence, this control may be limited in how effective it will be in detecting vocalising marine mammals and providing data to inform actions to protect these species. Given the short duration of the piling campaign (approximately 19 days) and that the boundary of the noise assessment area does not intersect any whale BIAs or critical habitat, deployment of PAM is not considered necessary to support the Crux piling campaign. Additional purchase of PAM equipment, deployment and technical support costs are also disproportionate to the environmental benefit gained. Although this control is rejected, an effective night–time whale monitoring alternative has been adopted (refer to EPS 3.2).			
Engineering	Noise reduction device.	No	To reduce the noise from offshore pile driving activities at the source, some systems are already on the market. Shell evaluated some of these systems for their suitability including: • Big Bubble Curtain (BBC) • Hydro Sound Damper (HSD) • The AdBM Noise Abatement System • BLUE Piling Technology • Menck Noise Reduction Unit • PULSE noise mitigation system.	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			These systems were considered unsuitable or ineffective due to the technical, safety, water depth and geotechnical requirements of this Activity. The assessment concluded that further research and development is required before applying these systems to this or similar projects.			
Administrative and Procedural Controls	Project vessel interactions with threatened and migratory species to follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06).	Yes	The EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06) is recognised as the industry standard for minimising disturbance due to physical presence and noise to whales and dolphins and will be applied to other species as relevant (i.e. turtles and whale sharks).	3.1	Vessels comply with EPBC Regulations 2000 Part 8, Division 8.1 Interacting with Cetaceans, specifically: • Project vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf. • If the whale, dolphin, turtle or whale shark shows signs of being distressed, project vessels will immediately withdraw from the caution zone at a constant speed of ≤6 knots (except in emergency conditions or when manoeuvring is not possible, such as in the case of pipelay activities or floatover activities).	During Environmental Assurance activities, responsible Contractor personnel demonstrate understanding of EPBC Regulations 2000 Part 8, Division 8.1. Incident report form used to record breaches of requirements outlined in the EPBC Regulations 2000.
Administrative and Procedural Controls	Implement pile driving procedure adapted from the 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (EPBC Act Policy Statement 2.1) (DEWHA 2008b).	Yes	Alignment with the 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines, for pile driving activities (including adaptions based on piling equipment), will minimise the risk of impairment or disturbance from underwater noise to whales, whale sharks and the dusky sea snake.	3.2	Pile driving activities implemented in accordance with the pile driving procedure, adopted from the EPBC Act Policy Statement 2.1 to minimise the risk of impairment or disturbance from underwater noise to whales, whale sharks and the dusky sea snake. The Procedure will include: A suitable number of competent marine mammal observers (MMOs) on a suitable observer platform (e.g. vessel) before any pile driving will occur, such that at least one	A copy of the pile driving procedure aligned to the EPS 3.2 requirements. Shell BES SME review and approval of dedicated MMOs CV prior to mobilisation

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			As the piling activities are intrinsically different to seismic activities the procedures outlined within the control measure have been adapted from EPBC Act Policy Statement 2.1. Further details related to night-time and low visibility procedures are outlined below. Due to the increased risk of pile refusal (stuck pile) below ~117m depth, about the final 3 meters of piling, Shell proposes it would not be ALARP to stop/lower power of piling in the event of a whale/whale shark and dusky sea snake sightings within the shutdown or low power zones. The impact of a stuck pile could result in significant project delays and costing implications (in excess of 1 million of dollars). Due to the limited amount of the overall piling length this applies too, and the relative lack of high densities of whales, whale sharks and dusky sea snakes within 1km of the platform location (based on current published research, anecdotal information from drilling operations and historical observations infield by the Shell BES SME), it is considered ALARP to implement this exclusion.		dedicated MMO will be on watch during the pile driving operations, supported by trained crew during breaks, with a minimum of two MMOs offshore. Pre–start-up visual observation: • During daylight hours, visual observations (using binoculars and the naked eye from a high vantage point) for the presence of whales/whale sharks/dusky sea snake will be undertaken by one dedicated MMOs for at least 30 minutes before commencing piling activities. Soft-start procedure (also known as ramp-up): • The hammer piling will be initiated at the lowest striking force, with a gradual ramp-up over 30 minutes until the full striking power (if required) is reached. Operations procedure: • During daylight hours, a dedicated MMO, supported by a trained crew member to cover breaks, will undertake visual observations continuously during the piling activity,. • Any break in piling >10 minutes will reinitiate the soft-start requirement. Stop work procedure: • If a whale/whale shark/dusky sea snake is sighted within the 3 km observation zone an additional trained crew member should also be brought to the bridge to continuously monitor the whale/whale shark/dusky sea snake while it is in sight. • If a whale/whale shark/dusky sea snake is sighted within or is about to enter the	demonstrates acceptable individual competency. Vessel personnel on board records show at least two Shell BES SME approved MMOs offshore at any time during piling activities. Training material and associated attendance sheets demonstrate crew members identified to fill crew trained MMO rolls have completed training to make them aware of the MMO techniques and management protocols. MMO logs (in the Cetacean Sightings Application (CSA) or excel document) demonstrate Pre–start-up visual observation was completed by dedicated MMOs, where required. MMO logs demonstrate a soft start procedure was implemented, where required.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
					protection zone (1 km), the acoustic source should be powered down to the lowest possible setting. • If a whale/whale shark/dusky sea snake is sighted or is about to enter the shut-down zone (500 m or 700m for the dusky sea snake), the acoustic source (piling) should be shut down completely. • An exception to shut-down and low power requirements within the shut-down and protection zones listed above, are allowable whilst completing the final 3m of each pile. • Powering up the acoustic source with soft-start procedures should only occur after the whale/whale shark/dusky sea snake has been observed to move outside the protection zone, or when 30 minutes have lapsed since the last sighting.	MMO logs demonstrate that any break in piling operations >10 minutes was followed by a soft start procedure implementation. MMO logs demonstrate a low power and shut down measures were initiated if a whale/whale shark enters or is sighted within either a protection zone or shutdown zone. MMO logs document situations where exceptions are implemented whilst completing the final 3m of each pile, if required.
Administrative and Procedural Controls	Night-time Piling Procedure	Yes	Night-time Procedure: Thermal imaging–based systems have been successfully implemented on vessels to detect the presence of marine mammals. Zitterbart (2020) evaluated the use of thermal imaging–based systems versus MMOs and concluded that the use of	3.3	Where three or more whale shark or dusky sea snake shutdowns occur in the prior 24 hours, no night-time piling operation will occur the following night[46].	MMO CSA application records show night observation procedures were followed.

[46] Nighttime is defined as where visibility out to 1km is not suitable for MMO activities with binoculars (notionally 40min post/prior sunset/sunrise).

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			an MMO with the assistance of thermal imaging may be ideal. There is good evidence supporting the use of high quality thermal imaging device like the HIKMICRO Habrok Pro HX60L Multi-Spectrum Thermal Binocular in the effective detection offshore of marine mammals. There is currently a number of papers supporting the effective use of quality thermal imaging device in greatly increasing detection probability of mammals and birds (warm blooded animals) onshore also (Jumail et al. 2020). Expert advice from those involved in research on the technologies application support the use of thermal imaging binoculars in the offshore environment for marine mammals. Advice also suggested the best unit to use for such a purpose is the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular Thermal Binocular at the time of discussions earlier in 2024 (R Clarke pers comm, 2024). Shell BES SME has tested a similar type of thermal imaging device in an onshore environment for cryptic small mammals and has proven to be highly effective in vastly increasing detection probabilities for such mammals. In an offshore environment it is expected to be effective, within the constraints of	3.4	Shell BES SME will carry out a field trial using the HIKMICRO Habrok Pro HX60L Multi-Spectrum Thermal Binocular prior to offshore piling operations commencing to confirm marine whale detection effectiveness is suitable at night and considerations of observer fatigue management. Outcomes and learnings from this field test will be used in informing the application of EPS3.5 and EPS3.6.	Note for file documenting the outcomes of the field trial and confirmation which subsequent EPS is applicable, and any other optimisations as a result. Outcomes are also communicated to MMOs for the activity.
				3.5	Subject to the outcomes of EPS3.4 which may find field trial confirms the HIKMICRO Habrok Pro HX60L Multi-Spectrum Binocular is effective in whale detection at night, observer fatigue management and other relevant considerations confirm the application of this EPS is suitable. A minimum of two MMOs, one on day and one on night, will be used throughout the piling operations, with at least 7 hours of active observation per shift whilst continuously piling, supported by trained crew members for MMO breaks to manage observer fatigue and breaks effectively. Training of crew members will be done by an MMO.	CSA application records show night observation procedures were followed as required by EPS3.5.

			its use and the environmental conditions. Constrains expected are that the thermal device will not be effective for detection of cold blooded animals like fish, including whale shark, or dusky sea snake or in low visibility conditions. Based on Shell BES SME's experience, prolonged use of night vision equipment by MMOs may increase observer fatigue significantly compared to daytime observation, so more regular breaks to manage fatigue effectively are likely to be necessary, supported by trained crew members whilst MMOs take breaks. Shells contractor will have two suitably qualified MMOs for the duration of the pile driving activities. Shell has considered below two options, having one MMO on the daylight hours and one MMO on night watch. Or a second option, which was the base case for selecting two MMOs to share daytime duties to effectively manage observer fatigue to therefore increase detection probabilities for whales and whale sharks and therefore there protection from noise impacts. Given the paucity of published research on thermal imaging cameras for whale detection offshore is limited, including in the seismic industry or offshore pile driving industry, Shell BES SME also proposes further field testing the HIKMICRO Habrok Pro HX60L Multi-Spectrum Thermal binocular in its application for whale detection effectiveness and probability at night including consideration of observer fatigue of MMOs in best managing	3.6	Subject to the outcomes of EPS3.4 which may find limitations and constraints do not support the more extended application of thermal camera technology outlined in EPS3.5 during the piling campaign this EPS will be adopted. Night observation using the HIKMICRO Habrok Pro HX60L Multi-Spectrum Thermal binocular will be implemented through the use of trained crew members on nights where three or more whale shutdowns occurred the day prior. Training of crew members will be done by an MMO.	CSA application records show night observation procedures were followed as required by EPS3.6

			this. The outcome of this field test, to be carried out prior to the activity commencing, will be used to adaptively inform the practicality of full-time night observation throughout the piling campaign, or if this control should just be implemented by train crew members on nights following three or more shutdowns from the previous day consistent with EPBC policy statement 2.1 requirement. On balance Shell consider the optimised, ALARP outcome is to have the two MMOs split, one on day and one on night duties, and allow both the observers reasonable breaks to best self-manage observer fatigue, with observers having a minimum watch time of 7 hours per shift, with the balance covered by crew trained by the qualified MMOs themselves. A third option is to employ another two qualified MMOs for the activity, however this was considered grossly disproportionate to the benefit gained which was a marginal improved observer effectiveness through better being able to manage fatigue by a qualified observer as opposed to a trained crew member. Therefore, given the above consideration of options and supporting evidence, Shell proposes to adopt the use of thermal imaging technology for nighttime observation throughout the pile driving activity, subject to outcomes of field tests of whale detection effectiveness and probability and observer fatigue management considerations to be completed before the start of the pile driving activity.			

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Low visibility procedure during pile driving	Yes	Applying a low visibility procedure during pile driving will assist in reducing impacts and risks to whales, whale sharks and the dusky sea snake to ALARP. The control is considered to be most effective during periods when high numbers of whale/whale shark/dusky sea snake instigated shutdowns occur. Therefore, consistent with EPBC policy statement 2.1, Shell proposes to cease piling during periods of low visibility, less than 1000m (the observation distance where piling power is reduced) when three or more whale/whale shark/dusky sea snake instigated shutdowns occur in the previous 24 hours. Alternatives to this considered, but discounted were, ceasing piling when low visibility occurs without any conditions (e.g. regardless of the number of shutdowns in the preceding day). Given the significant cost of shutdowns to project schedules and financial costs of vessel and crews, the limited benefit of low likelihood of protecting whales/whale sharks/dusky sea snakes was considered grossly disproportionate to any benefit gained. Therefore, a risk based approach to protection of whales and whales sharks during periods of low visibility was adopted.	3.7	Piling will cease where there is low visibility, less than 1000m, and there were three or more whale, whale shark or dusky sea snake shutdowns in the previous 24 hours.	CSA application records show Low visibility procedure was followed as required by EPS3.7

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Extend the implementation of the pile driving procedure adapted from the 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (EPBC Act Policy Statement 2.1) (DEWHA 2008b) to include whale sharks and dusky sea snakes.	Yes	One known BIA—whale shark migration BIA—overlaps with the Noise Assessment Area. The BIA is a broad corridor along the northwest coast of WA spanning 140-170 km in width near the Activity Area. The *Conservation Advice for Whale Sharks (Rhincondon typus)* (DoE 2015e) does not identify sound emissions as a threat to the species. Furthermore, underwater noise studies undertaken on sharks indicate that underwater noise effects are likely to result in avoidance behaviours (Popper and Hawkins 2019, Smith and Popper 2023; Chapuis et al. 2019). However, given the risk of sound impacts to whale sharks from the piling activity, applying the EPBC policy statement 2.1 may further reduce the impacts of piling noise. Therefore, Shell has considered adoption of this control is in line with the precautionary principle and reducing impacts to whale sharks to ALARP. As evaluated in section 9.5.2.2.3, pilling noise is identified as a threat to the dusky sea snake under the approved conservation advice. Given the limited science on the species and given the impact evaluation done, Shell has adopted the precautionary principle in applying relevant piling EPSs to the dusky sea snake also. Shell considered if further vessels should be employed to assist in sighting and identifying the dusky sea	3.2	Refer to EPS 3.2	Refer to EPS 3.2
				3.3	Refer to EPS 3.3	Refer to EPS 3.3

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			snake during piling operations, however this measure was deemed very costly (hundred or thousands of dollars per day minimum) and therefore grossly disproportionate to the benefit gained, particularly because the piling location is not within currently known dusky sea snake habitat which may reasonably be at nearby Shoals.			
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n) lists constant marine noise from marine vessels as a threat to the dusky sea snake. The associated conservation action lists the development and implementation of minimal noise operating guidelines for vessels operating in waters where the dusky sea snake is known or likely to occur. Consistent with the conservation advice, their preferred habitat is reefs and shoals which do not occur within the Activity Area. Shoals do occur adjacent to the Activity Area though. Therefore, Shell has adopted a control and performance standard (EPS3.8) consistent with a key management control outlined in the	3.8	Project vessels shall not operate within 1 km of named Shoals adjacent to the Activity Area.	Vessel AIS system shows project vessels do not enter within minimum 1 km of the named Shoals adjacent to the Activity Area. Vessel navigation system has a layer added to show named Shoals adjacent to Crux activity area which are exclusion zones.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			Crux OPP, to exclude vessels operating over any named Shoals adjacent to the Activity Area.			
Administrative and Procedural Controls	No piling or DTH drilling will occur simultaneously	Yes	This avoid cumulative noise impacts which could affect MNES.	3.9	No piling or DTH drilling will occur simultaneously shall occur through the substructure installation activity	Daily reports show that piling or DTH drilling will occur simultaneously shall occur through the substructure installation activity
Administrative and Procedural Controls	Verification of noise levels.	No	The Noise Assessment Area does not overlap any whale (or noise-sensitive fauna) species BIA. Shell has conducted activity-specific noise modelling to provide an accurate assessment of the predicted noise levels. Due to the short-term nature of the pile driving operations, lack of BIAs, and the current control measures adopted, implementing this control is considered grossly disproportionate to the negligible environmental benefits, if any.	N/A	N/A	N/A
Administrative and Procedural Controls	Sea snake (Dusky) monitoring	Yes	In accordance with the dusky sea snake conservation advice to "Ensure all images and footage from general NOPSEMA, and other, survey programs in deeper waters of the Timor Sea are sent to sea snake experts for review via established connections, the IUCN SSC Sea Snake Specialist Group, or experts in the 'Other sources cited' section of this document." Shell commits to sharing any footage or photographs of sea snakes during this activity to the https://iucn.org/our-	3.10	Shell will send any photos of sea snakes to the IUCN SSC Sea Snake Specialist Group within a month of the Shell BES SME receiving the data	Email or other communication sending sea snake image/s/footage to IUCN SSC Sea Snake Specialist Group.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			union/commissions/group/iucn-ssc-sea-snake-specialist-group			
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity noise emissions. No additional or alternative controls were identified that could further reduce the impacts—beyond negligible environmental benefits if any—without disproportionate effort and cost. Therefore, the impacts are considered to be reduced to ALARP.						

9.5.5 Acceptability of Impacts

Table 9-30: Acceptability of Impacts – Noise

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Biological Environment	Habitats and Communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	Highly localised noise-related impacts may occur during the short duration of pile driving operations. Soft sediment benthic communities are broadly distributed in the wider region and are not considered to be unique or highly sensitive. It is considered that there is not a credible risk of underwater noise resulting in significant impacts to benthic communities within the Noise Assessment Area.
	KEFs		No significant impacts to environmental values of KEFs.	Yes	One KEF—Continental slope demersal fish communities—occurs within the Noise Assessment Area and outside the noise impact range of the pile driving operations. This KEF is valued for high diversity of demersal fish assemblages. It is considered that there is not a credible risk of PTS or behavioural impacts to demersal fish resulting in significant impacts.
	Threatened and migratory species	Sharks and rays Other fish	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	One known BIA—whale shark migration BIA—occurs within the Noise Assessment Area and within potential noise impact range of the pile driving operations. The whale shark BIA within the Noise Assessment Area is known to be important for migratory behaviours rather than feeding, breeding or resting and as such potential impacts would not be expected to result in any long-term or significant impacts. The BIA spans across a 140-170 km wide corridor near the Activity Area and does not represent a confined pathway. PTS for fish without a swim bladder (including whale sharks) is predicted to potentially occur within 230 m from the pile driving source (PK) within the Noise Assessment Area. However, studies undertaken on sharks and rays in relation to underwater noise indicate that underwater noise effects are likely to result in avoidance behaviours

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
					(Popper and Hawkins 2019, Smith and Popper 2023; Chapuis et al. 2019). The whale shark is likely to move away from the source and not remain within an area of impact. As such it may be reasonably expected that underwater noise effects from the Activity to whale sharks are likely to elicit avoidance behaviour and be unlikely to result in injury or significant impacts. The cumulative TTS for pile driving noise was predicted to potentially occur out to ~35.1 km from the source, noting that the study results are conservative (i.e. the results likely over-estimate received sound levels). The prediction includes the underlying assumptions that an individual remains within the impact range for a 24-hour period, i.e. not move away from the source and that the pile driving operations are continuous over that period. Notably, TTS does not represent a lasting injury, TTS refers to a temporary threshold shift that is expected return to normal post exposure (**Error! Reference source not found.**). The *Conservation Advice for Whale Sharks (Rhincondon typus)* (DoE 2015e) does not identify sound emissions as a threat to the species. Given that there is limited potential exposure to migrating whale sharks from underwater noise it is expected that injury or significant impacts are not credible. Noise levels emitted from the Activity have been assessed as potentially able to cause only a Minor impact to whale sharks. The assessment of available controls aligns with conservation advice, recovery plans and threat abatement plans. Given this, there are no significant impacts, mortality or injury predicted to threatened or migratory MNES sharks or rays, including whale sharks.
		Marine mammals Marine reptiles	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	There are no marine mammal or reptile BIAs within the Noise Assessment Area. Relevant noise related conservation actions for cetaceans includes the need to assess and address/manage noise impacts to Sei whale, Blue whale, and Fin whale (Table 7-14). A noise modelling impact assessment established that PTS and TTS may be exceeded for LF cetaceans during pile driving operations and cumulative 24-hr PTS and TTS thresholds may be exceeded for cetaceans. Consistent with the conservation advice, controls and performance standards have been adopted to manage and reduce these potential impacts to ALARP and acceptable levels.

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
					For an assessment of acceptability and regard given to the Conservation Advice for the Dusky Sea Snake (*Aipysurus fuscus)* see Table 9-32 below. PTS for marine turtles is not considered credible. Potential pile driving impacts will be temporary and of a relatively short duration (<3 weeks). Noise levels emitted from the Activity have been assessed as potentially able to cause only a Minor impact to marine mammals and turtles. The assessment of available controls align with conservation advice, recovery plans and threat abatement plans. Given this, there are no significant impacts predicted to threatened or migratory MNES marine mammal or reptiles.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that could be credibly impacted by noise emissions from the Activity.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from noise emissions, given that no significant impacts to culturally significant marine species are anticipated with the proposed control measures in place.
	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Yes	No impacts that could result in demonstrated loss of income is expected to occur.
	Tourism and recreation		No negative impacts to nature-based tourism resources resulting in demonstrated loss of income. Temporary displacement of tourism activities within the Activity Area (excluding PSZs) is acceptable.	Yes	No impacts that could result in demonstrated loss of income is expected to occur.

Receptor		Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory			
		Permanent exclusion of tourism activities from PSZs is acceptable.		
	Defence	Temporary displacement of defence activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of defence activities from PSZs is acceptable.	Yes	No impacts to defence activities are expected to occur.
	Ports and commercial shipping	Temporary displacement of commercial shipping within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of commercial shipping from PSZs is acceptable.	Yes	No impacts to commercial shipping activities are expected occur.
	Oil and gas industry	Temporary displacement of petroleum exploration activities and operations within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of petroleum exploration activities from PSZs is acceptable.	Yes	No impacts to other petroleum activities are expected occur.

The assessment of impacts from underwater noise determined the worst-case residual ranking of Minor or lower (Table 9-28). As outlined above, the acceptability of the potential impacts from noise associated with the Activity have been considered in the following context.

Principles of ESD

The potential impacts from underwater noise emissions are consistent with the principles of ESD because:

- The underwater noise emissions aspect does not degrade the biological diversity or ecological integrity of the Commonwealth Marine Area and significant impacts to MNES are not anticipated to occur.
- The precautionary principle has been applied, and the most recent scientific literature and international guidelines on noise impacts (Popper et al. 2014; NOAA 2019; Southall et al. 2019; Finneran et al. 2017) have been reviewed and referenced to ensure the latest research and knowledge was taken into account when evaluating environmental impacts. And Shell has conservatively adopted EPS 3.2 for whale sharks.

Relevant Requirements

Managing the potential impacts from underwater noise emissions is consistent with relevant legislative requirements, including:

- Noise impact assessments are guided by the latest scientific research in defining impact thresholds.
- Policies, strategies, guidelines and conservation advice (see Table 9-31).
- Project vessel interactions with threatened and migratory species will follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06) and the Australian National Guidelines for Whale and Dolphin Watching 2017 (DoEE 2017), including:
    - vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf
    - if the whale, dolphin, turtle or whale shark shows signs of being distressed, the vessel will immediately withdraw from the caution zone at a constant speed of ≤6 knots.
- Adapted EPBC Policy Statement 2.1 – Part B (additional management measures).

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation of noise impacts indicates that no credible significant impacts to threatened and migratory species is predicted to result from underwater noise emissions during the Activity. Table 9-31 and Table 9-32 summarises the alignment with management plans, recovery plans and conservation advice for threatened and migratory fauna.

Commonwealth Marine Environment

Any potential impact from the noise emissions of the Activity on the Commonwealth marine environment are predicted to not exceed any of the significant impact criteria listed in Table 9-30; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-31: Summary of Alignment of the Potential Impacts from the Noise Aspect of the Petroleum Activities with Relevant Requirements for EPBC Threatened Fauna

MNES	MNES Acceptability Considerations (EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory Species – Marine Mammals	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	Project vessel interactions with threatened and migratory species will follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06). Pile driving activities will be carried out consistent with EPBC Policy Statement 2.1 – Part B (Additional management measures). A noise assessment consistent with the recommendations of the Technical guidance for
	Conservation advice on fin whale (*Balaenoptera physalus*) (TSSC 2015b)	
	Conservation management plan for the blue whale: A recovery plan under	

MNES	MNES Acceptability Considerations (EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
	the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (CoA 2015a)	assessing the effects of anthropogenic sound on marine mammal hearing (NMFS 2024) was undertaken.
Threatened and Migratory Species – Marine Reptiles	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1).	The evaluation of environmental impacts indicates that potential impacts from noise emissions on threatened or migratory marine reptiles are predicted to be slight and would not constitute a significant impact. As such, the petroleum activities do not exceed any of the significant impact criteria for threatened and migratory marine reptile species, as listed in Table 8-1.
	Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA 2017b)	Acute and chronic noise pollution has been identified as a threat in the Recovery Plan for Marine Turtles (CoA 2017b); however, there are no specific actions in the Plan in relation to noise pollution, except a recognised need to conduct additional research on the impacts of noise on turtles. A noise assessment consistent with the sound exposure level guidelines recommendations for marine turtles (McCauley et al. 2000; Finneran et al. 2017) was undertaken.
	Conservation advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n)	Refer to Table 9-32.
Other Species – Sharks and Rays	Conservation advice on whale shark (*Rhincodon typus*) (DoE 2015e)	A noise assessment consistent with the recommendations of the sound exposure guidelines for fishes and marine turtles was undertaken. This considered the potential impacts of underwater noise on whale sharks. Although there is not specific noise related conservation advice for whale sharks, as a result of the noise impact modelling establishing potential impacts to this species, additional controls were adopted to protect whale sharks during piling operations. This included, adapting the relevant parts of EPBC Act Policy Statement 2.1, to also cover whale sharks.
Commonwealth Marine Environment	Significant Impact Guidelines for the Commonwealth marine environment (Table 8-1)	The evaluation of environmental impacts indicates that any impacts from noise emissions aspect of Crux installation activities are predicted to not exceed the Commonwealth marine environment significant impact criteria, as listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-32: Summary of Acceptability and Regard given to the Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n).

Threat	Applicable Conservation Advice for *Aipysurus fuscus* (dusky sea snake)	Assessment of Acceptability and Regard given to Conservation Advice *Aipysurus fuscus* (dusky sea snake)
Fossil fuel exploration and extraction		
Excessive Marine Noise	It is essential that gas and oil exploration, extraction, production and decommissioning activities are adequately and effectively regulated and enforced to avoid negative	Excessive marine noise associated with piling and drilling has been identified as a threat in the Conservation Advice for *Aipysurus fuscus* (dusky sea snake). A noise impact assessment consistent with the recommendations of the conservation advice was

Threat	Applicable Conservation Advice for *Aipysurus fuscus* (dusky sea snake)	Assessment of Acceptability and Regard given to Conservation Advice *Aipysurus fuscus* (dusky sea snake)
	impacts to the dusky sea snake at all stages of each project. This includes the use of a precautionary approach to avoid potential threats until further information is available from targeted research. Monitoring for compliance is essential in this remote area. Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: All sources of excessive or constant marine noise that may impact the dusky sea snake: Use knowledge about barotrauma in oral gulping fish as a surrogate for assessing and avoiding barotrauma in the dusky sea snake until further information is available from targeted research; noting that reef-dependent sea snakes, including the dusky sea snake, have little to no capacity to relocate to avoid noise. Ensure all other sources of excessive or constant marine noise that may impact the dusky sea snake are eliminated, including from drilling and shipping.	undertaken. Sound exposure guidelines for fish with a swim bladder was used as a proxy for the dusky sea snake to evaluate potential impacts too this species from piling and DTH drilling. DTH drilling was found to have no potential noise impact pathways for the dusky sea snake. Mortal and potential mortal injury thresholds for the dusky sea snake, using fish with a swim bladder as a proxy, from the pile driving activity may be met if the animal remains within 3.47 km of the pile driving location and is exposed to continuous impulsive noise for a 24-hour period. Recoverable injury to the dusky sea snake, using fish with a swim bladder as a proxy, may be met if the animal remains within 6.4 km of the pile driving location for a 24-hour period. This assessment also found that the modelling of maximum-over depth PK from pile driving activity predicted a potential exceedance of the threshold for mortality and potential injury to the dusky sea snake within 700 m MHU 500T hammer) or 290 m (IHC 800S hammer) of the substructure location. Using the hierarchy of controls, Table 9-29 demonstrates the regard given to eliminating piling, which concluded that alternate piling methods such as suction piles are not deemed technically feasible. Although the closest dusky sea snake habitat that may occur is >10 km from the piling location, using the precautionary principle, in light of limited understanding of its range and habits, additional controls have been adopted to address potential risk of impacting the dusky sea snake. This resulted in the adoption of a control and performance standard which adapts the relevant parts of EPBC Act Policy Statement 2.1 to also apply to the dusky sea snake. This shows that an adequate level of regard has been given to the conservation advice, resulting in and improvement in understanding of potential impacts to the dusky sea snake and the adoption of additional controls to reduce potential impacts to acceptable levels. Vessel noise is further considered under the constant marine noise threat below.
Marine Vessel		
Constant Marine Noise	Develop, implement and enforce regulations that require marine vessels that are operating in areas where the dusky sea snake is known or likely to occur to have adequate noise-quieting technology installed.	This is not considered a relevant conservation action as it relates to the development, implementation and enforcement of regulation, which is a function of relevant regulatory authorities. Regardless, a noise impact assessment was undertaken consistent with the advice for excess/constant marine noise (descried above). PTS and TTS may be met for continuous noise for the dusky sea snake, using fish with a swim bladder as a proxy, if the animal remains within 200 m of the noise source. While the dusky sea snake may be at risk from constant noise effects, it is highly dependent on shallow water habitat (less than 15 m water depth). Given the

Threat	Applicable Conservation Advice for *Aipysurus fuscus* (dusky sea snake)	Assessment of Acceptability and Regard given to Conservation Advice *Aipysurus fuscus* (dusky sea snake)
		distance from the Activity Area to any potential dusky sea snake habitat (8 km) and the water depth of the Activity Area (160m), the presence of and potential impacts to the dusky sea snake from continuous vessel noise undertaking tasks within the Activity Area are consider minor. However, given vessel may operate outside of the Activity Area (when in transit), Shell has adopted an additional control and performance standard to restrict vessel from operating within 1 km of named shoals (habitat where the dusky sea snake may occur) adjacent to the Activity Area. By further restricting vessels from operating near or transiting over named shoals adjacent to the Activity Area, consistent with the conservation advice, any potential impacts associated with constant marine vessel noise are reduced without the need to adopt noise-quieting technology.
	Develop minimal-noise operating guidelines that address constant noise exposure and distribute these to captains of vessels operating in waters where the dusky sea snake is known or likely to occur. Ensure vessels are operating under minimal-noise guidelines in these areas.	As demonstrated above, vessel noise within the Activity Area does not interface with known or potential dusky sea snake habitat. By adopting a control and performance standard that restricts vessels from operating within 1km of the dusky sea snake habitat, the advice to adopt minimal-noise operating guidelines does not apply to the planned activities.
Conclusion of having had regard to the conservation Advice for Aipysurus fuscus (dusky sea snake)	The assessment of the conservation Advice for Aipysurus fuscus (dusky sea snake) shows that Shell has given regard to the applicable conservation advice in accordance with NOPSEMA and DECEEW requirements under the Streamlining Offshore Petroleum Environmental Approvals Program Report 2014[47].	

External Context

To date, no objections or claims about underwater noise have been raised by relevant persons. Shell's ongoing consultation program will consider feedback and claims or objections made by relevant persons throughout the life of this EP (refer to Section 5.8). Where new impacts or risks are established, these will be subject to the MOC process described in Section 10.1.3.

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of impacts and risks from noise determined the residual impact rankings were Minor (Table 9-28). As outlined above, the acceptability of impacts from underwater noise have been considered in the context of:

- the established acceptability criteria for the noise aspect

[47] https://www.dcceew.gov.au/sites/default/files/env/pages/06872cd4-b755-4ecf-a4e7-dd16145e1384/files/offshore-program-report.pdf

- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

Shell considers residual impacts of noise of Minor or lower to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to underwater noise. Shell considers the potential impacts from underwater noise to be ALARP and acceptable.

9.5.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No injury or mortality to listed threatened or migratory MNES species as a result of noise emissions from the Activity.	Fauna observations and incident reports demonstrate no injury or mortality of EPBC Act listed threatened or migratory MNES as a result of noise emissions within the Activity Area.

9.6 Seabed Disturbance

9.6.1 Aspect Context

Table 6-1 lists the key long–term infrastructure and structures, and temporary equipment and installation aids. Section 6.9 describes the activities that may have the potential for seabed disturbance. Seabed disturbance may occur from:

- long–term placement of infrastructure on the seabed (e.g. export pipeline, PLET foundations, flexible riser, umbilical, spool [and mattresses], substructure)
- temporary placement and set down of structures and equipment on the seabed (e.g. initiation structures, flying lead deployment frames, mooring lines and anchors, ROVs and baskets, wet parking)
- temporary seabed and sediment disturbance (e.g. excavation, water jetting).

Table 9-33 details the estimated overall seabed footprint from the Activity.

Table 9-33: Estimated Seabed Footprint

Activity/Description	Seabed footprint (~ha)
Includes placement of long–term infrastructure as listed in Table 6-1. It also includes temporary disturbance such as provision of temporary placement of infrastructure and equipment, such as ROVs and baskets, wet parking (if required), subsea beacons, transponders and clump weights. A 20% footprint contingency has been incorporated to provide for detailed design and contingency activities (if required).	23

Although not a planned activity, the potential for dropped objects exists—these objects may interact with the seabed on a very localised basis. Objects that have been dropped during previous offshore activities include small tools (e.g. spanners) and hardware fixtures (e.g. riser hose clamp). There is also potential for larger items to be dropped during the activity, particularly during temporary placement and equipment recovery. The spatial extent in which dropped objects can occur is restricted to the Activity Area.

Section 9.10 assessed the impacts associated with sedimentation of drilling cuttings.

The Prelude flexible riser and umbilical installation activities will occur within 1 km of the Prelude FLNG activities (covered under the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002] for a duration of approximately six weeks (see Section 6.9.6). These concurrent activities will result in cumulative seabed impacts. Hence, the cumulative impacts have been considered in this assessment (see Section 9.6.2.4).

9.6.2 Description and Evaluation of Impacts

9.6.2.1 Physical Environment

The seabed within the Activity Area is characterised by unconsolidated substrates (sand, gravel, mud etc.) interspersed with patches of hard substrate, which provide attachment points for sponges and molluscs. This habitat is widespread throughout the region and is not particularly unique or sensitive. Installation activities will have a physical impact within a localised disturbance footprint; however, impacts to sediment quality will only be slight.

Seabed disturbance will cause a localised increase in turbidity due to the resuspension of sediment and unconsolidated material. Section 9.10 assesses water quality, including turbidity, associated with drilling cuttings (Note: DTH drilling will use only untreated sea water). Sediment plumes will only slightly and temporarily decrease water quality.

Any seabed disturbance associated with dropped objects will be within the Activity Area and limited to a very localised footprint in the immediate vicinity of contact with the seabed.

The overall residual impact consequence level to water and sediment quality is ranked as Slight (Magnitude: −1, Sensitivity: L).

9.6.2.2 Biological Environment

9.6.2.2.1 Habitats and Communities

The benthic habitat surveys conducted by Fugro (2017) and AECOM (2017) (see Section 7.3.1), although not sufficiently statistically robust for future impact assessment comparison, indicated a low proportion of hard substrate in the Activity Area and that macrobenthic fauna may typically be in low abundance. The habitats present are broadly distributed in the wider region and associated communities unlikely to be unique or highly restricted. Benthic communities within the Activity Area may be impacted by seabed disturbance related to the activities described in Section 9.6.1. Seabed disturbance can alter habitat conditions, resulting in changes to epifauna and infauna (living on and in the sediment) communities (Newell et al. 1998). Long–term seabed disturbance will occur for the life of the project, resulting in the displacement and/or permanent loss of epifauna and infauna within the physical footprint. Temporary seabed disturbance (including temporary placement of equipment and sediment displacement) may disrupt a relatively small area of soft sediment habitats, which are likely to recover rapidly.

Habitat modification from depositing drilling cuttings could occur within ~386 m (up to 0.28 km^2) from the drill holes (up to 14 drill holes) (RPS 2023a). Within this area, benthic communities may be altered or reduced, resulting in a highly localised impact to any epifauna and infauna. Potential impacts include burial or smothering effects, particularly for sessile epifauna, from localised sediment deposition. Sediment coating resulting from elevated turbidity/total suspended solids (TSS) can also potentially cause clogging or damage to the physiological functioning of biota such as sea pens and polychaetes that rely on external respiratory and feeding structures. Soft sedimentary communities are known to recover rapidly to temporary disturbance.

The deepwater environment is not oxygen saturated and oxygen levels in the water column at depth are substantially reduced, compared to the upper surface layers. Deepwater benthic biota are adapted to such conditions, which also include zero light and reduced temperature. Changes in oxygen levels resulting from sediment disturbance during the Activity will be of short duration and temporary (excluding the footprint of long–term infrastructure and structures).

The proposed seabed disturbance is a small proportion of the soft sediment habitats available. The natural patchiness of benthic fauna distribution (at scales from centimetres up to hundreds of metres) within unconsolidated seabed substrates has been well documented through numerous studies (Sandulli & Pinckney 1999, Rogers *et al.* 2008, Zajac 2008, Kraan *et al.* 2009, Ramey *et al.* 2009, Meadows *et al.* 2012, Somerfield *et al.* 2019, Stark *et al.* 2024). Disturbed or altered substrates can reasonably be expected to be recolonised through recruitment from adjacent undisturbed areas. It is reasonable to expect that, for any benthic fauna that may be impacted during field activities, there will be species of equivalent ecological function that are present within the broader region.

Given the widespread extent of similar habitat, the low proportion affected within the Activity Area, and the high likelihood that temporarily affected areas will recover in a short time, environmental effects are considered to be of minimal ecological significance. Therefore, the consequence of any impacts is considered to be Slight.

9.6.2.2.2 Key Ecological Features

The Activity Area intersects one KEF—Continental slope demersal fish communities (see Figure 7-3). This KEF is partially overlapped by 7 km of the export pipeline corridor, with the corridor covering ~14 km^2 of the KEF (representing <0.05% of the total KEF area). This section has a water depth of ~200–230 m and environmental surveys recorded isolated areas of hard substrates and associated communities (Fugro 2017a). The value associated with this KEF is high levels of biodiversity and endemism in the demersal fish communities. The demersal fish species associated with the KEF tend to occupy two distinct demersal community types (biomes) associated with the upper–slope (water depth of 225–500 m) and the mid-slope (750–1,000 m) (DSEWPaC 2012a).

Disturbance to the seabed associated with installation of the pipeline has the potential to affect the benthic bacterial and fauna communities that are thought to underpin the food web that supports the demersal fish (and other higher order) communities on the slope. Assuming (conservatively) a 1 m wide seabed footprint for the pipeline (0.8 m OD) and associated stabilisation, the pipeline will affect <0.000043% of the KEF and its presence will locally increase the extent of hard substrate if/where it traverses areas of soft sediment, and directly displace associated benthic communities. However, considering the very small proportion of the KEF involved and the likelihood that bacterial or epifauna communities that exist on natural hard substrates of the KEF within the pipeline corridor will colonise the pipeline infrastructure over time, impacts to the food web are expected to be highly localised and temporary, with negligible ecosystem consequences. The presence of

pipelines has been positively correlated with the diversity and abundance of fish (McLean et al. 2017); ultimately, the export pipeline is expected to host an artificial reef community with relatively high fish diversity and abundance compared to the surrounding seabed areas of soft sediments.

Given the ecological value of the continental slope demersal fish communities KEF is the relatively high diversity of demersal fish species, and that the nature and scale of potential effects on the habitat that supports that biodiversity is negligible, seabed disturbance associated with the export pipeline is not expected to have any negative impact on the environmental value of the KEF. Subsea infrastructure construction has not been identified as an actual or potential concern in relation to the KEF (DSEWPaC 2012; DCCEEW 2022).

9.6.2.2.3 Threatened and Migratory Species

Habitat modification is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (Table 7-14); however, the extent of the seabed disturbance is not anticipated to significantly affect marine fauna that may be present, such as marine mammals, marine reptiles, sharks, rays and other fish. Further, seabed disturbance represents a negligible portion of the habitat available for threatened and migratory species. There are also no significant benthic habitat and communities that, if impacted, would result in a reduction in food sources for the species.

Seabed disturbance from temporarily displacing sediment may temporarily make prey for predatory demersal fish more available. Increased prey availability could result in a short-term attraction of demersal fish to the Activity Area.

Table 7-10 lists the EPBC Act listed threatened sharks and other fish that may occur within the Activity Area. A whale shark foraging BIAs overlaps the Activity Area; however, feeding patterns are unlikely to be impacted by seabed disturbance. Due to the highly mobile nature and wide representation of these sharks and other fish as well as the limited seabed disturbance associated with the Activity, it is considered unlikely that these species will be adversely impacted. Table 7-7 lists the EPBC Act listed marine reptiles that may occur within the Activity Area. The Activity Area does not contain suitable turtle foraging or sea snake habitat (no submerged features and water depths >95 m). Therefore, seabed disturbance within the Activity Area is considered unlikely to affect marine reptiles.

Habitat modification is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (Table 7-14); however, seabed disturbance represents a negligible portion of the habitat available for threatened and migratory species. As there is no significant benthic habitat and communities to be impacted; a reduction in food sources is not anticipated.

9.6.2.3 Socioeconomic and Cultural Environment

9.6.2.3.1 Indigenous Cultural Features and Values

There are no known First Nations underwater cultural heritage artifacts within the Activity Area. Cosmos Archaeology (2023) predicted that the Activity will not impact any tangible First Nations underwater cultural heritage as the proposed infrastructure locations (covered under this EP) are located below 130 m LAT which is the maximum extent of exposed land since humans have occupied the continent. Shell also has not identified through desktop research or through consultation in preparation of this EP, any intangible Indigenous cultural values, such as songlines, which may be impacted by the planned activities in this EP. Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For the assessment of impacts to marine species that may be of cultural significance, refer to Section 9.5.2.2.3.

No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to Indigenous cultural heritage features or values from this aspect. The overall impact consequence is considered to be no impact (Magnitude: 0, Sensitivity: L).

9.6.2.3.2 Marine Archaeology

There are currently no known underwater heritage artifacts (e.g. shipwrecks or other UCH sites) within the Activity Area (see Figure 7-29; DCCEEW n.d.) or identified during relevant persons consultation. Therefore, there are currently no predicted impacts to underwater heritage artifacts.

9.6.2.3.3 Fishing

Potential impacts to the seabed, and subsequently to the associated commercially targeted fish resources—such as scampi—will be localised and the potential impact to, and displacement of, fish is expected to be insignificant at a stock level.

No other environmental receptors are considered relevant to the aspect, Disturbance to Seabed, due to the limited nature and scale of the activity.

9.6.2.4 Cumulative Impacts

On the basis that concurrent activities will occur within proximity to the Prelude FLNG, the potential for cumulative seabed disturbance impacts is acknowledged.

The concurrent activities will be conducted in water depths greater than 240 m and in predominantly bare sediment that contains a low abundance and diversity of infauna. There are no known BIAs near the Prelude FLNG. The habitats and fauna assemblages that are expected to be disturbed are widespread throughout the region. The turbidity generated from infrastructure placement near the Prelude FLNG is expected to be short-term and localised within the Activity Area. The direct and indirect impacts from the concurrent activities are considered unlikely to substantially change or adversely impact on biodiversity or ecological integrity of benthic communities.

When considering the absence of BIAs and significant regional habitats near the Prelude FLNG, and the short and intermittent duration of concurrent activities, additive and cumulative seabed disturbance effects are considered to be of minimal ecological significance and hence negligible.

9.6.3 Impact Assessment Summary

Table 9-34 lists the highest residual impact consequence ranking of the relevant environmental receptor groups.

Table 9-34: Seabed Disturbance Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	−1	L	Slight
Biological Environment	−1	L	Slight
Socioeconomic and Cultural Environment	0	L	No impact

9.6.4 ALARP Assessment and Environmental Performance Standards

Table 9-35: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Prohibit project vessels from anchoring in the Activity Area except in emergency situations.	Yes	Prohibiting vessel anchoring for the activity reduces seabed disturbance to ALARP.	4.1	No vessel anchoring associated with the activities	Vessel logs confirm no project vessels used anchors within the Activity Area.
Substitution	N/A	N/A	Substitution of seabed disturbance is not technically feasible.	N/A	N/A	N/A
Engineering	Do not use an ROV close to or on the seabed.	No	ROV operations close to or on the seabed are considered ALARP due to the water depths of the Activity Area and hence cannot be eliminated. Given the nature of the seabed, disturbance from ROV operations will be negligible, and implementing this control is considered technically unfeasible.	N/A	N/A	N/A
Engineering	Position infrastructure on the seabed within the design footprint to reduce seabed disturbance.	Yes	Positioning of infrastructure on the seabed within the design footprint will ensure disturbance occurs within planned areas where impacts have been assessed. The environmental benefits outweigh the cost associated with implementing this control.	4.2	Infrastructure is installed on the seabed within the Activity Area and design footprint as confirmed by as laid surveys.	As-laid surveys are performed to confirm the infrastructure has been installed within the Activity Area and design footprint.
Administrative and Procedural Controls	Remove all temporary structures, equipment and property that are no longer in use.	Yes	Temporary structures, equipment and property will be designed and removed, if no longer required, in accordance with Section 572 of the OPGGS Act and aligned to Section 572: Maintenance and Removal of Property Policy (NOPSEMA 2022d). Implementing this control is a regulatory requirement and considered reduce the risks to ALARP.	4.3	All temporary structures, equipment and property will be designed to be retrievable and removed if no longer required. Should Crux activities beyond the scope of this EP require the temporary structures, equipment or property will be recorded in an asset register to facilitate future removal.	Records demonstrate that temporary structures, equipment and property are removed if no longer required or logged within an asset register.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Underwater heritage chance find process.	Yes	In the event of a chance find, a designed process will be implemented to mitigate damage and protect potential heritage artefacts and sites. For example, if ad hoc evidence, such as ROV footage, might represent a potential cultural heritage artifact, seabed disturbance works will be stopped until a cultural heritage expert can confirm if the identified object is not a cultural heritage artifact. In the event the object is confirmed to be a cultural heritage artifact, works will be stopped within an appropriate exclusion area until such point that relevant approvals are obtained from DCCEEW under the UCH Act. If the object is confirmed not to be, or likely not to be, a cultural heritage artifact, works may resume. The benefit outweighs the cost associated with implementing this control.	4.4	Shell's underwater heritage chance find process will be implemented should a chance find be encountered to reduce impacts to potential heritage and cultural features and values to ALARP. This process will include stop work triggers and notification processes.	A copy of the underwater heritage chance find process. Training records verify relevant project personnel have been provided the relevant chance find procedure prior to the activity commencing within the Activity Area. Further chance find process training will be available to relevant project personnel as required. ROV logs confirm implementation of the chance find process.
Administrative and Procedural Controls	Undertake in-field pre-operations baseline water quality, sediment quality and benthic habitat study	Yes	A scientifically robust pre-operations water quality, sediment quality and benthic habitat sampling design will be implemented to enable verification of the predicted level of impacts of operational phase activities and discharges. This monitoring could also be used to inform adaptive management over the whole project lifecycle, including operations and decommissioning phases. Suitably qualified personnel (e.g. external independent consultants) will be engaged to design and carry out the monitoring. Considerations of lessons learnt from other industry monitoring studies will be obtained where possible. The design will also consider where likely expected impacts are predicted given prevailing conditions onsite. Further details of the pre-operations baseline study are described in Section 10.4.2.	4.5	Pre-operations baseline water quality, sediment quality, and benthic habitat study will be undertaken in accordance with Section 10.4.2 and will be executed within the duration described in this EP.	Pre-operations baseline water quality, sediment quality, and benthic habitat study report demonstrates field execution timing and implementation of the pre-operations baseline study as described in Section 10.4.2.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Areas of the seabed disturbed by installation activities will be surveyed prior to installation.	Yes	Allow for infrastructure installation to avoid significant seabed features and/or habitats	4.6	Seabed surveys undertaken in areas disturbed by installation of facilities and infrastructure	Pre-installation seabed survey reports
Administrative and Procedural Controls	Separation distance to shoals identified to require protection in the OPP	Yes	Avoids potential for impacts to benthic habitats at shoals from seabed disturbance associated with installation activities.	3.8	Refer to EPS 3.8	Refer to EPS 3.8
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity seabed disturbance. No additional or alternative controls were identified that could further reduce the impacts. Therefore, the impacts are considered to be reduced to ALARP and an acceptable level.						

9.6.5 Acceptability of Impact

Table 9-36: Acceptability of Impact –Seabed Disturbance

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
Physical Environment	Water Quality Sediment Quality		No significant impacts to water quality during the Activity. No significant impacts to sediment quality during the Activity.	Yes	Seabed disturbance will be small scale, infrequent and a small fraction of similar habitat in the region. Rapid recovery is expected. Significant impact to water and sediment quality is a not credible.
Biological Environment	Habitats and Communities	Benthic Communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Crux Project Area (as defined in the OPP).	Yes	The seabed in the Activity Area is broadly distributed and not considered unique or particularly sensitive. Given the nature and scale of the planned impacts to the benthic habitat within the Activity Area, the threshold for Significant impacts will not be exceeded. Section 9.6.1 demonstrates that direct seabed disturbance of 23ha falls within the prescribed limit of 5% of the Crux Project Area.

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
		KEF	No significant impacts to environmental values of KEFs.	Yes	The export pipeline corridor intersects one KEF—Continental slope demersal fish communities and will disturb <0.000043% of the total KEF area. Given the nature and scale of the seabed disturbance within this KEF, there are no expected negative impacts on the environmental value of the KEF.
	Threatened and migratory species	Marine mammals Marine reptiles Sharks, rays and other fish Birds	No mortality or injury of threatened MNES fauna. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	Habitat modification is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (Table 7-14); however, seabed disturbance represents a negligible portion of the habitat available for threatened and migratory species. There is also no significant benthic habitat and communities that will be impacted; hence a reduction in food sources is not anticipated. Therefore, negligible impacts to threatened and migratory species from seabed disturbance are expected.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that occur within the Activity Area.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from seabed disturbance, given that no significant impacts to culturally significant marine species are expected.
	Marine Archaeology		No disturbance to historical shipwrecks and sunken aircrafts is acceptable.	Yes	No disturbance to historical shipwrecks and sunken aircrafts will occur.
	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Yes	There is a potential for impacts to commercially targeted fish resources—such as scampi. However, this impact will be localised and the potential magnitude of impact to, and displacement of, fish is considered to be insignificant at a stock level.

Principles of ESD

The potential impacts from seabed disturbance are consistent with the principles of ESD because:

- Seabed disturbance on such a small scale will not degrade the biological diversity or ecological integrity of the Commonwealth marine environment and therefore significant impacts to MNES will not occur.
- The health, diversity and productivity of the marine environment will be maintained for future generations.
- The precautionary principle has been applied, and studies were undertaken where knowledge gaps were identified. This knowledge was applied when evaluating environmental impacts.

Relevant Requirements

Managing the potential impacts from seabed disturbance is consistent with relevant legislative and other requirements, including

- OPGGS Act:
  - Section 460(2) – a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.
  - Section 572 of the OPGGS Act and Section 572: Maintenance and Removal of Property Policy (NOPSEMA 2022d) – places duties on titleholders in relation to maintaining and removing the structures, equipment and property brought onto the title.
- guidelines for the protection of MNES (Table 8-1).
- industry best practice.

External Context

To date, no objections or claims about seabed disturbance have been raised by relevant persons. Shell's ongoing consultation program will consider feedback and claims or objections made by relevant persons throughout the life of this EP (refer to Section 5.8). Where new impacts or risks are established these will be subject to the MOC process described in Section 10.1.3.

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of impacts and risks from seabed disturbance determined the residual impact rankings were Slight (Table 9-34). As outlined above, the acceptability of impacts from seabed disturbance have been considered in the context of:

- the established acceptability criteria for the seabed disturbance aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant person claims)
- internal context (i.e. Shell requirements).

Shell considers residual impacts of Minor or lower to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to seabed disturbance.

Shell considers impacts from seabed disturbance to be ALARP and acceptable.

9.6.6 Environment Performance Outcome

Table 9-37: Environmental Performance Outcomes and Measurement Criteria

Environment Performance Outcome	Measurement Criteria
No planned impacts to cultural heritage features within the Activity Area as a result of the petroleum activities.	Underwater heritage chance find process implementation records.
No significant impacts[48] to cultural heritage values within the Activity Area as a result of the petroleum activities.	Consultation records and/or MOC records show that any cultural heritage values identified within the Activity Area are not significantly impacted as a result of the petroleum activities.
Direct impacts to benthic habitats from the Crux infrastructure installation will be limited to <25 Ha of the total Project Area	Report(s) confirm the Crux infrastructure has been laid within the Activity Area and does not exceed a total direct disturbance footprint of <25 Ha.
Impacts from the export pipeline that intersects the Continental slope demersal fish communities KEF will be <0.05% of the total KEF area.	As laid survey records for the pipeline confirm Impacts from the export pipeline that intersects the Continental slope demersal fish communities KEF is <0.05% of the total KEF area.
No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal and Vulcan Shoal as a result of installation activities.	Vessel AIS system shows project vessels do not enter within 1km of the named Shoals adjacent to the Activity Area

[48] Significant impacts to cultural heritage values as defined in Table 8-3.

9.7 Vessel Movements

9.7.1 Aspect Context

A range of project vessel types will be needed to carry out the Activity (see Section 6). Table 6-6 lists indicative activities for each vessel type and Section 6.5 describes the vessel types and specifications. The type and number of project vessels within the Activity Area at any one time and how long they will be present, will differ depending on the work package being undertaken. Table 6-6 lists the project vessels estimated durations.

The physical presence of project vessels within the Activity Area may present a hazard to threatened marine fauna including mammals, turtles and whale sharks; however, the abundance of such fauna in and around the Activity Area has been observed to be low. Project vessels may collide with marine fauna, potentially resulting in injury or death. Factors affecting the likelihood and severity of impacts from collisions include vessel type, vessel speed, water depth and the behaviours of animals present (CoA 2017).

9.7.2 Description and Evaluation of Risks

Project vessel movements can result in collisions between the vessel (hull and propellers) and marine fauna, potentially resulting in superficial injury, serious injury that may affect life functions (e.g. movement, reproduction), or death. Marine fauna are also at risk of death if caught in thrusters during station keeping operations (DP).

The likelihood of vessel/fauna collision being lethal is influenced by vessel speed—the greater the speed at impact, the greater the risk of death (Jensen and Silber 2004; Laist et al. 2001, Conn and Silber 2013). During installation activities, most project vessels will travel at ~1 knot—effectively, they will be immobile and will not pose a vessel collision risk to marine fauna. At times, project vessels will transit through the Activity Area at higher speeds up to 15 knots.

The risk of megafauna getting caught in operating thrusters is considered unlikely, given the low presence of individuals, combined with their likely avoidance of DP operations due to factors such as noise emissions. The risk of a project vessel collision with marine fauna, particularly threatened and migratory species (i.e. MNES) (receptor category threatened and migratory species described in Section 9.7.2.1.1), is consistent with the acceptable levels of impacts defined in Section 8. Shell's environmental management of the vessel movements aspect of the petroleum activities aligns with conservation advice, recovery plans and threat abatement plans (Table 7-14); refer to the discussion of acceptability in Section 9.7.5.

No credible impacts are associated with vessel movements on other environmental receptor categories (Table 8-4); therefore, these are not considered in the assessment of impacts below.

Potential risks associated with vessel movements within the Activity Area are discussed below. As outlined in Section 9.2.4, the assessment considers only the residual risks following the application of controls.

9.7.2.1 Biological Environment

9.7.2.1.1 Threatened and Migratory Species

The Activity Area is not directly adjacent to or near any known important habitats for threatened or migratory species. The abundance of threatened or migratory species in the Activity Area is expected to be low and their presence transient.

Marine Reptiles

The Activity Area does not represent important habitat for marine turtles given the absence of potential nesting sites or sea snakes given the absence of shallow reefs or shoals. The Activity Area water depths range between ~90–260 m, which is deeper than typical foraging dives by marine turtles (e.g. Hays et al. 2001; Polovina et al. 2003) or sea snakes (TSSC 2010a, TSSC 2010b and DCCEEW 2024n). Therefore, the presence of marine turtles or sea snakes within the Activity Area is likely to be restricted to individuals transiting the area. As with cetaceans, the risk of collisions between turtles and vessels increases with vessel speed (Hazel et al. 2007). The typical response from turtles on the surface to the presence of vessels is to dive (a potential 'startle' response), which decreases the risk of collisions (Hazel et al. 2007). Given the low speed of the project vessels when in the Activity Area, combined with the expected low numbers of turtles and sea snakes in the area, the likelihood of collisions between vessels is assessed as Unlikely (C).

Sharks and Rays

Whale sharks and manta rays are at risk from vessel strikes when feeding at the surface (Womersley et al. 2022). Whale sharks have been observed in small numbers traversing the Activity Area, which is within a whale

shark foraging BIA. Within the whale shark foraging BIA, whale shark tagging surveys identified continual movement of the whale sharks in deeper, open offshore waters (Meekan and Radford 2010; Womersley et al. 2022). This was further supported by Reynolds et al. 2017 and Reynolds et al. 2021 that reported whale shark movements predominantly closer to shore between Shark Bay and Ningaloo with movements into deeper, offshore waters off the Western Australian coast north of Broome. The Conservation Advice (DoE 2015e) also indicates that this BIA is used by whale sharks as a migration corridor rather than as significant foraging habitat. These results indicate that the BIA is considered unlikely to be a significant foraging habitat and that whale shark presence is likely to be transitory. There are no constraints (e.g. shallow water, shorelines) in the Activity Area that prevent whale sharks from moving away from vessels. The BIA forms a wide corridor of up to 170 km near the Activity Area.

Given the generally low speeds of vessels in the Activity Area, installation vessel movements are unlikely to result in injury or significant impacts, however as a precautionary measure and in alignment with best practice Shell will adopt a speed limit (refer to Table 9-39) within the Activity Area for all installation vessels during the whale shark migration period (July to November). This speed limit is consistent with that applied by the US National Oceanic and Atmospheric Administration (NOAA) as a seasonal management measure to protect whales in areas of high vessel traffic of the Eastern Seaboard in the United States. A study undertaken by Conn and Silber (2013) proposed a significant (>80%) vessel strike and mortality risk reduction for large marine fauna such as whales associated with the speed restriction of 10 knots introduced by NOAA.

Similarly, interaction with other species of threatened sharks and rays (see Section 7.3.3.3) is considered unlikely because the Activity Area lacks benthic habitat that supports aggregation. If there was an encounter, avoidance of the vessel would be expected owing to the slow speed or stationary nature of the project vessels coupled with the sensory abilities of sharks and rays. Therefore, the likelihood of collisions is assessed as Unlikely (C).

Marine Mammals

Whales are particularly vulnerable to collisions with vessels due to their large size and the relatively high proportion of time they spend at or near the sea surface. The likelihood and consequence of vessel collisions with whales are influenced by vessel speed—the greater the speed at impact, the greater the risk of death (Jensen and Silber 2004; Laist et al. 2001). Conn and Silber (2013) proposed a significant (>80%) vessel strike and mortality risk reduction for large marine fauna such as whales associated with a speed restriction of 10 knots introduced by NOAA. Vanderlaan and Taggart (2007) found that the chance of lethal injury to a large whale as a result of a vessel strike increases from about 20% at 8.6 knots to 80% at 15 knots. Vanderlaan and Taggart (2007) estimate that the risk is <10% at a speed of 4 knots. Although dolphins are at much lower risk from collision (due their small size, manoeuvrability and echolocation abilities) compared to whales, they are still included in this assessment because they surface to breathe and are known to feed near the surface at times.

Section 9.7.2 describes the vessel speeds (~1 knot during installation activities; up to 15 knots during transit). With these low speeds combined with the proposed speed restriction within the Activity Area for installation vessels (July to November) and the relatively short duration of the activities, the likelihood of a vessel collision with threatened or migratory species is considered Unlikely (C).

A collision is only likely to affect individual fauna rather than at a population or species scale. Therefore, an injury or death of an individual from a threatened or migratory species from a collision is considered to be of Minor impact consequence (Magnitude: −2, Sensitivity: M) and Unlikely (C) likelihood with a residual risk assessed as Dark Blue (Table 9-38).

9.7.2.2 Socioeconomic and Cultural Environment

Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For the assessment of impacts to marine species that may be of cultural significance, refer to Section 9.7.2.1.1.

No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to socioeconomic receptors or Indigenous cultural heritage features and values from this aspect.

Given the Dark Blue residual risk to marine species, significant impacts to Indigenous cultural features and values receptors are not anticipated.

9.7.3 Risk Assessment Summary

Table 9-38 lists the highest residual risk ranking of the relevant environmental receptor groups.

Table 9-38: Vessel Movement with Marine Life Evaluation of Residual Risks

Environmental Receptor	Consequence	Likelihood	Residual Risk
Evaluation – Unplanned Risks			
Physical Environment	N/A	N/A	N/A
Biological Environment	Minor	C	**Dark Blue**
Socioeconomic and Cultural Environment	Minor	C	**Dark Blue**

9.7.4 ALARP Assessment and Environmental Performance Standards

Table 9-39: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	N/A	N/A	No appropriate control measures have been identified to eliminate this risk from the Activity.	N/A	N/A	N/A
Substitution	N/A	N/A	The number of proposed project vessels is considered the minimum to meet operational and safety needs.	N/A	N/A	N/A
Engineering	N/A	N/A	No appropriate control measures have been identified to reduce collision likelihood through engineering means.	N/A	N/A	N/A
Administrative and Procedural Controls	Project vessel interactions with threatened and migratory species to follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06). In particular: Project vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf. If the whale, dolphin, turtle or whale shark shows signs of being distressed, project vessels will immediately withdraw from the caution zone at a constant speed of ≤6 knots (except in emergency conditions or when manoeuvring is not possible, such as in the case of pipelay activities or floatover activities).	Yes	The EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06) are recognised as the industry standard for minimising disturbance due to physical presence and noise to whales and dolphins and will be applied to other species as relevant (i.e. turtles, whale sharks). Implementing this control, is based on legislative requirements and hence adopted.	3.1	Refer to EPS 3.1.	Refer to EPS 3.1.
Administrative and Procedural Controls	Vessel speed restrictions within the Activity Area during sensitive periods (whale shark migration period July to November).	Yes	The *Conservation Advice for Whale Sharks (Rhincondon typus)* (DoE 2015e) consider vessel collision as a threat to the species. Given the generally low speeds of project vessels within the Activity Area, installation vessel	5.1	Vessels shall not exceed 10 knots when operating within the Activity Area during the whale	Vessel logs confirm vessel speeds did not exceed 10 knots when operating within the Activity Area during the whale shark

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			movements are unlikely to result in injury or significant impacts, however as a conservative management measure the installation vessels will adopt a speed limit of no more than 10 knots within the Activity Area during the whale shark migration period (July to November). This speed limit is consistent with that applied by NOAA as a seasonal management measure to protect whales in areas of high vessel traffic of the Eastern Seaboard, United States. A study undertaken by Conn and Silber (2013) proposed a significant (>80%) vessel strike and mortality risk reduction for whales associated with the speed restriction of 10 knots introduced by NOAA. The environmental benefits outweigh the cost associated with implementing this control.		shark migration period (July to November).	migration period (July to November). Vessel navigation systems or charts have Activity Area boundary including speed limit warning on it.
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n) lists constant marine noise from marine vessels as a threat to the dusky sea snake. The associated conservation action lists the development and implementation of minimal noise operating guidelines for vessels operating in waters where the dusky sea snake is known or likely to occur. Given the locations where dusky sea snake may occur is adjacent to (outside of) the Activity Area, within shallow water shoals, restricting project vessels from operating in these areas, reduces potential exposure to vessel related impacts.	3.8	Refer to EPS3.8	Refer to EPS3.8
Administrative and Procedural Controls	Dedicated marine fauna observers on all project vessels.	No	The cost to have dedicated trained marine fauna observers on all project vessels represents a disproportionate cost given the low likelihood of the event occurring due to the absence of critical habitats or BIAs for cetaceans within the Activity Area.	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Demonstration						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with project vessel movements. No additional or alternative controls were identified that could further reduce the impacts without disproportionate effort and cost. Therefore, the impacts are considered to be reduced to ALARP.						

9.7.5 Acceptability of Risks

Table 9-40: Acceptability of Risks – Vessel Movements

Category	Receptor		Acceptable Level of Impact	Acceptable?	Acceptability Assessment
	Subcategory				
Biological Environment	Threatened and migratory species	Marine mammals Marine reptiles Sharks and rays	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	Vessel movement risks are of an acceptable level, given the vessel speed restriction for installation vessels during the whale shark migration period (July to November). With the exception of the whale shark BIA (which represents a broad migratory corridor), the Activity Area is not located in any BIAs or habitat critical to the survival of a species. Threatened and migratory species are also not expected in significant numbers and are considered likely to only be transiting individuals. In addition, with the low speeds of project vessels within the Activity Area, significant impacts to threatened and migratory species are not anticipated. Shell's environmental management of the vessel movements and potential impacts are not inconsistent with the conservation actions outlined in the relevant conservation advice, recovery plans and threat abatement plans.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that occur within the Activity Area.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from this aspect, given that no significant impacts to culturally significant marine species are expected.

The assessment of risks from vessel movements determined the residual ranking of Dark Blue (Table 8-4), deemed as inherently acceptable. As outlined above, the acceptability of risks to marine biota from vessel movements associated with the petroleum activities has been considered in the following context.

Principles of ESD

The potential risks of impacts from vessel movements are consistent with the principles of ESD because:

- The vessel movements aspect does not degrade the biological diversity or ecological integrity of the Commonwealth marine area in the northern Browse Basin.
- Significant impacts to MNES are highly unlikely.
- The health, diversity and productivity of the marine environment will be maintained for future generations.

- The precautionary principle has been applied, and studies were undertaken where knowledge gaps were identified. This knowledge was applied when evaluating environmental risks.

Relevant Requirements

Managing the potential risks of impacts from vessel movements is consistent with relevant legislative requirements, including:

- Vessel interactions with threatened and migratory species to follow the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06) and the Australian National Guidelines for Whale and Dolphin Watching 2017 (DoEE 2017):
  - Project vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf.
  - If the whale, dolphin, turtle or whale shark shows signs of being distressed, project vessels will immediately withdraw from the caution zone at a constant speed of ≤6 knots (except in emergency conditions or when manoeuvring is not possible, such as in the case of pipelay activities or floatover activities).
- Policies, strategies, guidelines, conservation advice, and recovery plans for threatened species (see Table 9-41).

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation of risks indicates significant impacts to threatened and migratory species will not credibly result from the vessel movements aspect of the petroleum activities.

An unplanned collision between a project vessel and threatened or migratory fauna is considered unlikely to occur; however, if it does occur, it may result in injury to or death of an individual animal. This unplanned event is not considered to have the potential for significant impacts to threatened or migratory species at the population level.

Table 9-41 summarises the alignment with management plans, recovery plans and conservation advice for threatened and migratory fauna.

Commonwealth Marine Environment

The potential impacts and risks from the vessel movements aspect of petroleum activities on the Commonwealth marine environment will not credibly exceed any of the significant impact criteria, as listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-41: Summary of Alignment of the Risks from the Vessel Movements Aspect of the Petroleum Activities with Relevant Requirements for EPBC Threatened Fauna

MNES	MNES Acceptability Considerations (EPBC Management Publications/Recovery Plans/Conservation Advice)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory Species – Marine Mammals	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The risk assessment indicates that the likelihood of vessel collisions with threatened or migratory marine mammals is considered unlikely, and the consequence of any such collision would be restricted to an individual animal. As such, the petroleum activities do not exceed any of the significant impact criteria for threatened and migratory marine species, as listed in Table 8-1.
	National Strategy for Reducing Vessel Strike on Cetaceans and other	Vessel movements will be aligned to 'Objective 3: Mitigation' of the National Strategy by: • maintaining separation of vessels and whales

MNES	MNES Acceptability Considerations (EPBC Management Publications/Recovery Plans/Conservation Advice)	Demonstration of Alignment as Relevant to the Project
	Marine Megafauna (CoA 2017)	• maintaining slow vessel speeds, including a speed restriction during the whale shark migration period for installation vessels (July to November) • avoidance manoeuvres. This will be met by the project vessels adhering to Part 8 (interacting with cetaceans and whale watching) of the EPBC Regulations. Note: The other objectives of the Strategy relate to actions for government agencies.
	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	The risk of vessel strikes will be managed by adhering to the EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06).
	Conservation advice on fin whale (*Balaenoptera physalus*) (TSSC 2015b)	
	Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (CoA 2015a)	
Threatened and Migratory species – Marine Reptiles	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The risk assessment indicates that the likelihood of vessel collisions with threatened or migratory marine reptiles is considered remote, and the consequence of any such collision would be restricted to an individual animal. As such, the petroleum activities do not exceed any of the significant impact criteria for threatened and migratory marine species, as listed in Table 8-1.
	Recovery Plan for Marine Turtles in Australia 2017-2027 (CoA 2017b)	Project vessels colliding with turtles is considered unlikely due to the offshore location (and resultant low densities of turtles), slow speeds of the vessels and diving startle response of turtles. Furthermore, the risk of a vessel collision with a turtle will be further reduced by implementing EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06)
	Conservation advice on leatherback turtle (*Dermochelys coriacea*) (TSSC 2008a)	
Threatened and Migratory species – Sharks and Rays	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The risk assessment indicates that the likelihood of vessel collisions with threatened or migratory sharks and rays is considered remote, and the consequence of any such collision would be restricted to an individual animal. As such, the petroleum activities do not exceed any of the significant impact criteria for threatened and migratory marine species, as listed in Table 8-1.
	Conservation advice on whale shark (*Rhincodon typus*) (DoE 2015e)	The Activity Area intersects a recognised foraging whale shark BIA. The conservation advice recommends minimising offshore developments close to marine features that may aggregate whale sharks and cites Ningaloo Reef and Christmas Island as examples. Studies of whale sharks tagged while aggregating at

MNES	MNES Acceptability Considerations (EPBC Management Publications/Recovery Plans/Conservation Advice)	Demonstration of Alignment as Relevant to the Project
		Ningaloo Reef have shown individuals transiting through the Timor Sea (Meekan and Radford 2010) but showed no evidence of aggregation around particular marine features in the open offshore waters within or near the Activity Area. However, vessel collision has been identified as a threat to whale sharks and as a conservative management measure a speed limit for all installation vessel will apply during the whale shark migration period (July to November).
Wetlands of International Importance	N/A	N/A
Commonwealth Marine Environment	Significant impact guidelines for the Commonwealth marine environment (Table 8-1)	The impact assessment indicates that any impacts from vessel movements are predicted to not exceed the Commonwealth marine environment significant impact criteria, as listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

External Context

To date, no objections or claims about vessel movements have been raised by relevant persons. Shell's ongoing consultation program will consider statements and claims made by relevant persons when further assessing the risks (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs, and the controls which will be implemented, are consistent with the outcomes from consultation for the petroleum activities and Shell's internal requirements.

Acceptability Summary

As outlined above, the acceptability of the associated risks from vessel movements have been considered in the context of:

- the established acceptability criteria for the vessel movements aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

The residual risks have been assessed as Dark Blue (Minor). Shell considers residual risks of Minor or lower to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to vessel movements.

Shell considers the risks to marine biota from vessel movements associated with the Activity to be ALARP and acceptable.

9.7.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No injury or mortality of listed threatened or migratory MNES species associated with vessel collisions within the Activity Area.	Records demonstrate no breaches with EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.

9.8 Introduction of Invasive Marine Species

9.8.1 Aspect Context

Invasive Marine Species (IMS) are non-indigenous marine fauna or flora that have been introduced into an area beyond their natural geographical range, and may have the ability to survive, reproduce and establish a population such that they threaten native species through increased competition for resources and/or increased predation.

The project vessels and equipment used in the Activity have the potential to introduce or transfer IMS to the Activity Area. Through oceanic currents and transport via activities such as project vessel movements, IMS may potentially spread to new areas or increase the impact of IMS already established in the wider region.

Successful IMS colonisation requires these stages (Marine Pest Sectoral Committee 2009):

- the potential IMS must be present on (e.g. biofouling) or in (e.g. ballast water) the vector
- the potential IMS must be released into the environment (e.g. ballast water discharge, release of propagules from biofouling)
- the potential IMS must survive, reproduce (either sexual or vegetative reproduction) and subsequently persist in the environment.

The introduction of IMS is recognised globally as a threat to marine biodiversity, and the International Maritime Organization (IMO) has developed guidelines for managing biofouling and ballast water. Commonwealth, state and territory authorities also regulate the risk of IMS from biofouling and ballast water. Vessels operating in Australia are required to meet these requirements, and vessels meeting these requirements pose a much lower risk of harbouring IMS or releasing IMS into the environment. During the Activity, project vessels will transit to and from the Activity Area—some of these vessels arriving from international ports. Table 6-6 lists the project vessel types. All project vessels are subject to marine fouling whereby organisms attach to the vessel hull. This particularly occurs in areas where organisms can find a good attachment surface (e.g. seams, strainers, unpainted surfaces) or where turbulence is lowest (e.g. niches, sea chests). Biofouling may also be present on submerged equipment such as ROVs. Standard ballast water exchange needs for the project vessels are expected to be limited. All vessels operating ballast water exchange in the Activity Area are obliged to conduct ballast tank operations in line with IMO guidelines and, where applicable, comply with the *Biosecurity Act 2015* (Cth).

The substructure transportation barge (see Section 6.8.3) and topsides HTV (Section 6.8.4) are specialised vessels equipped with rapid flood ballast systems. The use of rapid flood ballast systems is essential for offloading (including launch or floatover) heavy structures, such as the substructure and topsides from vessels in offshore marine locations. Section 6.9.7.1 describes the substructure launch and rapid ballast activities using the substructure transportation barge. Section 6.9.8.2 describes the topsides floatover and rapid ballast activities using the topsides HTV. Table 6-13 lists the ballast volumes associated with these vessels.

During the substructure installation process (see Section 6.9.7.1), the substructure will be lowered to the seabed with the assistance of controlled ballasting of the substructure's flooding compartments and ABT, via actuated valves controlled from the construction vessel. This ballast water will be locally sourced from the immediate vicinity. If required, the flooding compartment may release nominal volumes of the ballast water. After the substructure is installed, the ABTs will be removed from the substructure (via deballasting). The flooding compartments and ABT ballast water discharged pose no risk of introducing IMS as the substructure will be transported to the Activity Area on the substructure transportation barge and will use locally sourced sea water; therefore, these will not be considered further in this EP.

If potential IMS become established in the Activity Area, such as on the substructure or Prelude FLNG, vessel movements may subsequently provide vectors for translocating potential IMS to new areas (NOPSEMA 2024b) or increase the impact of IMS already established in the wider region (Department of Fisheries 2017). The likelihood of this sequence of events is considered remote given the controls that are routinely applied to project vessels (e.g. anti-fouling coating, inspections, hull cleaning), the remote offshore location, and the nature of typical vessel activities (e.g. infrequent and short duration alongside the substructure, topsides and Prelude FLNG).

Most native fouling species likely to be encountered within or transiting through the Activity Area are widely distributed, as similar habitats are broadly represented in the Timor Sea and Browse Basin. An IMS may

compete with these native species if it becomes established in the Activity Area or wider region. This may decrease the species diversity of benthic communities. Typically, IMS are extremely difficult to eradicate once established and reproducing in an area. If an IMS becomes established and reproductively viable (a highly unlikely event), it would be almost impossible to eradicate.

All known and potential introduced marine pests listed by Australian agencies are nuisance foulers, predators, invasive seaweeds or noxious dinoflagellates and tend to inhabit ports, harbours, embayments, estuaries, shorelines and shallow coastal waters, however several species can survive up to 200 m deep (Hayes et al. 2004, Barry et al. 2006).

9.8.2 Description and Evaluation of Impacts and Risks

Environmental sensitivities within these groups may be at risk from the introduction of potential IMS:

- biological environment
- socioeconomic environment.

Potential risks associated with IMS establishment as a result of the Activity are discussed below.

The risk of an IMS being able to successfully establish itself will depend on the depth of water, distance from the coast, water movement and latitude. The probability of successful IMS settlement and recruitment decreases in well-mixed, deep ocean waters away from coastal habitats. An IMS travelling through several latitudes also has to survive significant temperature and salinity changes.

Benthic communities are the receptors most at risk from IMS, either as residents or migrants. Marine pest species can also deplete fishing grounds and aquaculture stock, with ~10–40% of Australia's fishing industry being potentially vulnerable to marine pest incursion (AMSA n.d.). The introduction of the Northern Pacific seastar (*Asterias amurensis*) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries. Similarly, the ability of the New Zealand screw shell (*Maoricolpus roseus*) to reach densities of thousands of shells per square metre has presented problems for commercial scallop fishers (MESA 2017). The ABC (2000) reported that the New Zealand screw shell is likely to displace similar related species of screw shells, several of which occupy the same depth range and sediment profile. Other impacts from IMS include damage to marine and industrial infrastructure, such as encrusting jetties and marinas or blocking industrial water intake pipes. By proliferating on vessel hulls they can increase drag, thereby increasing fuel consumption.

9.8.2.1 Biological Environment

If IMS are introduced into a new area that can support their needs, they can reproduce and establish a population in that area. IMS can outcompete or predate native species, and are recognised globally as a threat to marine biodiversity. In addition to affecting biodiversity in the immediate area, newly established populations of IMS can spread to nearby areas because many IMS produce larval stages that are easily transported by ocean currents.

9.8.2.1.1 Habitats and Communities

Benthic Communities

The introduction and subsequent establishment of IMS could result in changes to the structure of benthic communities and ecological function due to the predation of native marine organisms and competition for resources.

Benthic communities within the Activity Area are characterised by macrobenthic communities of deposit and filter feeders on bare sediments. The seabed within the Activity Area does not receive sufficient sunlight to support benthic primary producer habitat, such as macroalgae and zooxanthellate corals. While project vessels have the potential to introduce IMS into the Activity Area, the deep offshore open waters (90–260 m deep) are not conducive to the settlement and establishment of IMS. Very few IMS (aside from planktonic oceanic species such as dinoflagellates) can credibly survive in the water depths of the Activity Area. Of the few species (e.g. European clam and Northern Pacific seastar) that can potentially survive in deep waters (up to 200 m), these species are generally unable to settle and establish in deep–water ecosystems successfully, most likely due to a lack of light and suitable habitat (e.g. hard substrate for attachment and nutrient-poor water) to sustain the growth and survival. 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). Most IMS introduced (via ballast

water) to an area outside of their natural range will not survive to establish or subsequently become invasive or a pest (Wells et al. 2009).

In the highly unlikely event potential IMS are released from biofouling or ballast water, the IMS are highly unlikely to encounter suitable natural habitat for settlement and establishment. Therefore, the introduction of IMS and successful establishment (and IMS-related impacts) in deep waters or in areas of relatively bare sediment is considered extremely remote.

With the stated controls in place, the likelihood of introducing IMS is considered remote as the potential vectors (e.g. project vessels) will typically be near the substructure or Prelude FLNG for relatively short periods.

Shoals and Banks; Offshore Reefs and Islands

The shoals and banks in the region are typically shallower than the Activity Area and may therefore be more vulnerable to introduction of IMS, although the shoals and banks are also below the preferred depth range of many potential IMS.

The closest reef and island to the Activity Area is Seringapatam Reef (~135 km west) and Browse Island (~42 km south-south-east). The nearest shoals or banks are ~8 km from the Activity Area—Goeree Shoal north-north-west and Eugene McDermott Shoal east-south-east. With the stated controls in place to minimise potential IMS risk, the likelihood of direct introduction of IMS to a shoal, bank or island is considered Remote. Given the major significance associated with the risk of IMS introduction to nearby shoals, reefs and islands, the overall risk to these receptors is considered Yellow.

9.8.2.1.2 Key Ecological Features

The proposed substructure location is >60 km from the nearest KEF; however, the export pipeline intersects the Continental Slope Demersal Fish Communities KEF (Figure 7-3). The values of Continental Slope Demersal Fish Communities KEF that support the demersal fish species occupy two distinct demersal community types associated with the upper slope (water depth of 225–500 m) and the mid–slope (water depth of 700–1000 m) (DSEWPaC 2012a). As water depths associated with this KEF are greater than 200 m; the values of the KEF are unlikely to be affected by IMS. Therefore the likelihood of IMS being introduced and establishing viable populations within a KEF is considered Remote.

9.8.2.1.3 Protected Areas

Australian Marine Parks

The nearest AMPs—Kimberley and Cartier Island—are ~80 km away. For the same reasons given above for benthic communities, the likelihood of IMS being introduced and establishing viable populations within an AMP is considered very unlikely. With the stated controls in place to minimise potential IMS risk, the likelihood of direct introduction of IMS to a shoal, bank or island is considered Extremely Remote.

9.8.2.2 Socioeconomic and Cultural Environment

The establishment of IMS has the potential to affect the activities of other users through indirect impact such as changes to fisheries target species resulting in economic and social implications, or due to compromised reputation to the oil and gas industry. No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to socioeconomic receptors from this aspect. The consequence of potential impacts to other users is considered Major. However, the likelihood for IMS introduction, establishment and survival at or within these receptors is Remote with the stated controls in place. Therefore, the residual risk is ranked Yellow (see Table 9-42).

Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For the assessment of impacts to marine species that may be of cultural significance, refer to Section 9.8.2.1. No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to Indigenous cultural heritage features and values from this aspect.

Given the Yellow residual risk consequence to the biological environment, significant impacts to socioeconomic and cultural environment receptors are not anticipated with controls in place.

9.8.3 Risk Assessment Summary

Table 9-42 lists the highest residual risk ranking of the relevant environmental receptor groups.

Table 9-42: IMS Evaluation of Residual Risks

Environmental Receptor	Consequence	Likelihood	Residual Risk
Evaluation – Unplanned Risks			
Physical Environment	N/A	N/A	N/A
Biological Environment	Major	B	Yellow
Socioeconomic Environment	Major	B	Yellow

9.8.4 ALARP Assessment and Environmental Performance Standards

Table 9-43: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Prohibit discharge of ballast water the Activity.	No	Vessels may be required to adjust their ballast during installation, loading and offloading operations to maintain stability, draft and trim to undertake installation activities. Given the low residual risk, prohibiting standard vessel ballast water discharge would provide little additional environmental benefit compared to the increase in safety risk for vessels. Rapid ballast water systems are necessary to install the substructure and topsides, hence is technically not feasible.	N/A	N/A	N/A
Elimination	Only use locally sourced project vessels (specifically those described in Sections 6.8.1 to 6.8.7).	No	As described in Sections 6.8.1 to 6.8.7, specialised project vessels are required to meet the technical capabilities to undertake the construction and installation activities described within this EP. Some of these vessels may be operating within the region, however, there home port and flag state is often outside of Australia and Shell does not have control on their movements and destination prior to mobilisation. Additionally, infrastructure, including the pipeline, PLETs, Substructure and Topsides are built and transported from international locations to the Activity Area, which means that using only locally sourced project vessels is not considered feasible for these works. Due to these technical constraints, the location of infrastructure being shipped	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			to the Activity Area and the limitations in availability to only source local project vessels, this control cannot be adopted. All contracted vessels must be of 'low' risk status of introducing IMS regardless of their origin.			
Administrative and Procedural controls	Anti–foul coating/system.	Yes	Anti-foul coating/system on the project vessels will reduce biofouling accumulation on the hull to reduce the likelihood of introducing IMS. Implementing this control is required under the International Convention on the Control of Harmful Antifouling Systems on Ships and the *Protection of the Sea (Harmful Anti–fouling Systems) Act 2006* (Cth), hence must be adopted.	6.1	Vessels (as appropriate for size, type and class) will have an antifoul coating applied in accordance with the International Convention on the Control of Harmful Antifouling Systems on Ships and the *Protection of the Sea (Harmful Anti–fouling Systems) Act 2006* (Cth), including Marine Order 98 (Marine Pollution – Anti-fouling Systems) including (as appropriate for size, type and class): a valid International Anti-fouling System Certificate or anti–fouling declaration.	A copy of a valid international anti–fouling system certificate or a declaration on antifouling system (as appropriate for size, type and class).
Administrative and Procedural controls	Vessel specific biofouling management and/or risk assessment.	Yes	Reduces the likelihood of introducing IMS by implementing proactive biofouling management options recommended under the Australian Biofouling Management Requirements (DAFF 2023) and Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009). Implementing this control is required under the legislative requirements; hence, it must be adopted, or it is aligned with best practice for vessels not entering Australian territorial seas. Hence, the benefits outweigh the costs of implementing.	6.2	Project vessels (as appropriate for size, type and class) entering Australian territorial seas [12 nm limit] from international locations, prior to entering the Activity Area, will apply the Australian Biofouling Management Requirements (DAFF 2023), including: • an effective biofouling management plan and record book; or • vessel cleaned of all biofouling within 30 days prior to arriving in Australian waters; or • implementation of an alternative biofouling management method.	A copy of the Biosecurity Status Document (issued via Maritime Arrivals Reporting System) showing an approved biofouling status.
				6.3	Projects vessels (as appropriate for size, type and class) entering the Activity Area	IMS Inspection Report that classifies the vessel as low risk,

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
					directly from international locations will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector; and • undertake IMS risk reduction measures as guided by an industry recognised IMS inspector if a vessel is not considered low risk; and • only vessels classified as low risk will be permitted entry into the Activity Area.	and if required, evidence of the mitigation measures implemented to reduce the risk to low.
				6.4	Locally sourced project vessels (as appropriate for size, type and class) entering the Activity Area from Australian domestic locations, will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009): • conduct a biofouling risk assessment using an industry recognised IMS inspector or using the industry recognised risk assessment tool Vessel–Check; and • undertake IMS risk reduction measures if a vessel is not considered low risk (either guided by an IMS inspector or through implementation of the measures	IMS Inspection Report, or output of Vessel-Check record and supporting records which demonstrate implementation actions have been carried out as required, that classifies the vessel as low risk.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
					which address risks identified by Vessel-Check); and • only vessels classified as low risk will be permitted entry into the Activity Area.	
Administrative and Procedural controls	Vessel specific ballast management.	Yes	The likelihood of introducing IMS via ballasting activities is reduced by implementing the recommendations outlined in the Australian Ballast Water Management requirements (DAWE 2020), and aligned with the *Biosecurity Act 2015* (Cth) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (as appropriate for size, type and class). The implementation of this control is necessary to comply with legislative requirements, so it must be adopted.	6.5	Ballast water discharges are aligned with the Australian Ballast Water Management Requirements (DAWE 2020), the *Biosecurity Act 2015* (Cth) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (as appropriate for size, type and class).	Records demonstrating a Ballast Water Management Plan is in place (as appropriate for size, type and class). Records demonstrating a ballast water record system is maintained (as appropriate for size, type and class). A copy of the International Ballast Water Management Certificate to demonstrate the principal ballast water management method is in accordance with D–2 standards. If the vessel cannot demonstrate it meets D–2 standards, records of ballast water discharge logs confirm no discharge within 12 nm of coastlines including any ports. Biosecurity Status Document (issued via Maritime Arrivals Reporting System) showing an approved ballast status (for vessels arriving from international locations and entering the Australian territory [12 nm limit] or a low-risk exemption through a domestic ballast water risk assessment (for domestic vessels and other international vessels).

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural controls	Only use locally sourced supply and support vessels (specifically those described in Section 6.8.8) where practicable.	Yes	The locally sourced supply and support vessels (described in Section 6.8.8), that meet the technical capabilities and are commercially viable to undertake contracted activities may be located within the region (specifically, those operating out of ports within the NT and WA). Availability of these vessels is subject to oil and gas and other offshore industry demand and therefore the Crux project's ability to secure these vessels is dependent on market conditions at the time of procurement. These limitations mean that variables outside the control of the project will influence the successful selection of locally sourced supply and support vessels. Taking into consideration these limitations, adopting this control and including a EPS and Measurement Criteria provides an adequate focus on the selection of locally sourced supply and support vessels. Where the procurement process results in the successfully selection of locally sourced supply and support vessels, the risk of introducing IMS from outside the region is reduced. Additionally, as required by EPS 6.4, all locally sourced vessels must demonstrate low risk status of introducing IMS prior to entering the Activity Area.	6.6	Supply and Support vessels (described in Section 6.8.8) that are locally available (regionally operating within WA or NT), meet technical and commercial requirements will be selected for use where practicable.	Vessel procurement outcomes demonstrate locally sourced supply and support vessels are selected which meet technical and commercial requirements where practicable.
Administrative and Procedural controls	Conduct environmental DNA (eDNA) water sampling within ports visited by vessels.	No	Due to the number of users in the port, eDNA analysis of water samples from the port will be inconclusive as to whether the risk has originated from the petroleum activities. As agreed by the	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
	going to and from the Activity Area.		state marine biosecurity agencies, this is the responsibility of state agencies. Consequently, any additional benefit gained through the implementation of this control is considered outside the control of Shell and hence not feasible.			
Administrative and Procedural controls	Develop specific IMS response plans and carry out training and drills to prepare for the need to respond to an IMS incident.	No	The resources and time needed to implement this control is significant and considered grossly disproportionate to the benefit gained. IMS response plans are planned to be developed by government as outlined in the National Strategic Plan for Marine Pest Biosecurity 2018–2023 (DAWE 2018). Consequently, any additional benefit gained through the implementation of this control is considered outside the control of Shell and hence not feasible.	N/A	N/A	N/A
Administrative and Procedural controls	Transportation restrictions for Crux platform and jacket	Yes	Restricting transportation methods from international locations for platform and jacket to those involving carrying (e.g. barge, transport vessel) rather than wet towing reduces the likelihood of introducing IMS due to the extended out of water period enroute.	6.7	The Crux platform and jacket will not be wet towed from international locations to the Crux Activity Area.	Pre-mobilisation Environmental Assurance confirms dry transport of Crux platform and jacket from international locations will occur via barge or transport vessel.
Administrative and Procedural controls	Separation distance to shoals identified to require protection in the OPP	Yes	Prevents direct introduction of IMS to shallow water environments at shoals	3.8	Refer to EPS 3.8	Refer to EPS 3.8
ALARP Demonstration Statement						
Based on the risk assessment outcomes and control measures that have been adopted, Shell considers that implementing the control measures are appropriate to manage the potential risks of introducing IMS associated with the Activity. No feasible additional or alternative controls were identified that could further reduce the impacts and risks. Therefore, the impacts and risks are considered to be reduced to ALARP.						

9.8.5 Acceptability of Risks

Table 9-44: Acceptable Levels of Risks – IMS

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Biological Environment	Habitats and communities	Benthic communities	No significant impacts to benthic habitats and communities.	Yes	The introduction and survival of an IMS as a result of the Activity is considered remote, given the application of the control measures and adherence to legislation and regulations to reduce the likelihood of introducing IMS into the Activity Area, and the deep offshore open waters are not conducive to the survivability and establishment of IMS within the Activity Area. The impact assessment has been based on conservative assumptions, including that the conditions are conducive to IMS establishment and that the vessels mobilised are vectors for IMS. Shell will apply industry best practice and meet all regulatory requirements to reduce the risk to ALARP and acceptable levels.
		Shoals and Banks	No direct impacts to named banks and shoals. No loss of coral communities at named banks or shoals as a result of indirect/offsite[34] impacts.		
		Offshore Reefs and Islands	No impacts to offshore reefs and islands.		
	KEFs		No significant impacts to environmental values of KEFs.		
	Protected areas	Commonwealth Marine Area	No significant planned impacts to the Commonwealth marine area.		
		Marine Parks	No impacts to the values of marine parks.		
Socioeconomic Environment	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries.		
	Tourism and recreation		No negative impacts to nature-based tourism resources resulting in demonstrated loss of income.		
	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.		
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.		

The assessment of risks from IMS determined a residual risk ranking of Yellow (Table 9-42). The acceptability of the potential risks of impacts from the introduction of IMS associated with the petroleum activities has been considered in the following context.

Principles of ESD

EPOs are aligned with the principles of ESD:

- The introduction of an IMS poses a risk to the diversity and ecological integrity of the biological and socioeconomic environments in the vicinity of the Activity Area and the wider region.

However, Shell will apply a range of controls to ensure that the risk of IMS introduction is reduced to a level that is acceptable and ALARP. Following successful application of these controls, Shell considers the residual risk to be consistent with the principles of ESD.

Relevant Requirements

Managing the risks is compliant with relevant legislative and guidelines requirements, including:

- compliance with international maritime conventions, including:
  - International Convention for the Control and Management of Ships' Ballast Water and Sediments
  - International Convention on the Control of Harmful Anti-Fouling Substances
  - Guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (IMO 2011)
- compliance with Australian legislation and requirements, including:
  - *Biosecurity Act 2015* (Cth):
    - Chapter 4 (Managing biosecurity risk)
    - Chapter 5, Part 3 (Management of discharge of ballast water)
  - *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (Cth):
    - Part 2 (Application or use of harmful anti-fouling systems)
    - Part 3 (Anti-fouling certificates and anti-fouling declarations)
    - Marine Order 98 – Marine Pollution prevention – anti-fouling systems
  - *Fisheries Act 1988* (NT)
  - *Fish Resources Management Act 1994* (WA), Fish Resources Management Regulations 1995 (WA) and the *Aquatic Resources Management Act 2016* (WA)
- Control measures are consistent with these guidelines and requirements:
  - Reducing Marine Pest Biosecurity Risks Through Good Practice Biofouling Management Information Paper (NOPSEMA 2022b)
  - National Biofouling Management Guidelines (Marine Pest Sectoral Committee 2009)
  - Australian Biofouling Management Requirements (DAFF 2023)
  - Australian Ballast Water Management Requirements: Version 8 (DAWE 2020)
  - MarinePestPlan 2018–2023: The National Strategic Plan for Marine Pest Biosecurity (DAWE 2018)
  - Offshore Installations–Biosecurity Guide: Version 1.5 (DAFF 2023a)
  - WA's Biofouling Biosecurity Policy* (Department of Fisheries 2017).

** This policy's objective is to minimise the adverse impacts of aquatic pests and diseases in WA through '1. Preventing the establishment of aquatic pests and diseases in new locations' and '2. Minimising the impact of established aquatic pests and diseases'. As such, the acceptable level of risk for IMS (stated in the EPO) is consistent with this policy.*

Strict controls are in place to prevent the introduction of IMS into Australian waters, which the project will abide by. Biosecurity is regulated under the *Biosecurity Act 2015* (Cth). The Australian Ballast Water Management Requirements (DAWE 2020) provides Australia's commitment to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention). The National Biofouling

Management Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009) gives recommendations to the petroleum industry for managing biofouling hazards industry. The control measures adopted in Table 9-43 are aligned with these guidelines, which vessel operators must abide by.

Matters of National Environmental Significance

Threatened and Migratory Species

The policies, strategies, guidelines, conservation advice and recovery plans for MNES that may occur within the potential area affected by an IMS do not identify IMS as a threat.

Table 9-45: Summary of Alignment of the Risks from the IMS Aspect of the Petroleum Activities with Relevant Requirements for EPBC Threatened Fauna

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory Species	The threatened and migratory species within the Activity Area are all highly mobile. Benthic species are generally more susceptible to the effects of IMS and there are no EPBC Act listed benthic species in the Activity Area.	N/A
Commonwealth Marine Area	Significant impact guidelines for the Commonwealth marine environment (Table 8-1)	The residual risk assessment indicates that any impacts from the aspect are predicted to not exceed the Commonwealth marine environment significant impact criteria, as listed in Table 8-1; as such, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

External Context

To date, no objections or claims about IMS have been raised by relevant persons. Shell's ongoing consultation program will consider statements and claims made by relevant persons when further assessing the risks (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of risks from IMS determined the residual risk rankings were Yellow (Table 9-42). The acceptability of the impacts and risks from IMS associated with the Activity has been considered in the context of:

- the established acceptability criteria for the IMS aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. stakeholder claims)
- internal context (i.e. Shell requirements).

Given the water depth (>90 m within the Activity Area and >130 m at proposed infrastructure location), potential IMS species which may be present on equipment and vessels used for the Activity would be unlikely to settle and establish on the available natural substrate. The export pipeline intersects Continental Slope Demersal Fish Communities KEF and the nearest shoals or banks are ~8 km from the Activity Area—Goeree Shoal north-north-west and Eugene McDermott Shoal east-south-east. Considering all of the controls which are in place, the residual risk of potential species of IMS being introduced to the Activity Area, spreading, attaching

to project vessel hulls and establishing in new areas such as high value areas and/or inshore coastal waters of Australia such as at ports following a long distance vessel transit is Yellow.

Shell considers residual risks of Yellow to be acceptable with controls if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to the IMS aspect of the petroleum activities.

Shell considers the risk of IMS introduction associated with the Activity to be ALARP and acceptable.

9.8.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No IMS of concern[49] introduced in the Activity Area as a result of the petroleum activities.	No confirmed and externally reported instances of IMS within the Activity Area as a result of the petroleum activities.

[49] IMS of concern are species that are listed on the WA Prevention List for Introduced Marine Pests or Commonwealth National Introduced Marine Pest Information System and could survive in the natural environment.

9.9 Discharges of Liquid Effluent

9.9.1 Aspect Context

The Activity will use a range of project vessels that will discharge liquid effluent streams to the marine environment within the Activity Area. Discharge of liquid effluent to the marine environment from project vessels, substructure and topsides may include:

- deck drainage and bilge water
- putrescible waste, greywater and sewage
- cooling water
- desalination brine
- residual chemicals (ad hoc)
- EGCS wash water

Section 6.5 describes the various project vessels and Table 6-6 lists the project vessels activities and estimated durations.

The Prelude FLNG generates a range of liquid waste streams (e.g. effluent, sewage, cooling water, produced water etc) as described and assessed under the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002]. Several Crux project vessels may discharge liquid effluent within 1 km of the Prelude FLNG facility. These include project vessels supporting the export pipeline installation activities– limited to vicinity of the Prelude-end PLET and assumes up to two weeks (see Section 6.9.5) and Prelude flexible riser and umbilical installation activities for a duration of approximately six weeks (see Section 6.9.6). Note that these two installation activities are unlikely to coincide.

On the basis that the Prelude FLNG discharges and limited Crux project vessels effluent discharges may occur concurrently, the potential impacts from cumulative discharges is acknowledged and hence considered in this assessment (see Section 9.9.2). Refer to Section 9.9.2.4 for an assessment of the cumulative effects associated with the concurrent Prelude FLNG facility discharges and Crux dewatering activities.

Vessel ballast water discharges are assessed in Section 9.8. Discharges from the installation or cold commissioning activities, such as pile cuttings and dewatering, are considered in Section 9.10. Unplanned spills (e.g. chemicals, hydrocarbons) are considered in Sections 9.13 and 9.14.

9.9.1.1 Deck Drainage and Bilge Water

Deck and surface drainage, including bilge water, from project vessels and the topsides will mainly comprise wash down water, sea water spray and rainwater. These discharges may contain small quantities of oil, grease, metals, detergents (surfactants) and other residual chemicals present on the deck, which have the potential to create surface sheens and short-term, localised reduction in water quality if they enter the marine environment.

Section 9.10.1.4.4 addresses the first flush of the topsides utility open drain system.

9.9.1.2 Putrescible Waste, Greywater and Sewage

The project vessels and topsides routinely generate and discharge treated sewage, putrescible wastes and greywater (referred to as treated domestic wastewater) to the marine environment.

The volume of treated domestic wastewater discharged is proportional to the number of POB. The maximum POB number within the Crux topsides vicinity, is 750 (base case of 300 POB) for the ASV and along the export pipeline route the maximum POB is up to 520 (assuming the pipelay and construction vessel are working side by side). Therefore, conservative estimated domestic wastewater volume per day is up to 75 m^3 (base case 30 m^3) in the vicinity of the Crux topsides location and 70 m^3 along the export pipeline route (~0.1 m^3 per person per day).

9.9.1.3 Cooling Water

Sea water is used as a heat exchange medium for cooling machinery engines and equipment. Sea water is drawn from the ocean and flows counter current through closed-circuit heat exchangers, transferring heat from the machinery or production process to the sea water via an intermediate circulating freshwater system. Sea water is then discharged to the ocean at an average of ~5–9° C above the ambient sea water temperature

(depending on season and the depth it is drawn from). Cooling water is often treated with additives including scale inhibitors and biocide to avoid fouling pipework.

Small volumes of cooling water are expected to be discharged from the project vessels.

9.9.1.4 Desalination Brine

Using sea water to produce freshwater via reverse osmosis (RO), distillation or desalination plants on project vessels results in a discharge of sea water with a slightly elevated salinity (typically 20–50% higher than sea water) to the marine environment. Chlorine-scavenging, scale-inhibiting and/or small volumes of other treatment chemicals may be present in the waste stream at low concentrations.

Modelling of brine discharges from vessels found the brine discharged at the surface was predicted to be diluted 40-fold within 4 m of the discharge point, assuming no ocean current (Frick et al. 2001). The modelling predicted that the salinity concentration would drop below environmental impact thresholds within 4 m of discharge.

9.9.1.5 Residual chemicals (ad hoc)

Chemical are used for various processes and applications (routine, non-routine and contingency) on project vessels and the platforms of the Crux substructure and topsides. Therefore, chemicals may be present in wastewater streams that are discharged to the ocean. These include:

- maintenance/non-process chemicals (e.g. paints, degreasers, greases, firefighting foam, lubricants, domestic cleaning products)
- subsea discharges (e.g. hydraulic fluids from ROVs or other underwater equipment).

9.9.1.6 EGCS wash water (if required)

Using EGCS is a viable method to meet the low-sulfur fuel requirements outlined in MARPOL Annex V, as set out in the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth). The EGCS wash water will comply with discharge water quality criteria set out in the EGCS Guidelines (IMO 2021). These parameters include pH criteria, polycyclic aromatic hydrocarbon (PAH) criteria, turbidity and temperature. Residues and sludge generated by EGCSs must be disposed at a licensed facility onshore.

9.9.2 Description and Evaluation of Impacts

Liquid effluent discharges to the marine environment may result in a localised decline in water and sediment quality, which may cause sensitive biological receptors in those environments to be exposed to physical characteristics and contaminants at concentrations that may cause acute or chronic effects. The magnitude and sensitivity of any impacts on sensitive receptors will vary depending on multiple factors, including discharge composition, plume dilution/dispersion, bioavailability, duration of exposure and marine species physiology and behaviour.

9.9.2.1 Physical Environment

9.9.2.1.1 Water and Sediment quality

Deck Drainage and Bilge Water

Deck drainage and bilge water discharges are intermittent. These discharges can result in water quality changes immediately surrounding the discharge point, with the spatial extent of changes to water quality remaining very localised. Discharges of oily water from vessels will be treated to ≤15 ppm in accordance with MARPOL requirements whilst platform discharges from the open drains system will be reduced to ≤30 ppm. Some minor quantities of various metal and chemical constituents may not be captured as a part of the oil treatment systems associated with the open drains and bilge systems on project vessels, and these minor quantities of diluted toxicants may be discharged into the ocean, potentially causing localised and temporary reductions in water quality. Any effects on water quality are expected to be within the surface layers only and have no impact on or damage to seabed/benthic receptors. Discharges are expected to disperse and dilute rapidly, with concentrations significantly dropping with distance from the discharge point. As such, no significant impacts from the discharge of deck drainage and bilge water are anticipated, because of the minor quantities involved, the localised mixing zone and the high level of dilution within the open water environment of the Activity Area.

Overall, the residual impact consequence to water quality from discharging deck drainage and bilge water is considered Slight (Magnitude: −1, Sensitivity: L).

Putrescible Waste, Greywater and Sewage

Discharge of putrescible waste, sewage and greywater into the marine environment may impact water quality, resulting in eutrophication, increased turbidity, increased pathogens (bacteria, viral agents and/or parasites), and increased biological oxygen demand (BOD). These discharges can contain various substances (typically at very low concentrations), including oil/grease, some organic compounds, detergents, metals, suspended solids, chemicals, personal hygiene products and pathogens. Any effects on water quality are expected to be within the surface layers only and have no impact on or damage to seabed/benthic receptors.

Discharges of putrescible waste, sewage and greywater can cause temporary localised nutrient enrichment of the surface waters around the discharge point and have the potential to attract marine fauna that feed on the particulate material. The low-volume outputs of nutrients relative to the receiving environment are considered to present no credible risk of environmental damage or effects to water quality associated with eutrophication, increased BOD and/or decreased dissolved oxygen concentrations. The BOD of putrescible waste, sewage and greywater effluent is considered unlikely to lead to oxygen depletion of the receiving waters as highly oxygenated receiving waters will rapidly oxygenate the discharge in such a dynamic offshore environment.

In 2008, Woodside monitored 10 m^3 of sewage discharged at distances of 50 m, 100 m and 200 m downstream of a platform and at five different water depths over a period of 24 hours (Woodside 2008). This monitoring confirmed that discharges of macerated sewage were rapidly diluted and nutrients rapidly metabolised. No elevations in water quality monitoring parameters (e.g. total nitrogen, total phosphorous and selected metals) were recorded above background levels at any station. Similar rates of dilution are expected for the open waters of the Activity Area.

Given the volume and properties of the discharged effluent, which are highly biodegradable, low toxicity and low persistence, the rapid dilution in the open ocean environment, localised impact area, and the offshore location of the Activity Area, the residual impact consequence to water quality is assessed as Slight (Magnitude: −1, Sensitivity: L).

Cooling Water and Desalination Brine

The key physicochemical stressors associated with reject brine and cooling water discharges include salinity, pH, temperature and chemical toxicity. Generally, desalination brine and cooling water containing chemical additives are that safe at the low dosages used. They are usually consumed in the inhibition process, so there is little or no residual chemical concentration remaining upon discharge. No detectable impacts to marine sediment quality are predicted based on the water depth, open ocean currents and low concentration/toxicity of chemical additives.

The potential impacts on water quality due to cooling water discharge include chlorine toxicity and increased water temperatures. The effect of chlorine and chlorine breakdown products in cooling water discharges have been the subject of many studies, generally through toxicity testing. Chlorine is a strong oxidant and following discharge and dilution, the residual (free) chlorine quickly reacts with inorganic constituents such as sodium, iron (II), nitrite and sulfide to produce chlorides (such as NaCl). The higher temperature of cooling water discharge is expected to cool rapidly as it mixes with the receiving waters. As such, any potential impacts to water quality are expected to be highly localised.

Desalination brine is typically 20–50% more saline than the surrounding water. Because it is denser than sea water, it will sink and disperse rapidly in the deepwater and open oceanic currents, decreasing in salinity rapidly as distance from the source increases.

The residual impact consequence for water quality as a result of cooling water and desalination brine discharges is assessed as Slight (Magnitude: −1, Sensitivity: L).

Residual chemicals (ad hoc)

The infrequent release of minor quantities of process and non-process chemicals during planned activities may result in a localised and temporary reduction in water quality. Small volumes of these discharged fluids are predicted to disperse and dilute rapidly, and the spatial extent of any impacts are likely to be limited to the water column and very localised around the discharge point. Therefore, the residual impact consequence is assessed as Slight (Magnitude: −1, Sensitivity: L).

EGCS Wash Water

EGCS wash water discharges are unlikely to occur due to limited duration (days) of the topsides HTV (the only project vessel that may discharge EGCS wash water) within the Activity Area.

The EGCS discharge is treated and monitored in accordance with EGCS Guidelines (IMO 2021) including PAHs. PAHs tend to be persistent and bioaccumulate in the marine environment. If discharge was to occur, a temporary reduction (compliant with International Convention for the Prevention of Pollution from Ships [MARPOL]) in water quality would occur around the discharge point.

The residual impact consequence for water quality as a result of cooling water and desalination brine discharges is assessed as Slight (Magnitude: −1, Sensitivity: L).

9.9.2.2 Biological Environment

9.9.2.2.1 Habitats and Communities; Threatened and Migratory Species

Deck Drainage and Bilge Water

As described above, discharges of oily water will be treated to <15 ppm (v) in accordance with MARPOL requirements. It is possible that marine fauna transiting the localised area may come into contact with these discharges (e.g. marine turtles, cetaceans, whale sharks) as they traverse the Activity Area. Most threatened fauna species potentially exposed to deck drainage and bilge water discharges are air-breathing vertebrates, which are unlikely to be directly affected as their skin is relatively impermeable. Given the low concentrations of oil (<15 ppm) no surface expression is expected and therefore damage to eyes and lungs from exposure to oil on the sea surface is not anticipated. Given the localised extent of potential impacts from deck drainage and bilge water discharges and limited exposure within the Activity Area, significant impacts to marine fauna are not expected.

Overall, the residual impact consequence of the discharge of treated deck drainage and bilge water to the biological environment is considered Slight (Magnitude: −1, Sensitivity: M).

Putrescible Waste, Greywater and Sewage

Nutrients in sewage, greywater and putrescible waste, such as phosphorus and nitrogen can contribute to eutrophication of receiving waters. However, this is only likely in still, calm, inland waters, where it can cause algal blooms, which in turn degrades aquatic habitats by reducing light levels and producing certain toxins, some of which are harmful to marine life and humans. Sewage and greywater can also contain hazardous pathogens (including faecal coliform bacteria), intestinal parasites and viral agents that, if released, may contaminate the food chain.

The overboard discharge of sewage and putrescible wastes will create a localised and temporary increase in particulates on or near the surface waters. This may act as a food source for scavenging marine fauna and seabirds, whose numbers may temporarily increase as a result. Any ingestion of small (macerated or reduced to <25 mm) particle sizes within the effluent is not anticipated to have an adverse physical or toxic impact on resident and transient marine fauna, including listed threatened and migratory species (e.g. marine turtles, cetaceans, whale sharks).

Open marine waters are typically influenced by regional wind and large-scale ocean current patterns resulting in the rapid mixing of surface and near-surface waters where sewage, greywater and food waste discharges will occur. Because of this highly dispersive environment, nutrients from these discharges will not accumulate or lead to eutrophication. Therefore, the receptors with the greatest potential to be impacted are those in the immediate vicinity of the discharge. Effects on environmental receptors along the food chain (e.g. fish, reptiles, birds, cetaceans) are not expected beyond the immediate vicinity of the discharges.

The residual impact consequence associated with the discharge of putrescible waste, sewage and greywater is considered Slight (Magnitude: −1, Sensitivity: M).

Cooling Water and Desalination Brine

The chemicals in cooling water and desalination brine typically have low toxicity, low residual discharge concentrations, and/or the active ingredients are consumed through the process for which they are used. Sea snakes, including the dusky sea snake are aquatic ectotherms that have little capacity to thermoregulate. However, marine sea snakes can generally avoid high water temperatures for short periods of time by moving to deeper and cooler layers of water (Heatwole *et al*. 2012). Additionally, no habitat where sea snakes may occur has been identified within the Activity Area. As described above, environmental effects associated with

cooling water and desalinisation brine are expected to be highly localised, therefore impacts to marine fauna in the vicinity of the discharge are not expected.

The residual impact consequence as a result of the discharge of cooling water desalination brine to marine fauna is considered Slight (Magnitude: −1, Sensitivity: M).

Residual chemicals (ad hoc)

As described above, the infrequent release of minor quantities of process and non-process chemicals during planned activities may result in a localised and temporary reduction in water quality around the discharge. The potential for impacts to biota depends on the nature and degree of exposure received by a particular receptor. Given the short-term durations and low frequencies of any ad hoc discharges associated with planned activities, any potential effects are likely limited in duration to a matter of minutes after the release and confined to a small area in the water column. Therefore, only a low number of individuals that may intersect the discharge plumes before sufficient dilution has occurred would be affected. No adverse environmental effects can reasonably be expected at a community or habitat level for any marine fauna species.

Chemicals present within these discharge streams are predicted to have Slight residual impact consequence (Magnitude: −1, Sensitivity: M) given the typically low toxicity of chemicals selected through the Shell Australia Chemical Change Process (Section 10.4.2), distance to sensitive habitats, lack of sensitive receptors and high inherent rates of dilution and dispersion.

EGCS Wash Water

As described above, the unplanned and unlikely release of minor quantities of EGCS wash water may result in a localised and temporary reduction in water quality around the discharge. The potential for impacts to biota depend on the nature and degree of exposure received by a particular receptor. Given the unlikely nature of this discharge occurring and the short-term duration and volume if it did occur, only a very limited number of individuals would potentially be exposed to the discharge plume. No adverse environmental effects can reasonably be expected at a community or habitat level for any marine fauna species.

The discharge plume is predicted to have Slight residual impact consequence (Magnitude: −1, Sensitivity: M) given the typically low toxicity of chemicals and strict monitoring and discharge criteria, distance to sensitive habitats, lack of sensitive receptors and high rates of dilution and dispersion.

9.9.2.3 Socioeconomic and Cultural Environment

No to negligible impacts on social receptors (e.g. recreational users; commercial operators of fishing, aquaculture, diving and boating operations) are anticipated due to remote location of the Activity Area, the localised nature of the discharges and the rapid dispersion and dilution in open offshore waters. No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to socioeconomic receptors from this aspect.

There are no known sensitive receptors to human pathogens in the vicinity of the Activity Area. It is expected that any discharged pathogens will be susceptible to rapid mortality following exposure to natural levels of ultraviolet (UV) radiation, oxygen, increased salinity and natural predation resulting in their reduction and ultimate destruction (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) 1997). Regardless, transference of human pathogens into marine fauna resulting in adverse impacts to the organism itself, fishermen or consumers is not anticipated to occur and/or is not considered a feasible cause and effect pathway due to the inherent biological and physiological differences in the host species; therefore it is considered to present a non-credible impact. There are no identified recreational uses within the vicinity of the Activity Area and thus any impacts associated with human primary/secondary contact and the presence of 'nuisance' organisms is considered non-credible.

Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For an assessment of impacts to marine species that may be of cultural significance, refer to Section 9.9.2.2.1. No specific objection, claim or relevant matters were raised during consultation for this EP regarding potential impacts to Indigenous cultural heritage features and values from this aspect. Given the Slight consequence to marine species, significant impacts to socioeconomic and cultural environment receptors are not anticipated.

9.9.2.4 Cumulative Impacts

Overlapping plumes from Prelude FLNG discharges and Crux project vessel effluent discharges may occur. The RPS (2019) modelling for the potential cumulative impacts of all liquid discharges released simultaneously from the Prelude FLNG (excluding the Crux project vessels) are not expected to exceed the predicted potential impact (within 1 km) of the individually assessed worst-case discharge being produced water. RPS (2019) calculated the defined fields of effect (impact area) of wastewater discharges from the Prelude FLNG, taking account of any co-mingling or cross-contamination potential. Such fields of effect were calculated as the maximum distance from the Prelude FLNG where concentrations might exceed Predicted No-Effect Concentrations (PNECs) for each constituent of concern calculated using available ecotoxicity data and applying the CIN (2017) methodology. Given the high dilution, low volume and low toxicant concentrations, it is not anticipated that other minor Prelude FLNG discharges (e.g. food, sewage or greywater discharges; desalination brine, mixed bed polisher effluent and boiler blowndown discharges) would result in any cumulative impacts amongst each other or any other liquid discharge streams from the Prelude FLNG facility (RPS 2019).

The Prelude FLNG produced water, Treated Drainage and Bilge (Slops) and bilge waste flows are expected to be relatively low volume and frequency, and are grouped in the cumulative assessment given that all three discharge streams are expected to contain oil in water. Allowing for the dilutive influence of other discharge plumes (e.g. cooling water), the adopted threshold is predicted to be achieved before it departs the lee of the Prelude FLNG under the 95th percentile current regime. Given the produced water discharge is located some distance (>400 m) from the other two hydrocarbon influenced discharge ports (slops), any influence of produced water stream on the physical or chemical behaviour of these other discharge plumes is predicted to have no effect. By this point the produced water stream is predicted to have diluted in the order of thousands of times already which will result in all defined constituent PNECs being achieved prior to any plume intersection. Any interaction with or flow past the main cooling water discharges will result in entrainment within the cooling water plume and accelerated dilution due to increased energy and turbulence. In the case of interaction with cooling water, where the flow rate is significant, the produced water plume would be completely disrupted and entrained into the cooling water plume, dramatically increasing the effective dilution of the produced water plume as it undergoes a secondary nearfield phase. Contaminants already at very low concentration are then further diluted. There are no significant total petroleum hydrocarbon (TPH) compounding effects predicted between the produced water and slops. The slops discharge plumes are anticipated to co-mingle but the resultant plume TPH concentration is predicted to be diluted to within the defined 7 ppb PNEC within 150 m of the Prelude FLNG facility under the 95th percentile current regime. Allowing for the 99th percentile current, the field of effect could extend to 200 m from the Prelude FLNG facility.

As described in Section 9.9.1, effluent discharges resulting in potential overlapping concurrent plumes are considered unlikely due to the infrequent and temporary nature of these discharges. In addition, the limited and intermittent duration (<2 months total duration) of project vessels working within 1 km of the Prelude FLNG. A relatively small volume (incremental increase) released over a very short duration (hours) may result in a highly localised overlapping plume and temporary decrease in water quality, considering the high dilution levels in open water and the nature of the marine environment in the vicinity of the Prelude FLNG. The nearest potentially high environmental value habitat to the Prelude FLNG is Browse Island (approximately 42 km distant), Echuca Shoal (approximately 63 km distant) and Continental Slope Demersal Fish Communities KEF (approximately 14 km). There is no known significant feeding, breeding, migratory or aggregations of marine fauna within the potential zone of impact. Within potential overlapping plumes, there may be transiting marine fauna such as whale sharks, cetaceans and marine turtles. However, the exposure time for these species within the cumulative impact discharges will be very short term with no long-term impact being associated.

Notwithstanding the potential overlap of the extent of discharge effects from potential concurrent activities, given the open offshore location, absence of sensitive or high-value marine ecosystems or habitats at the Prelude FLNG location and the very intermittent and infrequent discharges over a short duration (<2 months), additive and cumulative discharge effects can reasonably be expected to be Slight (Magnitude: –1; Sensitivity: L). Therefore, no increase to the overall consequence level has resulted.

The remoteness of the Activity Area means that it is unlikely that there will be a cumulative impact with other marine users. Therefore, no change to the overall consequence level due to cumulative effluent discharge impacts can reasonably be expected.

Table 9-46: Summary of Credibility for the Potential Receptor Interactions from Liquid Effluent Discharges

Category	Subcategory	Deck drainage and bilge Water	Putrescible waste, greywater and sewage	Cooling Water	Desalination brine	Residual chemicals (ad hoc)	EGCS wash water
Physical Environment	Water quality						
	Sediment quality						
	Air quality						
Biological Environment	Habitats and communities: benthic communities						
	Habitats and communities (excluding benthic communities)						
	KEFs						
	Threatened and migratory species						
	Protected areas						
Socioeconomic and Cultural Environment	Fishing						
	Marine archaeology						
	Tourism and recreation						
	Defence						
	Ports and commercial shipping						
	Oil and gas						
	Indonesian coastlines						
	Interaction assessed as non-credible and/or no environmental damage or effects						
	Interaction considered credible – discussed through relevant impact assessment (see Sections 9.9.1, 9.9.2 and 9.9.2.3)						

9.9.3 Impact Assessment Summary

Table 9-47 lists the highest residual impact consequence rankings of the relevant environmental receptor groups.

Table 9-47: Discharges of Liquid Effluent Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	−1	L	Slight
Biological Environment	−1	M	Slight
Socioeconomic and Cultural Environment	0	L	No impact

9.9.4 ALARP Assessment and Environmental Performance Standards

Table 9-48: Deck Drainage and Bilge Water Discharges ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Eliminate discharges from project vessels by storing all open drainage and bilge effluent, then transport and treat/dispose of it onshore.	No	There are significant costs and HSSE risks associated with storing all open drainage and bilge effluent on the project vessels and transporting it onshore. These costs are grossly disproportionate to the potential environmental impacts of onboard treatment before discharge overboard.	N/A	N/A	N/A
Substitution	Use an alternative technology to oil-water separator system.	No	The oil-water separator systems on the project vessels are standard MARPOL-compliant systems for managing accidentally oil-contaminated drainage and bilge in offshore installations and vessels. Hence, this activity and the associated potential impacts are well regulated. Implementing this control across the project vessel fleet is considered grossly disproportionate to any environmental benefit, if any.	N/A	N/A	N/A
Engineering	For project vessels, treat oily bilge water with an oil-water separator before discharge, in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil).	Yes	Ensures oily water on project vessels is treated and discharged in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil). Discharges at this level are not expected to cause any significant impact to the marine environment given low flow rates and high dilutions close to the source. The benefits outweigh the costs associated with implementing this control.	7.1	For project vessels, bilge and slops effluent will be discharged via an oil-water separator compliant with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil) requirements (≤15 ppm).	Supplement to the International Oil Pollution Prevention (IOPP) Certificate that indicates that the vessel has approved oil-water separator calibrated to discharge at ≤15 ppm (as appropriate to class, size and type). Vessel computerised maintenance management system records demonstrate vessel oil-water

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
						separator is maintained and operating effectively to meet discharge specification of ≤15 ppm.
Engineering	For the topsides, treat potentially oil contaminated water collected in the open drains system with an oil-water separator before discharge.	Yes	Captures any oil that might be present on the topsides decks before it is discharged to the ocean. The open drains systems design basis included the capture of the first flush of drainage water across plated areas, and treatment to achieve a free oil in water limit of ≤30 mg/l. The system is an inherently low risk system that will mostly receive rainwater. The oil water separator system (V-26501) is designed to be able to capture the contents of the greatest hydrocarbon inventory tank on the topsides. The topsides design has bunding for the diesel tote tank and waste oil tank, which minimises the potential for significant hydrocarbons to end up in the open drains system.	7.2	Topsides deck drainage will be discharged via an oil-water separator (V-26501) once commissioned, except by design, where drain boxes discharge clean water directly overboard in the event of heavy rains or further wash water which is considered clean.	Distributed Control System (DCS) indicates that the open drains system is discharged to sea via an oil-water separator (V-26501) once commissioned in field and where designed to do so.
				7.3	As soon as practicable during cold commissioning, the topsides deck drainage oil-water separator (V-26501) will be verified that it achieves its design basis of ≤30 mg/l free oil in water.	Commissioning test procedure records for deck drainage oil-water separator (V-26501) involving taking manual samples of the treated discharge for onshore NATA accredited lab analysis demonstrate it achieves its design basis of ≤30 mg/l free oil in water specification as soon as practicable (when water is flowing through the system and water samples are able to be taken).

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Engineering	Project vessels to comply with Marine Order 91 (IOPP certificates).	Yes	The marine assurance system is administered by Shell's marine team and, amongst other requirements, ensures contract vessels comply with MARPOL, *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Order 91. The benefits outweigh the costs associated with implementing this control.	7.4	Project vessels will have a valid and in date IOPP certificate (as required by vessel class and type) in accordance with Marine Order 91.	A copy of a current IOPP certificate (as required by vessel class and type).
Administrative and Procedural Controls	Shell Australia Chemical Change Process.	Yes	Shell has adopted a chemical selection and approval process in accordance with its chemical selection and approval guidelines (as indicated in Shell Australia Chemical Change Process and Shell Global Product Stewardship guidelines) to assess chemicals that may pose a risk of environmental impact via planned discharges. Following the chemical change process (as detailed in Section 10.1.6) will minimise to ALARP levels the impact of those chemicals that are used and discharged.	7.5	Chemicals that are planned for discharge to sea are substitution warning free and are rated Gold, Silver, D, or E through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oslo and Paris Convention for the Protection of the Marine Environment of the North-east Atlantic [OSPAR] Commission), or have a complete ALARP assessment.	Chemical change assessment process forms outlined in the Shell Australia Chemical Change Process showing chemicals that are planned for discharge to sea are substitution warning free and are rated Gold, Silver, D, or E through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oslo and Paris Convention for the Protection of the Marine Environment of the North-east Atlantic [OSPAR] Commission), or have a complete ALARP assessment.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n) lists the risk of other pollutants affecting the dusky sea snake and its habitat as a threat to the dusky sea snake. Consistent with the conservation advice, their preferred habitat is reefs and shoals which do not occur within the Activity Area. Shoals do occur adjacent to the Activity Area though. Therefore, Shell has adopted a control consistent with a management control outlined in the Crux OPP, to exclude vessels operating over any named Shoals adjacent to the Activity Area. This limits vessels from discharging liquid effluent in areas where the dusky sea snake habitat may occur.	3.8	Refer to EPS 3.8.	Refer to EPS 3.8.
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with deck drainage and bilge water discharges. No feasible additional or alternative controls were identified that could further reduce the impacts. Therefore, the impacts are considered to be reduced to ALARP.						

Table 9-49: Putrescible Waste, Greywater and Sewage Discharges ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Store sewage, greywater and food wastes on board for transport to and disposal at an onshore facility.	No	Offers limited environmental benefit, as any changes to water quality beyond a localised mixing zone are likely to have no environmental effect. Will likely increase operational costs associated with additional transits to and from port and introduce additional safety and environmental risks related to increased transit time and operation of additional vessels, plant and	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			equipment; these would be grossly disproportionate to the risk of potential environmental impact.			
Substitution	Use alternative treatment technologies.	No	Requires additional cost due to the space requirement for installation on project vessels; this would be grossly disproportionate to the risk of potential environmental impact. Increases operational costs for maintenance and staffing due to performance challenges associated with these technologies (e.g. clogging of membranes/screens). Also increases potential exposure of the workforce to pathogens associated with these waste streams.	N/A	N/A	N/A
Engineering	Macerate food waste to ≤25 mm particle size before discharge to sea.	Yes	The marine assurance system is administered by Shell's Marine team and, amongst other requirements, ensures compliance of contract vessels with MARPOL Annex V, *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth). In addition, project vessels will be required to reduce food waste to ≤25 mm derived from Marine Order 95: Marine pollution prevention – garbage.	7.6	Food macerator is maintained in accordance with the maintenance management system to reduce food waste to ≤25 mm.	Maintenance management system confirms that food scraps are passed through a screen with no opening wider than 25 mm.
Engineering	Project vessels routine discharges of treated sewage and grey water will comply with *Navigation Act 2012* (Cth), *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Order 96 (International Sewage Pollution Prevention [ISPP] certificates) as relevant to vessel class, size and type.	Yes	The marine assurance system is administered by Shell's Marine team and, amongst other requirements, ensures compliance of contract vessels with MARPOL and Marine Order 96. This control measure is in accordance with *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and the relevant Marine Orders.	7.7	Assurance will be undertaken for project vessels to check for a valid and in date ISPP Certificate (or equivalent voluntary statement of compliance audits where relevant) (as required by vessel class, size and type) in accordance with Marine Order 96.	Assurance records; or Offshore Vessel Inspection Database (OVID); or A copy of a valid ISPP certificate demonstrating the vessel has a MARPOL approved sewage

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
						treatment plant (as appropriate to class, size and type).
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n) lists the risk of other pollutants affecting the dusky sea snake and its habitat as a threat to the dusky sea snake. Consistent with the conservation advice, their preferred habitat is reefs and shoals which do not occur within the Activity Area. Shoals do occur adjacent to the Activity Area though. Therefore, Shell has adopted a control consistent with a management control outlined in the Crux OPP, to exclude vessels operating over any named Shoals adjacent to the Activity Area. This reduces the risk of liquid effluent being discharged in locations where the dusky sea snake habitat may occur.	3.8	Refer to EPS 3.8.	Refer to EPS 3.8.
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with putrescible waste, greywater and sewage discharges. No feasible additional or alternative controls were identified that could further reduce the impacts without increasing safety and health risks. Therefore, the impacts are considered to be reduced to ALARP and an acceptable level.						

Table 9-50: Cooling Water and Desalination Brine Discharges ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	N/A	N/A	N/A	N/A	N/A	N/A
Substitution	Source all freshwater from onshore.	No	Using a sea water desalination system and discharging reject brine is a common and accepted practice for vessels and offshore oil and gas facilities. Offshore	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			activities cannot operate without fresh water, hence is not considered technically feasible.			
Engineering	Store waste desalination brine on board and transport for onshore treatment and/or disposal.	No	Storing brine on board and then transferring it to shore results in increased personnel and environmental costs associated with more vessel movements, and is not possible because the required storage space would not be available on project vessels.	N/A	N/A	N/A
Administrative and Procedural Controls	Shell Australia Chemical Change Process.	Yes	Shell has adopted a chemical selection and approval process in accordance with Shell's chemical selection and approval guidelines (as indicated in Shell Australia Chemical Change Process and Shell Global Product Stewardship guidelines) to assess chemicals that may pose a risk of environmental impact via planned discharges. Following the chemical change process (as detailed in Section 10.1.6) will minimise to ALARP levels the potential for impacts from those chemicals that are used and discharged.	7.5	Refer to EPS 7.5.	Refer to EPS 7.5
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n) lists discharged cooling water, or other heat sources, increasing water temperature for the dusky sea snake and its habitat as a threat to the dusky sea snake. Consistent with the conservation advice, their preferred habitat is reefs and shoals which do not occur within the Activity Area. Shoals do occur adjacent to the Activity Area though. Therefore, Shell has adopted a control consistent with an management control outlined in the Crux OPP, to exclude vessels operating over any named Shoals adjacent to the Activity Area.	3.8	Refer to EPS 3.8.	Refer to EPS 3.8.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with cooling water and desalination brine discharges. No feasible additional or alternative controls were identified that could further reduce the impacts. Therefore, the impacts are considered to be reduced to ALARP and an acceptable level.						

Table 9-51: Residual Chemicals (ad hoc) ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	N/A	N/A	N/A	N/A	N/A	N/A
Engineering	Use equipment to capture or collect subsea discharges.	No	No practicable engineering controls are available that are proven to be able to capture or contain subsea discharges. Designing and installing a temporary capture system would result in significant financial costs, with technical uncertainty, grossly disproportionate to any slight increase in environmental benefit of preventing small and infrequent discharges.	N/A	N/A	N/A
Administrative and Procedural Controls	Shell Australia Chemical Change Process.	Yes	Shell has adopted a chemical selection and approval process in accordance with Shell's chemical selection and approval guidelines (as indicated in Shell Australia Chemical Change Process and Shell Global Product Stewardship guidelines) to assess chemicals that may pose a risk of environmental impact via planned discharges. Following the chemical change process (as detailed in Section 10.1.6) will minimise to ALARP levels the impact of those chemicals that are used and discharged.	7.5	Refer to EPS 7.5.	Refer to EPS 7.5

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with residual chemicals (ad hoc) discharges. No feasible additional or alternative controls were identified that could further reduce the impacts. Therefore, the impacts are considered to be reduced to ALARP and an acceptable level.						

Table 9-52: EGCS Wash Water ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	N/A	N/A	N/A	N/A	N/A	N/A
Substitution	N/A	N/A	N/A	N/A	N/A	N/A
Engineering	N/A	N/A	N/A	N/A	N/A	N/A
Administrative and Procedural Controls	EGCS discharges are managed in accordance with standard maritime practice.	Yes	The marine assurance system is administered by Shell's Marine team and, amongst other requirements, ensures compliance of contract vessels with MARPOL. This control measure is in accordance with *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and the relevant Marine Orders.	7.8	Project vessels (if relevant) to maintain an EGCS Record Book in accordance with EGCS Guidelines (IMO 2021) to ensure discharges meet water quality guidelines.	A copy of a current and maintained EGCS Record Book (if relevant).
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with EGCS wash water. No additional or alternative controls were identified that could further reduce the impacts. Therefore, the impacts are considered to be reduced to ALARP and an acceptable level.						

9.9.5 Acceptability of Impacts

Table 9-53: Acceptability of Impacts – Discharges of Liquid Effluent

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Physical Environment	Water quality Sediment quality		No significant impacts to water or sediment quality during the Activity.	Yes	Liquid discharges have the potential to result in localised reduced water quality at the discharge location; however, discharges will rapidly dilute in the open ocean environment. Shell will implement measures to reduce the potential for impacts to water quality from routine discharges. Given the offshore location and absence of particularly sensitive marine ecosystems at the Activity location and immediate surrounds, the potential magnitude of impacts to the marine environment is considered Minor.
Biological Environment	Habitats and Communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	The benthic communities within the Activity Area that may be impacted by discharges of liquid effluent are broadly represented in the region and are not of high environmental value.
	Threatened and migratory species	Marine mammals Marine reptiles Birds Fish Sharks and rays	No mortality or injury of threatened or migratory MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory MNES fauna.	Yes	Most threatened and migratory fauna species within the area predicted to be influenced by liquid effluent discharges are air-breathing vertebrates, which are unlikely to be directly affected as their skin is relatively impermeable and they breathe air. Hence, direct impacts are not considered credible. Non-air breathing species are not anticipated to be present in significant numbers nor be exposed to discharge concentrations that may adversely impact on individuals. Giving regard to the Conservation advice for the dusky sea snake and the risk of pollutants affecting the dusky sea snake, the vessel discharges including liquid effluent and cooling water, will cause highly localised affects. By adopting the precautionary principle and restricting access

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
					of vessels to adjacent shoals, where the dusky sea snake habitat may occur, these impact pathways are reduced to ALARP and acceptable levels. (refer to EPS 3.8). Therefore, it is considered there will be no potential for significant impacts upon threatened or migratory species.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that occur within the Activity Area.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from discharges of liquid effluent, given that no significant impacts to culturally significant marine species are expected.

The assessment of impacts from liquid effluent discharges determined the residual impact consequence to be Minor or lower (Table 9-47). As outlined above, the acceptability of the potential impacts from liquid effluent discharges associated with the petroleum activity have been considered in the following context.

Principles of ESD

The potential impacts from liquid discharges are consistent with the principles of ESD because:

- The environmental receptors within the Activity Area are not expected to be significantly impacted.
- The precautionary principle has been applied, and reviews were undertaken where knowledge gaps were identified. This knowledge was applied when evaluating environmental impacts.

Relevant Requirements

Managing the potential impacts from liquid effluent discharges are consistent with relevant legislative requirements, including:

- Compliance with international maritime conventions, including:
  - MARPOL:
    - Annex I: regulations for the prevention of pollution by oil
    - Annex III: regulations for the prevention of pollution by harmful substances carried by sea in packaged form
    - Annex IV: regulations for the prevention of pollution by sewage from ships
    - Annex V: regulation for the prevention of pollution by garbage from ships.
- Compliance with Australian legislation and requirements, including:
  - *Navigation Act 2012* and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*:
    - Marine Order 91 (Marine pollution prevention – oil)
    - Marine Order 94 (Marine pollution prevention – packages harmful substances)
    - Marine Order 95 (Marine pollution prevention – garbage)

  - Marine Order 96 (Marine pollution prevention – sewage).

- Policies, strategies, guidelines, conservation advice, and recovery plans for threatened species (Table 9-54).
- Implementation of recognised industry standard practice, such as:
  - Treatment of collected drainage bilge water to <15 mg/L residual oil.

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation of liquid discharges predicts that there will be no credible risk of significant impacts to threatened and migratory species as a result of liquid effluent discharges during the Activity. Table 9-54 summarises the alignment of the petroleum activities with management plans, recovery plans and conservation advice for threatened and migratory fauna.

Commonwealth Marine Area

The potential impacts and risks from the liquid effluent discharges aspect on the Commonwealth marine environment are predicted to not to exceed any of the significant impact criteria, as listed in Table 8-1. Hence, it is considered that the Activity does not pose a credible risk to the Commonwealth marine environment.

Table 9-54: Summary of Alignment of the Potential Impacts from the Liquid Effluent Discharges Aspect of the Petroleum Activities with Relevant Requirements for MNES

MNES	MNES Acceptability Considerations (EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory Species	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	The application of the Shell Chemical Management Process and proposed management controls for liquid effluent discharges reduces the potential for impacts from toxic Pollutants introduced into. and/or persisting in, the marine environment.
	Conservation advice on *Balaenoptera borealis* (sei whale) (DoE 2015c)	
	Conservation advice fin whale (*Balaenoptera physalus*) (TSSC 2015b)	
	Recovery plan for Marine Turtles in Australia 2017– 2027 (CoA 2017b)	
	Conservation advice on *Rhincodon typus* (whale shark) (DoE 2015e)	
Commonwealth Marine Area	Significant impact guidelines for Commonwealth marine environment (Table 8-1)	Water quality impacts by planned liquid effluent discharges are expected to be highly localised. Impacts are not considered to be significant in the context of the significant impact criteria for the Commonwealth Marine Area given the nature and scale of the impacts and the characteristics of the local receiving environment (open offshore waters with regionally well represented soft and bare sandy sediments). The impact assessment indicates that any impacts associated with liquid effluent discharges are predicted to not have the potential to result in significant adverse impacts on marine ecosystem functioning/integrity, social amenity or human health. Shell has sought to reduce potential impacts by selecting and implementing the controls and EPSs listed in Section 9.9.4.

External Context

To date, no objections or claims about liquid effluent discharges have been raised by relevant persons. Shell's ongoing consultation program will consider statements and claims made by relevant persons when further assessing impacts (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of potential impacts and risks from liquid effluent discharges determined the residual impacts rankings were Minor (Table 9-53). As outlined above, the acceptability of the impacts has been considered in the context of:

- the established acceptability criteria for the liquid effluent discharges aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

Shell considers residual impacts of Slight or lower to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to the liquid effluent discharges aspect.

Shell considers the potential for impacts from liquid effluent discharges associated with the Activity to be ALARP and acceptable.

9.9.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No Significant Impacts to water and sediment quality from liquid effluent discharges.	Demonstrated implementation of EPSs for discharge of liquid effluent discharges.
No injury or mortality of listed threatened or migratory MNES species resulting from liquid effluent discharges.	
Impacts from liquid effluent discharges on the continental slope demersal fish communities KEF limited to <0.05% of the total area of the KEF.	
No measurable impacts to sediment quality or water quality in the region from liquid discharges during the Crux project.	

9.10 Activity Discharges

9.10.1 Aspect Context

9.10.1.1 Pipework Cold Commissioning Discharges

Section 6.10.1 describes the pipework cold commissioning activities. The associated activity discharge types and volumes include:

- Export pipeline FCGT (Section 6.10.1.2): ~52,800 m^3 of treated sea water discharged over ~4 to 8 days at the Prelude- end PLET (~4 m above the seabed)
- leak testing and depressurisation (Sections 6.10.1.3 and 6.10.1.4): negligible volumes of treated sea water, treated freshwater and hydraulic control fluid at the Prelude FLNG or Crux locations
- dewatering (Section 6.10.1.5): ~48,000 m^3 of treated sea water, 900 m^3 of treated freshwater and if required ~250 m^3 of MEG discharged over ~4 to 8 days at the Prelude FLNG (~12 m below waterline)
- Contingencies, if required (Section 6.11.1):
  - wet buckle and stuck pig (Sections 6.11.1.1 and 6.11.1.2): location and volumes are dependent on the unplanned event, however the volumes will be less than ~52,800 m^3 of treated sea water
  - onshore pipework cold commissioning (Section 6.11.1.3): maximum of up to 1,000 m^3 of treated sea water or freshwater at the Crux location
  - TEG system cleaning contingency (Section 6.11.1.5): ~160 m^3 of freshwater and cleaning product, noting no TEG will be present
  - pipework re-dosing (Section 6.11.1.6): ~48,000 m^3 of treated sea water and 900 m^3 of treated freshwater discharged over ~4 to 8 days at the Prelude FLNG
  - flooding compartment ballast (Section 6.11.2): ~340 m^3 of treated sea water in the vicinity of the Crux location.

The Prelude FLNG discharges may occur concurrently with the Crux dewatering discharge (see Section 6.10.1.5) for a duration of approximately two to six days. The Prelude FLNG generates a range of liquid waste streams (e.g. effluent, sewage, cooling water, produced water etc) as described and assessed under the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002]. The Crux dewatering discharge will occur ~12 m below the water line at the turret of the Prelude FLNG (covered under this EP) and the Prelude activity discharges will be released from multiple locations and water depths along the FLNG facility depending on the discharge type. The primary and closest Prelude FLNG discharge to the Crux dewatering discharge location is the produced water discharge. The Prelude FLNG produced water discharge will not occur concurrently with the Crux dewatering activity in order to avoid the potential for cumulative impacts with this key Prelude FLNG discharge. On the basis that the Prelude FLNG facility discharges and Crux dewatering discharges may occur concurrently, the potential impacts from cumulative discharges is acknowledged and hence considered in this assessment (see Section 9.10.2.4). The planned Crux FCGT discharges at the Prelude PLET were considered, however, given the planed discharge depth of greater than 240 m below the sea surface and the distance to the Prelude FLNG (~1 km), no additive and cumulative effects can reasonably be expected.

9.10.1.1.1 Pipework Cold Commissioning fluids

Section 6.10.1.1 describes the cold commissioning fluids. The fluids that are likely to be discharged to the marine environment from this process include treated freshwater, treated sea water, hydraulic control fluids and chemical sticks. The sea water and freshwater will be dosed with a targeted 500 ppm mixture of Hydrosure 0-3670R™ (or similar) which is a mixture of biocide, oxygen scavenger and corrosion inhibitor plus an additional targeted 40 ppm of fluorescein dye (during the FCG and pre commissioning flooding only).

An impact threshold of 1 mg/L of biocide was defined, which assumes that concentrations below this threshold would not result in significant environmental impacts. This threshold is consistent with published acute toxicity test data for aquatic species for typical biocides that may be used. For example, the Wheatstone Project Offshore Facilities and Produced Formation Water Discharge Management Plan: Stage 1 (Chevron 2015) identified an acute toxicity threshold of 1 mg/L for Hydrosure 0-3670R™ a representative biocide product. The Safety Data Sheet (SDS) for Hydrosure 0-3670R™ states the 96-hour LC50 as 17.5 mg/L for fish in marine waters, with a 48-hour EC50 of 0.54 mg/L for aquatic invertebrates (Champion Technologies 2013). Sano et

al. (2005) assessed the potential toxicity effects of glutaraldehyde, another representative biocide, and reported a 24-hour LC50 of 4.7 mg/L for the aquatic invertebrate *Ceriodaphnia dubia*. Note: Typically, ecotoxicological studies are undertaken using constant doses for periods ranging from 24–96 hours under controlled conditions. This approach contrasts with the natural environment, where exposure durations are much lower. For this assessment, selecting an impact threshold of 1 mg/L provides a conservative basis to evaluate the potential effects of biocide in the receiving environment.

Small volumes of MEG will be discharged neat or at near neat concentrations if MEG slugs are required. Monoethylene glycol (MEG) is a colourless, odourless, non-volatile and hygroscopic liquid. It is characterised by 2 hydroxyl groups, which contribute to its high water solubility, hygroscopicity and reactivity with many organic compounds. MEG is ranked as E (lowest hazard) under the Offshore Chemical Notification Scheme Chemical Hazard and Risk Management (CHARM) non-CHARM products ranked list of notified chemicals and are considered readily biodegradable and non-bioaccumulative (Centre for Environment, Fisheries and Aquaculture Science 2019). MEG is on the OSPAR PLONOR list and therefore is deemed safe to discharge to the marine environment.

MEG is soluble in water, does not volatilise or undergo photodegradation, and is not adsorbed on to soil particles (Hook and Revill 2016). Studies on a green alga (*Chlorella fusca*), a freshwater crayfish (*Procambarus sp.*) and a golden orfe carp (*Leuciscus idus melanotus*) revealed low potential for bioaccumulation in the marine environment (International Programme on Chemical Safety 2000). Ethylene glycols biodegrade readily when released to the environment, and several strains of microorganisms can use them as an energy source.

The World Health Organization (WHO) has reported a no observed effect concentration (NOEC) of 24,000 mg/L for MEG. In accordance with the Organisation for Economic Co-operation and Development (OECD), because three NOECs are described for three separate taxonomic groups a safety factor of 10 was adopted for the protection of marine fauna and benthic habitats. Based on the NOEC provided by WHO a predicted no effect concentration of 2,400 mg/L was used to inform the concentration level above which there is potential to result in an environmental impact (Chevron 2020).

9.10.1.1.2 Dispersion Modelling

Table 9-55 lists the dispersion modelling parameters for FCGT and dewatering which was carried out using near-field modelling using CORMIX and far-field modelling using CHEMMAP. The smaller volumes of cold commissioning discharges associated with leak testing and depressurising (Sections 6.10.1.3 and 6.10.1.4) were not modelled because FCGT and dewatering discharge volumes are much higher and present worst-case results. The full text FCGT and Dewatering Plume Modelling and Dispersal Report (RPS 2023) is provided in Appendix I, the following provides a summary the modelling outcomes to enable an effect evaluation of impacts.

Table 9-55: Summary of Treated Sea Water Model Parameters

Variable	Set Value		
	FCGT(Horizontal)	FCGT(Vertical)	Dewatering
Location	Prelude-end PLET		Prelude FLNG (turret base)
Discharge volume (m^3)	49,959		47,763
Discharge duration (~hours)	46.5		
Orifice diameter (inches) [mm]	4 [100]	24.5 [622]	10 [245]
Discharge rate range (m^3/s)	0.15 to 0.30		
Discharge velocity range (m/s)	18.5 to 36.7	0.49 to 0.99	2.96 to 5.92
Depth	4 m above seabed		20 m below sea level
Orientation	Horizontal	Vertical	Vertical
Chemical concentration (mg/L)	500		
Discharge density (assumed; kg/m^3)	1,027.3		

Based on the requirement to dilute the treatment chemicals from 500 mg/L to 1 mg/L (i.e. 500-fold dilutions), the maximum distance calculated at the 95th percentile confidence level to the combined near-field and far-field dilution. The maximum distance and area predicted were ~430 m (maximum area of ~0.14 km^2) and

~1,300 m (maximum area ~1.33 km^2), varying seasonally, for the FCGT$_{(Horizontal)}$ and FCGT$_{(Vertical)}$ discharge respectively. Figure 9-4 and Figure 9-5 present the results for the maximum distance for the FCGT$_{(Horizontal)}$ and FCGT$_{(Vertical)}$ discharges.

The differences between the extent of the FCGT$_{(Horizontal)}$ and FCGT$_{(Vertical)}$ discharges are attributed to two variables—the orifice diameter and diffuser. By reducing the orifice diameter and incorporating a horizontal diffuser (directed away from the seabed), a higher initial dilution rate is predicted due to the increased velocity, range, turbulent mixing and forced upwards direction of the discharge and thereby reducing the extent of the modelled plume. In addition, no seabed contact above impact thresholds was predicted by incorporating a horizontal diffuser, whereas contact may occur above impact thresholds otherwise. Only minor differences were calculated between the seasons indicating that the outcome will be dominated by the tidal currents that operate within the area, with a low influence of seasonally varying drift currents.

The maximum distance modelled at the 95th percentile confidence level predicted ~280 m (0.08 km^2) varying seasonally for the dewatering discharge (see Figure 9-6).

In the upper water column, currents tend to be affected by multiple forces that add complexity and variation to the plume's direction and dilution rate. In contrast, tidal currents near the seabed are typically slower and have a lower mixing influence on the plume. In addition, the prevailing tidal circulation near the seabed influences the plume dynamics, with a potential for redosing if the plume oscillates.

No seabed contact is predicted and no shallow seabed features were identified within the calculated effect zone of the FCGT$_{(Horizontal)}$ and dewatering discharge, indicating that any effects will be on organisms within the water column. In contrast, the plume of the FCGT$_{(Vertical)}$ could potentially interact with the seabed at <500 dilutions, indicating the potential for effect on the benthic habitat.

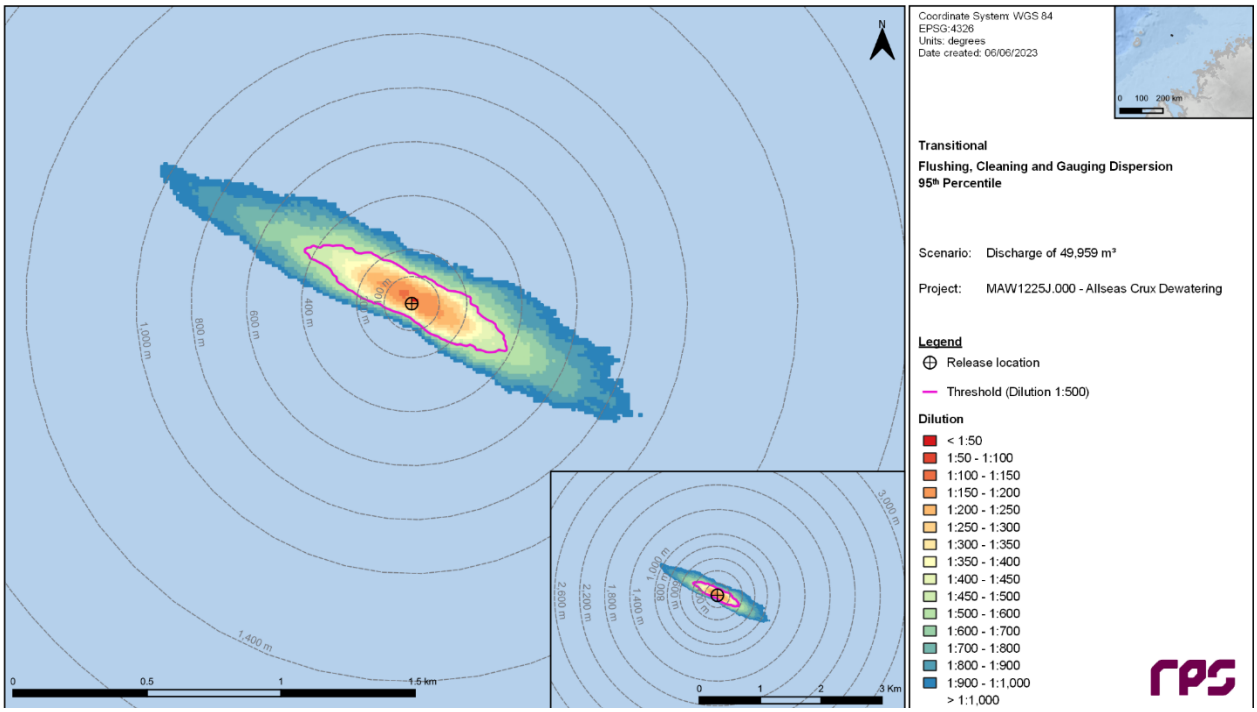


Figure 9-4: Predicted Maximum Extent for FCGT$_{(Horizontal)}$ Discharge (Transitional Season)

The magenta line designates the threshold dilution for a typical biocide contained within the hydrotest waters.

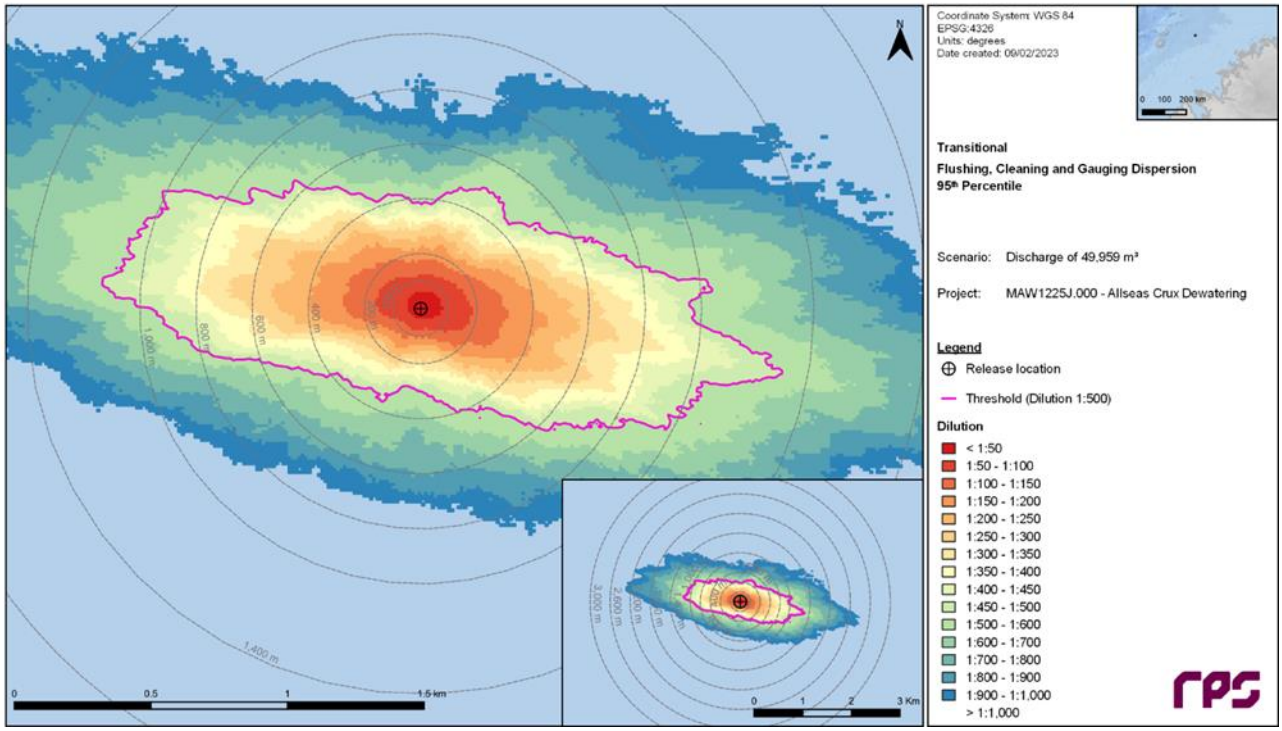


Figure 9-5: Predicted Maximum Extent for FCGT$_{(Vertical)}$ Discharge (Transitional Season)

The magenta line designates the threshold dilution for a typical biocide contained within the hydrotest waters.

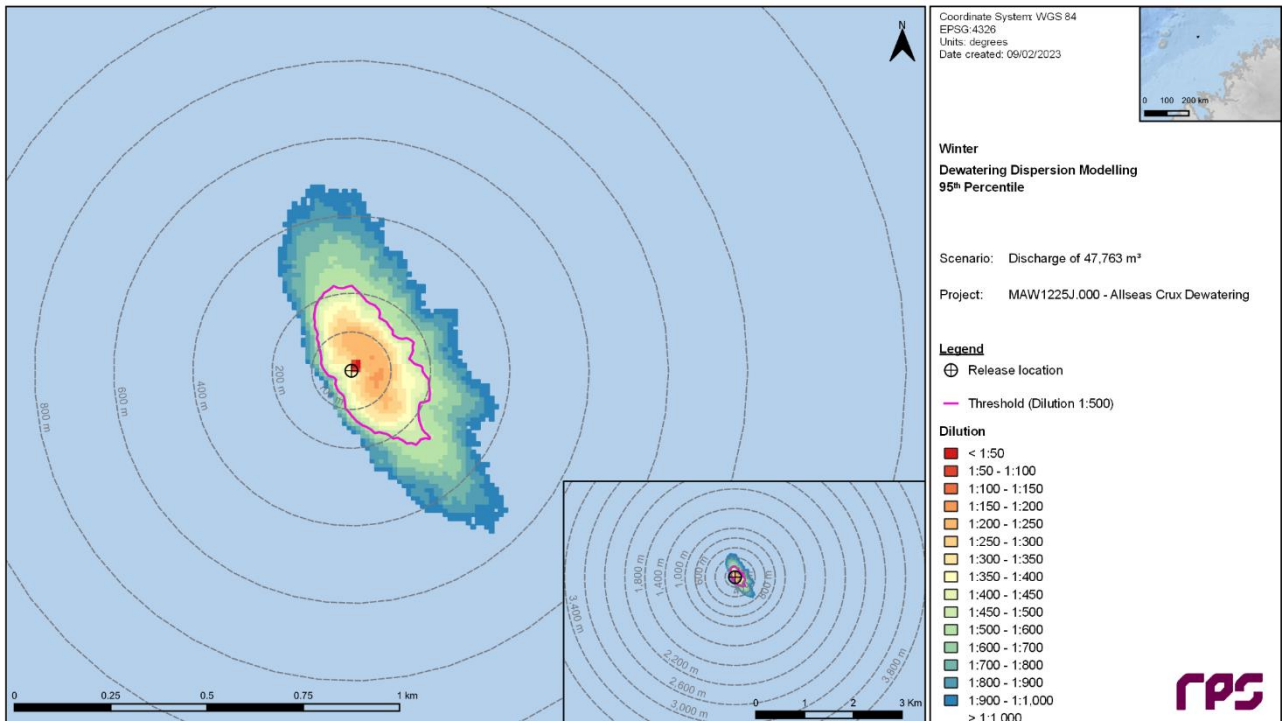


Figure 9-6: Predicted Maximum Extent for Dewatering Discharge (winter season metocean conditions)

The magenta line designates the threshold dilution for a typical biocide contained within the hydrotest waters.

9.10.1.2 Drilling Cuttings Discharges

Section 6.9.7.3 describes the DTH drilling method—using untreated sea water only—for the drilling operations required to install the inert piles. Each hole will be drilled with a marine riser in place, which will allow the drilling cuttings and untreated sea water to be circulated back to the temporary pile drilling deck. The drilling cuttings

(total ~19,558 m^3) will then be discharged to the marine environment from the drilling deck discharge point. The drilling operation will take ~30–35 days to complete.

9.10.1.2.1 Dispersion Modelling

Drilling cuttings dispersion analysis was undertaken to model the fate of the cuttings discharged, the likely coverage area. and bottom deposition (thickness and accumulated load). The risk of contact to sensitive receptors was also considered (RPS 2023a). Table 9-56 summarises the discharge configuration and the estimated drilling cutting volumes used as input into the sediment dispersion model (MUDMAP). MUDMAP is a three-dimensional plume model used by industry and regulators to help assess the potential environmental effects from operational discharges such as drilling cuttings. The full text Drill Cutting Dispersion Analysis Report (RPS 2023a) is provided in Appendix J, the following provides a summary of the modelling outcomes to enable an effect evaluation of impacts.

The particle size distribution data was measured by Fugro (2019) from downhole samples collected as part of a geotechnical investigation in the Crux field. Samples were collected at various depths downhole and across multiple sample locations. To establish the sediment dispersion models, the measured data was grouped into four depth ranges (0–25 m, 25–65 m, 65–125 m and >125 m). The data was further classified into six main particle classes (coarse gravel, fine gravel, coarse sand, medium sand, fine sand, and clays and silts).

Table 9-56: Key Inputs to the Drilling Cuttings Dispersion Modelling

Parameter	Data
Timing/commencement	First day of each calendar month (May–Oct, inclusive)
Number of simulations	60
Geographic coordinates (GDA2020 datum)	Drill centre: 12° 57′ 52.414″ S and 124° 26′ 33.238″ E
Discharge material	Commingled stream of seabed material, sea water, and air. No drilling muds present.
Density of seabed material (when in place)	2.2 MT/m^3
Density of commingled discharge stream	~1.15 MT/m^3
Flowrate of commingled discharge stream	510 m^3/h (seabed material – 85 m^3/h)
Discharge depth	Sea surface
Discharge pipe orientation	Horizontal
Discharge pipe diameter	~300 mm
Duration to drill single hole	16.2 hours
Drill hole diameter	3.3 m
Number of holes	Up to 14
Length of holes	163.5 m
Volume of seabed material discharge (per pile)	1,397 m^3
Total volume of seabed material discharge (14 piles)	19,558 m^3
Water depth	168.5 m

Table 9-57 summarises the natural and impact threshold levels used to assess sedimentation.

Table 9-57: Natural and Impact Threshold Levels for Bottom Thickness

Parameter	Natural Threshold Level (mm)	Impact Threshold Level (mm)	
		Low Exposure	High Exposure
Bottom thickness – multiple (14) holes drilled	0.058	1	10

A study by Glen (1997) found that the maximum natural sedimentation rate for north-west Australia is 223.21 cm per thousand years. As a conservative measure, a minimum threshold thickness of 0.058 mm was calculated from the maximum natural sedimentation rate of 2.23 mm/year (or 0.0061 mm/day) multiplied by the combined discharge duration (9.45 days).

Impact thresholds of 1 mm (low exposure) and 10 mm (high exposure) were applied based on available literature and are considered industry standard. A study by Trannum et al. (2009) showed a significant decrease of species, abundance of individuals, Shannon-Wiener diversity (diversity between habitats), and biomass of marine animals with increasing depth of water-based mud cuttings (3–24 mm) on sediment in the microcosms. Therefore, a conservative 1 mm impact threshold was selected as representative of low exposure. A study by Kjeilen-Eilertsen et al. (2004) showed that deposition >9.6 mm is likely to cause smothering impacts on benthic ecosystems, including corals, and a study by Smit et al. (2008) established a thickness threshold of >6.5 mm would be needed before potential harm occurred to benthic macrofauna. This sediment thickness threshold is based on data from shallow-water fauna.

Note: The predicted sedimentation is the level *above* any background sedimentation process relevant to the substructure location. Moderate levels of sediment movement are expected in this region due to drift and tidal currents, and therefore it is expected that these results are conservative (i.e. more sedimentation predicted than would be the case).

The results for each month were integrated to define the likely coverage area of bottom thickness above the thresholds for 'any time' or current conditions modelled. Table 9-58 shows the combined distribution of maximum sediment thickness, coverage area and the maximum distance from the well location for each threshold level. The maximum thickness (or height of mound) was predicted to be 32.21 mm adjacent to the discharge location (Table 9-58).

Figure 9-7 aggregates all stochastic simulations over the 10-year hindcast period. The modelling results demonstrated that larger particles (>0.25 mm diameter) were predicted to settle typically within 250 m of the discharge location, while the currents transported smaller sediments (<0.25 mm) further away from the discharge location.

Modelling predicted a relatively wide zone of potential influence at the natural threshold level, with thicknesses of ≥0.058 mm expected up to ~11.8 km from the hole location, over an area ~40.45 km^2. This potential zone of influence was localised at the low (1 mm) and high (10 mm) exposure thresholds, with drilling cuttings not expected beyond 986 m and 386 m, respectively. Total coverage areas at the low (1 mm) and high (10 mm) exposure threshold were 2.09 km^2 and 0.28 km^2, respectively.

Table 9-58: Drilling Cuttings Predicted Bottom Thickness, Coverage Area and Maximum Distance

Period	Maximum bottom thickness (mm)	Maximum total area of coverage (km^2) above threshold			Maximum distance (m) from well to threshold		
		0.058 mm	1 mm	10 mm	0.058 mm	1 mm	10 mm
May–Oct[50]	32.21	40.45	2.09	0.28	11,844	986	386

[50] Results are calculated across all 60 simulations.

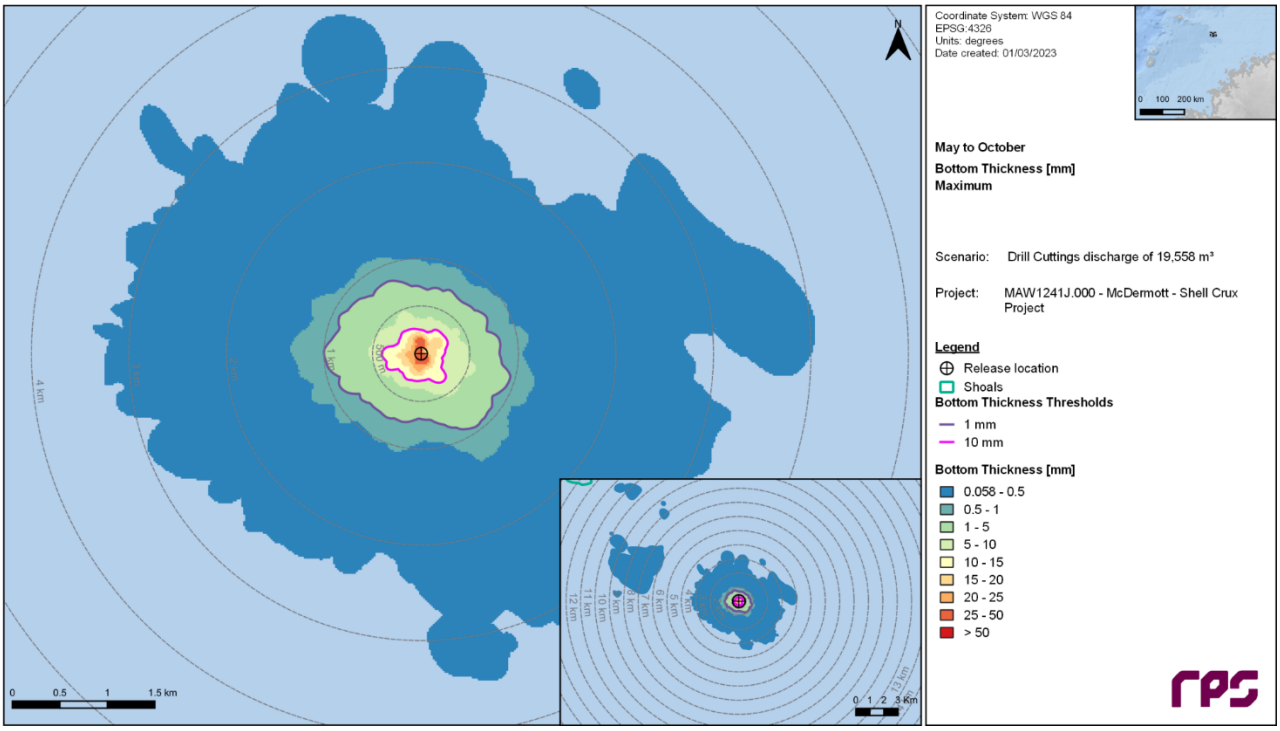


Figure 9-7: Predicted Maximum Bottom Thickness from the Combined Drilling Cuttings

9.10.1.3 Grout Discharges

Sections 6.9.7.2 and 6.9.7.3 describe the grouting operations required for each primary and insert pile. At the start of grouting operations, equipment and lines will be tested using water and an inert dye. Once grouting is complete, the equipment and lines will be flushed, washed and cleaned with sea water to prevent grout setting. This will result in ~21 m^3 discharge of residual grout and wash water to the environment per flush.

Grouting fluids, including grouting mix water, comprise, but are not limited to, cement and additives such as anti-foamers, extenders, accelerators, dispersants, silica, retarders, fluid loss agents and gas block agents. Note that these do not contain any heavy metals (such as mercury). The grouting fluid is likely to be a high temperature cement blend (or similar).

Grout may remain liquid for several hours, during which some chemicals may be released into ambient waters. Once the grout hardens, any chemical components of the grout are locked into the inert grout.

Excess or contaminated liquid grout that cannot be used downhole will be discharged to the environment—to prevent grout from solidifying in the storage tanks. Grout will be mixed and pumped as required from a small mixing tank on the grout unit, which limits the volume of excess or contaminated grout that could potentially require discharge into the ocean.

Post-filled grout bags may also be used in the unlikely event that a higher span rectification is needed (see Section 6.9.4). Empty bags are filled with a liquid grout slurry from the surface through a downline. The downlines are flushed to subsea after each operation to prevent the grout from setting in the downline between filling operations. The grout composition comprises cement, sand, and water, and it is classified under the OSPAR PLONOR list. Filling grout bags is a contingency activity and the discharged grout is deemed safe for release into the marine environment.

No dry grout will be discharged to the environment. Unused grout and additives will be returned to shore for re-use or disposal.

9.10.1.4 Miscellaneous Planned Discharges

9.10.1.4.1 Inert Material

A bulka bag filled with inert material (such as sand or similar) will be used as a temporary turning bollard. To retrieve the bulka bag, the bag is cut and its contents emptied. In addition, surface preparation/blasting activities may result in negligible quantities of inert material being released to the marine environment. The

very minor volumes that may be potentially released is considered to have negligible adverse effects on the seabed biota.

9.10.1.4.2 Hydraulic Fluid

To recover the temporary hammer hose hydraulic lines, an ROV will sever the line resulting in a negligible volume (~0.5 m^3) of hydraulic fluid released to the marine environment (see Section 6.9.7.4). The hydraulic fluid used, such as Shell Tellus T46™ or similar, will be selected using the chemical selection process (see Section 10.1.6). Based on this assessment, the environmental impacts associated with the release of negligible volume of hydraulic fluid is deemed insignificant and therefore is not considered further.

9.10.1.4.3 Grease

Skidway grease—a lubricant that allows the smooth movement of heavy structures by helping reduce friction—is required when transferring the substructure and topsides from onshore facilities onto the project vessel.

There is potential for grease to be released into the marine environment; however, the amount of residue from the skidway grease that may wash off into the marine environment is considered negligible. Based on this assessment, the environmental impacts associated with the release of skidway grease residues are deemed insignificant and therefore are not considered further.

9.10.1.4.4 Utility Open Drain System

The topsides utility open drainage system requires a first flush (via the oily water separator) to the marine environment (See Section 6.10.2.4). The first flush of stormwater from potentially contaminated areas will be captured for treatment; drainage water above the first flush, or from non-contaminated areas, will be considered clean and discharged directly overboard and, therefore, not considered further.

9.10.1.4.5 Fire Extinguishing Type

All fire extinguishers on the substructure and topsides will be water-based, except for the wheeled fire extinguisher stored on the topsides helideck. All fire extinguishers will be free from PFOS (perfluoro-octane sulfonate) and PFOA (perfluorooctanoic acid).

Fire extinguishers on the substructure and topsides (except the extinguisher on the helideck) will only be used in an emergency event but may require testing—such usage may lead to discharges of negligible volumes being released overboard where it cannot be contained. Combined with the chemical characteristics of the water-based fire extinguishing fluid, the release of these negligible volumes to the marine environment will not cause any adverse environmental impacts. Therefore, this release is not assessed further.

9.10.1.4.6 Topsides Installation Ballast Water

Once set down, the ABTs will be retrieved (via deballasting locally sourced untreated sea water with air) and recovered to the vessel deck or configured for wet tow for transportation from the Activity Area (see Section 6.9.8.3). If the substructure needs to be elevated or manoeuvred within the water column (an unlikely event) before it is landed on the seabed, a negligible volume of treated sea water may need to be released from the substructure compartments.

Contingency and planned ballast water discharges associated with topsides will result in negligible volumes (see Section 6.11.1.5) of locally sourced untreated sea water—these are deemed insignificant and are not considered further in this EP.

9.10.2 Description and Evaluation of Impacts

9.10.2.1 Physical Environment

9.10.2.1.1 Water and Sediment quality

Cold Commissioning Discharges

The cold commissioning discharges will occur near the seabed (i.e. FCGT discharges) and at the surface (i.e. dewatering discharges). Based on the requirement to dilute the combined dose of the Hydrosure 0-3670R™ (or similar) from 500 mg/L to 1 mg/L (i.e. 500-fold dilutions) and the selection of horizontal discharge orientation for the FCGT release, modelling predicted maximum distances of potential impact of ~430 m for the FCGT discharge and ~280 m for the dewatering discharges (RPS 2023).

The high turbulent flow of the selected FCGT discharge methodology (high velocity and small pipe outlet diameter; Table 9-55) is predicted to result in high initial mixing and dilution rates. The neutral density of the FCGT discharge plume is unlikely to influence vertical movement (neither sinking nor rising) reducing the subsequent rate of dispersion. The prevailing tidal circulation near the seabed will likely influence the plume dynamics, thus enabling the potential for redosing to occur as the plume oscillates. The far-field modelling shows that sediments are unlikely to be impacted by $FCGT_{(Horizontal)}$ discharges and that the average distance from the release point at which the treatment chemicals would diluted to below the 1 mg/L impact threshold is predicted to be 110 m. The chemicals proposed for use in the hydrotest water will not persist in the environment. They will be readily biodegradable and have no potential for bioaccumulation.

The slight negative buoyancy of dewatering discharge (cooler than the ambient water near the surface) results in it sinking downward after release. Although it sinks more slowly (~6 m/s) than the FCGT discharge, the downward orientation of plume and the deep waters in the surrounds means it will likely to continue to sink and entrain ambient water into the plume after the initial jet momentum is lost, then continue sinking until neutral buoyancy is achieved. The downward orientation of the plume will direct the plume across the current, irrespective of the current direction.

Consequently, in contrast to the FCGT discharge, where build-up was calculated over the turning of the tide, the dewatering plume will be influenced by the speed of the current. When the prevailing current speed is slower, the dewatering plume will be directed downwards at a faster rate. Hence, increased vertical spreading will likely occur, reducing the likelihood of redosing during periods of sluggish current.

Therefore, cold commissioning discharges are predicted to result in localised and temporary reduction in water quality around the release location. The hydrotest mixture will not persist in the environment (e.g. they are readily biodegradable and have no potential for bioaccumulation) and impacts to sediment are predicted to be negligible. Given the mixing potential (influenced by oceanic currents) for the cold commissioning discharges, impacts to water quality will be limited in duration and water quality is expected to rapidly recover once the discharges stop.

Drilling Cuttings Discharges

The DTH drilling method—using untreated sea water—will release drilling cuttings at the surface (Section 9.10.1.2) and the changes to water quality will be limited, conservatively, to within hundreds of metres of the discharge source. The offshore receiving environment typically has low turbidity (AECOM 2016), and the discharge of cuttings from the drilling deck discharge point will result in a temporary increase in turbidity and TSS. Turbidity changes depends on the characteristics of the drilling cuttings, primarily particle size and density. The particle size distribution data measured by Fugro (2019) from downhole samples ranged from coarse gravel (>37.5 mm) to clays and silts (<0.049 mm). Typically, coarse particles will settle rapidly (66.4–93.9 cm/s) and have little potential to impact water quality (International Association of Oil and Gas Producers (IOGP) 2016). As particle size decreases, the settling velocity will typically decrease. This will result in a turbid plume that will decrease as the plume is diluted and the suspended particles are deposited (Continental Shelf Associates 2006).

The RPS (2023a) dispersion modelling results demonstrated that larger particles (greater than 0.25 mm diameter) were predicted to settle typically within 250 m from the discharge location, while the currents transported the smaller sediments (less than 0.25 mm) further away from the discharge location. The maximum thickness (or height of mound) was predicted to be 32.21 mm adjacent to the discharge location. Finer sediments are forecast to disperse more widely, with the finest sediments contributing a lower proportion of sediment to deposits greater than 0.058 mm (natural threshold) thick. Deposits of finer sediments are consistently calculated to build up along the tidal axis on either side of the discharge location rather than displace to a particular side, indicating that tidal currents will have influence over movement of the finer particles and that ocean currents will have a small impact on the net movement direction and distance travelled before settlement occurs. This potential zone of influence was localised at the low (1 mm) and high (10 mm) exposure thresholds, with drill cuttings not expected beyond 986 m and 386 m, respectively. Therefore, habitat modification could occur within ~386 m (up to 0.28 km^2) from the drill holes (up to 14 drill holes). Within this area, benthic communities may be altered or reduced, resulting in a highly localised impact to any epifauna and infauna. Potential impacts include burial or smothering effects, particularly for sessile epifauna, from localised sediment deposition. Sediment coating resulting from elevated turbidity/total suspended solids (TSS) can also potentially cause clogging or damage to the physiological functioning of biota such as sea pens and polychaetes that rely on external respiratory and feeding structures. Soft sedimentary communities are known to recover rapidly to temporary disturbance. Deepwater benthic biota are adapted to low oxygen levels, zero light and reduced temperatures. Changes in oxygen levels resulting from drilling sediment dispersion will be

of short duration and temporary especially as no drilling fluids used. Therefore, the consequence of any impact is considered to be Slight (Shell 2009).

Hence, drilling cuttings sedimentation is likely to result in short-term and negligible impacts to sediment quality.

Because the mixing potential of the discharges is influenced by oceanic currents and impacts to water and sediment quality will be for a short period, water and sediment quality is expected to rapidly recover once the discharges stop.

Grout Discharges

Liquid grout discharges may remain liquid for several hours, during which there may be some release of chemicals into ambient waters. The grout is likely to harden after grout downline flushing and form a hard substrate in a highly localised area around the insert pile locations, permanently altering the physical properties of the sediment at that location.

Excess or contaminated liquid grout discharged into the ocean would result in increased local turbidity as the plume dilutes and disperses though the water column. The grout will be dispersed by currents, potentially resulting in minor alteration of benthic habitat characteristics (sediment particle size, element composition). However, given the depth of water (~168 m at the pile locations) and the local currents, it is considered unlikely that detectable concentrations will accumulate on the seabed.

Summary

Overall, the residual impact consequence of activity discharges to water and sediment quality is considered Minor (Magnitude: −2, Sensitivity: L).

9.10.2.2 Habitats and Communities

9.10.2.2.1 Plankton

Cold Commissioning Discharges

Plankton drifting past the outlet at the time of discharge may be exposed to elevated concentrations of treated sea water and freshwater. However, dilution of the plume is rapid and the concentration that an individual organism is exposed to will continually reduce with dispersion. Plankton are widely distributed throughout the region, and, in the context of their lifecycle, impacts will be short term and negligible.

Drilling Cuttings Discharges

Injury or mortality to planktonic species may occur due to increased turbidity following discharges of drilling cuttings.

Studies by Smit et al. (2008) indicated that phytoplankton and filter-feeding zooplankton typically exhibit greater effects from suspended solids from drilling cuttings and suggested that these biotas are less well-adapted to relatively high concentrations of suspended sediments than benthic biota. Smit et al. (2008) suggested that impacts to zooplankton were primarily the result of physical effects to filter-feeding and respiration organs, while impacts to phytoplankton were the result of reduced light levels. Concentrations at which impacts to phytoplankton may occur are highly localised and unlikely to occur >25 m from the discharge point (IOGP 2016; Smith et al. 2004).

As only untreated sea water (instead of drilling muds) will be used as the drilling fluid, toxicity and bioaccumulation potential is considered to be negligible.

Grout Discharges

Plankton drifting past the immediate vicinity of grout discharges may be exposed for a very short time before the grout sets. Plankton are widely distributed throughout the region, and, in the context of their lifecycle, impacts will be short term and negligible.

Summary

Due to the low levels of planktonic productivity in the vicinity of the substructure location, plankton populations on a regional scale are not expected to be affected by activity discharges. The open nature of the marine environment and associated environmental conditions (i.e. windy, strong currents), the content and dispersive nature of activity discharges within the marine environment, and the high population replenishment of these organisms, means that impacts to plankton species are expected to be limited to within tens of metres of the

discharge points and return to previous conditions within a relatively short time. Therefore, the impacts to plankton from activity discharges is Slight.

9.10.2.2.2 Benthic communities; Shoals and Banks

Cold Commissioning Discharges

The nearest shoals to cold commissioning discharge locations with depths <20 m are Echuca Shoal (63 km east) and Heywood Shoal (85 km north-east). Therefore, no protected or sensitive benthic habitats have the potential to be exposed to the cold commissioning discharges.

Drilling Cuttings Discharges

Studies by Smit et al. (2008) indicated that phytoplankton and filter-feeding zooplankton typically exhibit greater effects from suspended solids from drilling cuttings and suggested that these biotas are less well-adapted to relatively high concentrations of suspended sediments than benthic biota. Smit et al. (2008) suggested that impacts to zooplankton were primarily the result of physical effects to filter-feeding and respiration organs, while impacts to phytoplankton were the result of reduced light levels.

Minimal impact to plankton (phytoplankton, zooplankton and meroplankton (larvae of invertebrates and fish) is therefore expected from the discharge of drill cuttings. Neff (2010) explains that the lack of toxicity and bioaccumulation potential of the drilling cuttings means that the effects of the discharges are highly localised and are not expected to spread through the food web (of which planktonic species are the basis).

Low levels of planktonic productivity are expected in the offshore area. Plankton populations on a regional scale are not expected to be affected by drilling cuttings (using untreated sea water) discharge. Impacts to individual plankton will be limited to within tens of metres of the discharge point and return to previous conditions within a relatively short duration. On this basis, the impacts to plankton from drilling discharges is considered Slight.

Drill cuttings will likely impact benthic communities due to sedimentation. However, as no drilling fluids will be used, impacts associated with traditional drilling fluids, such as sediment chemistry changes, are not expected. The deposition of cuttings has the potential to smother sessile benthic organisms, with effects predicted to occur at deposition thicknesses of greater than 6.5 mm (IOGP 2016). Sedimentation is an ongoing natural process, and benthic organisms exhibit adaptations to respond to increased sediment deposition. Natural sedimentation rates Northwest Australia were estimated by Glenn (2004) between ~0.17–2.23 mm per year. This potential zone of influence was localised at the high (10 mm) exposure thresholds, with drill cuttings not expected beyond 386 m. Therefore, habitat modification could occur within ~386 m (up to 0.28 km^2) from the drill holes (up to 14 drill holes). Section 9.10.2.1.1 details the dispersion modelling results and impacts to sediment quality. Benthic communities subject to deposition between 1 mm and 10 mm thickness are less likely to experience mortality but may experience sub-lethal impacts (IOGP 2016), such as impaired feeding due to clogging of filter feeding organs and increased energy expenditure from removing sediment from burrows. Recognising that sediment deposition from drill cuttings is in addition to natural processes, benthic communities subject to deposition of drill cuttings of <1 mm thickness are unlikely to experience impacts from physical deposition of drill cuttings, as this thickness is consistent with natural sedimentary deposition rates.

Jones et al. (2021) undertook pre– and post–drilling surveys for the Greater Western Flank-2 drilling holes to determine impacts on epibenthic communities. The program involved measuring and profiling TSS concentrations under the mobile offshore drilling unit by an ROV. Effects to the sparse benthic filter feeder communities close to the wells were observed, but no effects were seen on the epibenthic or demersal fish assemblages across the nearby mesophotic reef (Jones et al. 2021). Overall, the surveys suggest a zone of high impact surrounding the drill centre up to 50–75 m in all directions caused by drill cuttings discharged. A zone of moderate impact was observed up to 200 m from the drill centre with epifauna loss. Some sponges and soft corals were also recorded with sediment. Sponges tend to keep their surfaces free of sediment and have cleaning mechanisms to remove sediments, including mucus production, tissue sloughing, and self-cleaning surfaces.

The area with a deposition of ≥10 mm thickness will potentially take years to recover, depending on natural sedimentary processes. Recovery may be linked to the deposition of relatively fine natural sediments on the coarse sediments in the drill cuttings pile to create suitable habitat. Studies relating to benthic communities on visible cuttings piles (consistent with the area subject to drill cuttings and fluids deposition ≥ 10 mm) indicated considerable recovery within three years (particularly where the deposition was thinner). However the benthic communities had not fully recovered to pre-discharge conditions or the surrounding unaffected seabed.

At the low (1 mm) and high (10 mm) exposure thresholds, drilling cuttings are not expected beyond 986 m (~2.09 km^2 coverage area) and 386 m (~0.28 km^2 coverage area), respectively. The two closest shoals to the drilling cuttings discharge location are Goeree Shoal (~13.5 km) and Eugene McDermott Shoal (~17.8 km). Therefore, no protected or sensitive benthic habitats have the potential to be exposed to drilling cuttings discharges.

The absence of benthic primary producers in this environment and the relatively short discharge duration limits the potential for impacts upon receptors such as plankton or benthic communities. Given this, the consequence of any impact is considered to be Minor, with no long-term effects anticipated.

Grout Discharges

Grout discharges are not expected to significantly impact the benthic environment, given the localised grout discharge distribution and that the receiving environment comprises soft sediments and likely previously disturbed seabed from other activities related to the Crux Project (outside the scope of this EP). The grout will cover the seabed around the pile locations, burying benthic organisms and altering benthic substrate in a very localised area. The grout will solidify, potentially providing a hard substrate for epifaunal organisms to occupy.

Excess or contaminated grout discharged (if required) will likely be dispersed by currents, potentially resulting in minor alteration of benthic habitat characteristics (sediment particle size, element composition). However, given the currents and the water depth at the substructure location (~168 m), it is considered unlikely that detectable volumes will accumulate on the seabed.

9.10.2.2.3 Threatened and Migratory Species

Cold Commissioning Discharges

If present in the vicinity of the discharge location during discharges, mobile animals could pass through the discharge plume; however, exposure will most likely be at a low concentration and for a short duration with no significant impacts. Biocide chemicals selectively target simpler life forms, so much higher concentrations would be required to affect more developed species. For example, for Hydrosure 0-3670R™ the No Observable Effect Concentration (NOEC) for a fish species is 12.5 mg/L compared to 1.3 mg/L for algae (Chevron 2015). Modelling demonstrated that concentrations within the plume vary both temporally and spatially, rarely exceeding instantaneous concentrations of 10 mg/L.

There are no gazetted BIAs, breeding grounds or sensitive habitats (including habitat critical to the survival of species) for EPBC Act listed species within or near the cold commissioning discharge locations, and no marine mammal, turtle, pelagic fish, demersal fish, shark or ray aggregation areas have been identified near the discharge locations. In addition, no habitat where dusky sea snakes are known to, or have been identified in the Activity Area where effects from cold commissioning discharges will be confined too.

Most threatened and migratory fauna species that could be present are air-breathing vertebrates, which are unlikely to be directly affected as their skin is relatively impermeable and they breathe air. Therefore, direct impacts from cold commissioning discharges are not considered credible. Non–air-breathing species are not expected to be present in significant numbers nor be exposed to discharge concentrations that may adversely affect individuals. With controls in place, impacts to the fauna listed above are predicted to be Slight.

Drilling Cuttings Discharges and Grout Discharges

A whale shark BIA for foraging intersects the drilling cuttings and grout discharge location. However, it is anticipated that whale shark presence will be limited, primarily because they exhibit continuous movement patterns in deeper, open offshore waters (Meekan and Radford 2010). Consequently, it is more likely that the BIA functions as a larger foraging area for their migrations.

No sensitive habitats or known aggregation sites for marine fauna, including dusky sea snakes occur within impact footprint of drill cuttings and grout discharges. Therefore, fauna presence is likely to be limited to transiting individuals, which are unlikely to be exposed to discharge concentrations that may adversely affect individuals.

Therefore, potential short-term and limited spatial extent behavioural impacts may occur to individual marine fauna, including whale sharks, although it is considered unlikely.

Summary

Given the activity discharges are temporary and in localised plumes, impacts are considered Slight, with no long-term effects anticipated.

9.10.2.2.4 Key Ecological Features

There are no KEFs within any activity discharge location or modelled plume. The closest KEF—Continental Slope Demersal Fish Communities—is >14 km away. Therefore, no impact from the activity discharges is expected.

9.10.2.2.5 Australian Marine Parks

The nearest AMP (the Kimberley Multiple Use Zone) is ~80 km away; there will be no impact from the activity discharges on this AMP.

9.10.2.3 Socioeconomic and Cultural Environment

9.10.2.3.1 Indigenous Cultural Features and Values

There are no known First Nations underwater cultural heritage artifacts within the Activity Area. Cosmos Archaeology (2023) predicted that the Activity will not impact any tangible First Nations underwater cultural heritage as the proposed infrastructure locations (covered under this EP) are located below 130 m LAT which is the maximum extent of exposed land since humans have occupied the continent. Shell also has not identified through desktop research nor through consultation in preparation of this EP, any intangible cultural values, such as songlines, which may be impacted by the planned activities in this EP.

Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For an assessment of impacts to marine species that may be of cultural significance, refer to Section 9.10.2.2.3. No specific feedback or concerns were raised during consultation for this EP regarding potential impacts on Indigenous cultural heritage features and values from this aspect. Given the Slight consequence to marine species, significant impacts to socioeconomic and cultural environment receptors are not anticipated.

9.10.2.3.2 Marine Archaeology

There are currently no known underwater heritage artifacts (e.g. shipwrecks or other UCH sites) within any activity discharge location or modelled plume (see Figure 7-29; DCCEEW n.d.) or identified during relevant persons consultation. Therefore, it is expected that there are no predicted impacts to known underwater heritage artifacts from activity discharges.

9.10.2.3.3 Fishing

Commercially targeted fish resources found in the water column are expected to actively avoid discharge plumes and associated turbidity and toxicity within the water column. Marine fauna most sensitive to changes in water quality within a couple of hundred metres of the discharge are species that are sedentary within the discharge plume and thus exposed for a prolonged duration. Marine fauna found in the water column, such as fish, marine mammals, and marine reptiles, are expected to actively avoid discharge plumes and associated turbidity and toxicity within the water column and no site attached species are expected to occur given the absence of suitable habitat in these water depths. There are no fish aggregation sites within the Activity Area given the absence of suitable habitat and the water depths (~168 m at the Crux substructure and 250 m at the FLNG location). Scampi—a benthic species—is commercially targeted by the North West Slope Trawl Fishery which has active licences that intersect the Activity Area. Although there may be habitat modification due to drill cuttings sedimentation, impacts will likely be limited to up to 382 m from the discharge location and will remain within the Crux PSZ. Therefore, impacts to targeted fish resources will be localised and displacement is expected to be insignificant at a stock level.

With controls in place, impacts to the fishing listed above are predicted to be Slight.

9.10.2.4 Cumulative Impacts

Section 9.10.1 describes the concurrent discharges that may occur at the Prelude FLNG facility, except for produced water discharge, being the key discharge proximal to the Crux dewatering location, for up to ~8 days. The Prelude FLNG EP and this EP assessed the consequences of the activity discharges as minor. As discussed in Section 9.10.2.1.1, the modelling predicted that the dewatering discharge (hydrotest mixture) is diluted to below the acute toxicity threshold (1 mg/L) within ~280 m of the discharge location.

The Prelude FLNG routine planned liquid discharge types and rates are typical of most manned offshore facilities. Concurrent discharge plume interactions may be possible under the following circumstances:

- the concurrent discharges are located in sufficient proximity so that the dynamic plumes may overlap

- certain or changing ambient current directions bring the plumes of the same or other discharges into the discharge path of a plume
- severe conditions create substantial turbulence that allows the interaction of plumes that are normally at different depths.

The RPS (2019) modelling for the potential cumulative impacts of all liquid discharges released simultaneously from the Prelude FLNG (excluding the Crux dewatering discharges) are not expected to exceed the predicted potential impact (within 1 km) of the individually assessed worst-case discharge being produced water. RPS (2019) calculated the defined fields of effect (impact area) of wastewater discharges from the Prelude FLNG, considering any co-mingling or cross-contamination potential. Such fields of effect were calculated as the maximum distance from the Prelude FLNG where concentrations might exceed Predicted No-Effect Concentrations (PNECs) for each constituent of concern calculated using available ecotoxicity data and applying the CIN (2017) methodology. Given the high dilution, low volume and low toxicant concentrations, it is not anticipated that other minor Prelude FLNG discharges (e.g. food, sewage or greywater discharges; desalination brine, mixed bed polisher effluent and boiler blown-down discharges) would result in any cumulative impacts amongst each other or any other liquid discharge streams from the Prelude FLNG facility (RPS 2019).

The Prelude FLNG slops and bilge waste flows are expected to be relatively low volume and frequency, and are grouped in the cumulative assessment given that all three discharge streams are expected to contain oil in water. Allowing for the dilutive influence of other discharge plumes (e.g. cooling water), the adopted threshold is predicted to be achieved before it departs the lee of the Prelude FLNG under the 95th percentile current regime. Given the produced water discharge is located some distance (>400 m) from the other two hydrocarbon influenced discharge ports (slops), any influence of the produced water stream on the physical or chemical behaviour of these other discharge plumes is predicted to have no effect. By this point, the produced water stream is predicted to have diluted in the order of thousands of times already, which will result in all defined constituent PNECs being achieved prior to any plume intersection. Any interaction with or flow past the main cooling water discharges will result in entrainment within the cooling water plume and accelerated dilution due to increased energy and turbulence. In the case of interaction with cooling water, where the flow rate is significant, the produced water plume would be completely disrupted and entrained into the cooling water plume, dramatically increasing the effective dilution of the produced water plume as it undergoes a secondary nearfield phase. Contaminants already at very low concentrations are then further diluted. There are no significant total petroleum hydrocarbon (TPH) compounding effects predicted between the produced water and slops. The slops discharge plumes are anticipated to co-mingle, but the resultant plume TPH concentration is predicted to be diluted to within the defined 7 ppb PNEC within 150 m of the Prelude FLNG facility under the 95th percentile current regime. Allowing for the 99th percentile current, the field of effect could extend to 200 m from the Prelude FLNG facility.

As described in Section 9.10.1.1, effluent discharges resulting in overlapping concurrent plumes may occur but are considered unlikely due to the infrequent and temporary nature of these discharges. Potential overlapping plumes will be temporary, localised (within hundreds of metres) of the discharge location and can reasonably be expected to not exceed the predicted potential impact zone assessed under the Prelude FLNG EP. The nearest potentially high environmental value habitat to the Prelude FLNG is Browse Island (approximately 42 km distant), Echuca Shoal (approximately 63 km distant) and Continental Slope Demersal Fish Communities KEF (approximately 14 km). There is no known significant feeding, breeding, migratory or aggregations of marine fauna within the potential zone of impact.

Within the vicinity of potential overlapping plumes, there may be transiting marine fauna such as whale sharks, cetaceans and marine turtles. However, the exposure time for these species within the cumulative impact discharges will be short term with no long-term impact being associated.

Notwithstanding the potential overlap of the extent of discharge effects from potential concurrent activities, given the open offshore location, absence of sensitive or high-value marine ecosystems or habitats at the Prelude FLNG location and the very short duration (up to ~8 days), additive and cumulative discharge effects can reasonably be expected to be Slight (Magnitude: –1; Sensitivity: L). Therefore, no increase to the overall consequence level has resulted.

The remoteness of the Activity Area means that it is unlikely that there will be a cumulative impact with other marine users. Therefore, no change to the overall consequence level due to cumulative discharge impacts can reasonably be expected.

9.10.3 Impact Assessment Summary

Table 9-59 summarises the highest residual impact consequence ranking for activity discharges.

Table 9-59: Activity Discharges Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	−2	L	Minor
Biological Environment	−1	M	Slight
Socioeconomic and Cultural Environment	0	L	No impact

9.10.4 ALARP Assessment and Environmental Performance Standards

Table 9-60: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Omission of drilling muds such as water- and synthetic-based muds.	Yes	Geotechnical assessment confirmed that drilling muds can be omitted. This is due to the large drillhole diameter (~2.9 m), downhole geographic data and corresponding cutting removal efficiency for the insert pile, which reduces the volume of chemicals discharged and distributed in the drilling cuttings plume. The environmental benefits outweigh the costs associated with implementing this control and are considered to reduce impacts to ALARP.	8.1	The drilling method will use untreated sea water only (e.g. no chemical additives)	Drilling logs demonstrate that no chemical additives were added to the untreated sea water for inert pile drilling.
Elimination	No disposal of dry grout to the marine environment.	Yes	By restricting the disposal of dry grout to the marine environment, impacts on water quality are reduced.	8.2	No disposal of dry grout to the marine environment.	Drilling logs demonstrate that no dry grout was discharged to the marine environment.
Elimination	Recovery and storage of drill cuttings for onshore disposal.	No	Return of drill cuttings for onshore disposal would achieve a reduction in cuttings discharged. This process would require back-loading of the drill cuttings from the temporary pile drilling deck into project vessel skips, which then transfer the cuttings to an alternative onshore location. This option introduces safety risks and costs associated with additional lifting operations, vessel movements and onshore landfill disposal. The cost is considered grossly disproportionate to the environmental benefit impacts of disposal in deep, offshore waters specifically as the use of drilling muds has been omitted.	N/A	N/A	N/A
Elimination	Omission of cold commissioning operations.	No	Cold commissioning is essential to ensure the integrity of the export pipeline and other relevant infrastructure and cannot be omitted. Hence, implementing this control is considered not technically feasible.	N/A	N/A	N/A
Elimination	Use untreated sea water without any chemical treatment for	No	Chemical treatment is essential to protect the export pipeline and other relevant infrastructure from internal corrosion, which could ultimately compromise integrity.	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
	FCGT and dewatering fluids.		Hence, implementing this control is considered not technically feasible.			
Elimination	Use freshwater only to reduce dosage of any chemical treatment for FCGT and dewatering fluids.	No	The volume of freshwater required to be transported to the Activity Area would provide logistical challenges and increase the duration of the activity. In addition, the risk of stuck pigs is increased due to the slow and intermittent flooding process. The cost and alternative impacts and risks associated with implementing this control is considered grossly disproportionate to the environmental benefit, if any.	N/A	N/A	N/A
Elimination	Use deoxygenated freshwater for cold commissioning fluids.	No	Although technically acceptable, using deoxygenated freshwater in place of treated sea water is not considered practical due to the large volume of freshwater that would need to be continuously supplied to the offshore location from the mainland. The cost and alternative impacts and risks associated with implementing this control is considered grossly disproportionate to the environmental benefit, if any.	N/A	N/A	N/A
Elimination	Treat sea water with oxygen scavenger and expose it to UV light for cold commissioning operations.	No	The option of sea water treated with an oxygen scavenger and exposed to UV light for bacterial sterilisation is not considered acceptable to prevent internal corrosion and ensure the integrity of the export pipeline and other relevant infrastructure. The effectiveness of UV sterilisation to kill bacteria species is affected by particulate shadowing; therefore, it cannot provide a definitive sterilisation solution. Furthermore, UV sterilisation provides no 'residual' treatment, and as a result, corrosion-causing bacteria colonies can grow in the treated sea water left in place before dewatering. Hence, implementing this control is considered grossly disproportionate to the environmental benefit, if any.	N/A	N/A	N/A
Elimination	Recover and store the fluid for transport onshore.	No	This would shift any environmental impact to the mainland (storage; waste management) and increase health and safety issues due to handling and transport, cargo lifts, etc. The environmental impact of the additional fuel use from vessel movements and	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			treatment or disposal at landfill sites (usually through high-temperature incineration) is also considered greater than the slight impact from discharging offshore. Hence, implementing this control is considered grossly disproportionate to the environmental benefit, if any.			
Substitution	No simultaneous discharge of the Crux dewatering fluids and Prelude FLNG produced water (outside the scope of this EP) to avoid cumulative impacts.	Yes	Minimises the risk of additive or cumulative effects from this Activity and other Projects (e.g. Prelude FLNG) by preventing the simultaneous release of fluids which are proximal. Whilst potentially reducing impacts, this control also improves confidence on the predicted impacts from the dewatering discharge.	8.3	No simultaneous discharge of the pipeline dewatering fluids and Prelude FLNG produced water to avoid cumulative impacts	Evidence of timestamping for the dewatering and Prelude FLNG produced water discharges in the DCS demonstrate the discharges did not occur simultaneously.
Substitution	Discharge drill cuttings and untreated seawater at the seabed.	No	Discharge at the seabed is expected to result in a negligible reduction to the spatial extent affected by water quality changes and seabed disturbance compared to discharge at ~18 m above the waterline. Additionally, discharge at the seabed has the potential to cause drill cuttings to accumulate around the proposed infrastructure, necessitating additional seabed rectification. Therefore, implementing this control is unlikely to change the overall environmental impacts.	N/A	N/A	N/A
Substitution	Stock polyfluoroalkyl substances (PFAS)-free fire extinguishers on the topsides.	Yes	This control is effective in eliminating PFAS which are a group of chemicals known for their persistence, bioaccumulation, and potential adverse effects on human health and fauna.	8.4	Topsides will stock PFAS-free fire extinguishers.	Vendor data sheets demonstrate fire extinguisher stocks are PFAS-free. Safety Data Sheet/s demonstrate the fire extinguishers located on the topsides are PFAS-free.
Substitution	Use alternative biocide.	No	Glutaraldehyde and tetrakis (hydroxymethyl) phosphonium sulfate have been identified as viable alternatives. These chemicals have similar toxicity profile as alkyl dimethyl benzyl ammonium chloride	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			(the biocide in Hydrosure 0-3670R™), although higher dosage rates will be required to achieve the same microbial control. Therefore, implementing this control is unlikely to change the overall environmental impacts.			
Substitution	Use alternative oxygen scavenger.	No	No alternative oxygen scavenger has been identified. Ammonium bisulfite and its by-products are classified as non-hazardous and listed on the OSPAR list of substances which are considered PLONOR to the environment. Therefore, implementing this control is unlikely to change the overall environmental impacts and considered ALARP and safe to discharge.	N/A	N/A	N/A
Engineering	Implement export pipeline FCGT and dewatering operations in accordance with the contractor's Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	Yes	These procedures will ensure the activity will be executed according to engineering and environmental requirements. The purpose of the procedures is to provide detailed step-by-step procedures that Shell's contractor shall follow to flood, clean, and gauge (FCG) and separately carry out final pre-commissioning and dewatering of the as-laid Crux Export Pipeline. The objective of the procedure is for chemical injection is to achieve the targeted 500 mg/L chemical concentration consistently over the pipeline length, as per vendor and contractors recommendations. The plan describes how chemical dosing rates are managed to minimise the risk of overdosing chemicals (mixture of biocide, oxygen scavenger, corrosion inhibitor and fluorescein dye), which result in unnecessary discharge of residual chemicals into the ocean including additional expense, or under dosing, which could result in the need to reflood the pipeline due to integrity risks with preservation of the pipeline.	8.5	Hydrosure 0-3670R™ (or similar) concentration over the pipeline length, up to the targeted 500 mg/L is achieved, in accordance with contractor Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	Contractor Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure. Chemical injection system records and supporting quality assurance FCGT metering logs confirm chemical concentration in pipeline achieves the 500 mg/L target for the FCG chemically treated seawater concentration in the pipeline in accordance with the procedure. Pipeline Fill Report Pipeline Chemical Injection Report

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			The key measures of the plan aimed at achieving the targeted 500 mg/L chemical concentration consistently over the pipeline length are: • dosing rate management during the flooding of the pipeline; and • quality assurance and quality control of the dosing management prior to and during and following the flooding activity if necessary Dosing Rate Management: A chemical injection system will be used during the pipeline flooding process which automatically adjusts chemical injection rates (Hydrosure 0-3670R™, not for the dye which the stroke rate of the dye injection pumps will be set manually) within a set range of values that is suited to the injection activity (variability in flooding rates and associated chemical injection rates) to achieve a targeted chemical dosing concentration of 500 mg/L over the full length of the flooded pipeline. The chemical injection system will be maintained in accordance with manufacturers recommendations to ensure the chemical dosing system operates as accurately as possible during the chemical dosing activity. The chemical injection system will have a visual and audible alarm and shutdown system when chemical injection rates fall outside the set points. The chemical injection system will be operated by a competent operator, as determined by the Contractor, for the duration of the flooding activity and will respond immediately to alarms and activate the chemical fluid pump shutdown system when chemical injection rates fall outside the set points. Quality Assurance Measures: To assure the chemical dosing system is accurately dosing the pipeline to achieve the targeted 500 mg/L chemical concentration consistently along the pipeline, chemical injection rates/volume will also be logged every ~15 minutes to assure the dosing rates manually. This will involve	8.6	A chemical injection system will be used during the pipeline flooding process which automatically adjusts chemical injection rates within a set range of values that is suited to the injection activity (variability in flooding rates and associated chemical injection rates), in accordance with final contractor Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	Vendor data sheet of chemical injection system including statements of automatically adjustable chemical injection rates within a set range of values. Contractor spreadsheet of calculations of set range of values that is suited to the injection activity (variability in flooding rates and associated chemical injection rates), and the basis for the set range of values for the chemical injection system.
				8.7	The chemical injection system will be maintained in accordance with manufacturers recommendations, including pre-startup calibration of the stroke volume on the chemical injection pumps, to ensure the chemical dosing system operates as accurately as possible during the chemical dosing activity, in accordance with final contractor Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	Maintenance records for the chemical injection system in accordance with vendor recommendations and Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure. Spread rig-up and post mobilisation function testing records in accordance with Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure. Calibration records for the stroke volume on the chemical injection pumps demonstrate that is has been carried out in

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			visual checks by an operator of chemical tanks are performed, cross checked against the chemical injection system to confirm the volume of chemical injections aligns.			accordance with the Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.
				8.8	The chemical injection system will have an operational alarm and shutdown system when chemical injection rates fall outside the set point values outlined within Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure includes a description of the alarm and shutdown system, including low and high alarm set-points and low-low and high-high alarm set-points.
				8.9	The chemical injection system will be operated by a competent operator, as determined by the Contractor, for the duration of the flooding activity and will respond immediately to alarms and activate the chemical fluid pump shutdown system as required when chemical injection rates fall outside the set range values.	Contractors competency standards and records for the operator/s of the chemical injection system, including alarms and shutdown system.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
				8.10	Chemical injection rates/volume will be logged every ~15 minutes to assure the dosing rates and flooding rates are aligned and in accordance with final contractor Flooding, Cleaning and Gauging Operational Procedure and Dewatering Operational Procedure.	A chemical injection rate/volume log showing logs every 15 minutes or less during chemical dosing/flooding. Operator records of cross checks against the chemical injection system which confirms suitable alignment. Pipeline Fill Report Pipeline Chemical Injection Report
Engineering	Fail-safe tensioner (locks on and contingency tensioners) is in place on the pipelay vessel	Yes	Reduces the likelihood of a loss of position event due to mechanical failure of the tensioner or clamping mechanism, thereby reducing the likelihood unplanned discharges to the marine environment due to a wet buckle.	8.11	The pipelay vessel will have a fail-safe tensioner in place and operational to provide additional loss of position safeguard.	Pre-mobilisation inspection report demonstrates that the pipelay vessel has a fail-safe tensioner installed and operational.
Engineering	Criticality mode software system is in place on the pipelay vessel	Yes	Reduces the likelihood of a loss of position (or drift off) event due to mechanical failure of the tensioner or clamping mechanism and adverse weather, thereby reducing the likelihood of unplanned discharges to the marine environment.	8.12	The pipelay vessel will have a criticality mode software system in place and operational to provide additional loss of position safeguard.	Premobilisation inspection report demonstrate the pipelay vessel has criticality mode software installed and is operational.
Engineering	Export pipeline FCGT discharge undertaken via horizontal manifold ports	Yes	Optimises dispersion and reduces the area of potential adverse effects from residual treatment chemicals in the discharge. Modelling of subsea plumes that result from horizontal or vertical orientated FCGT discharge scenarios identifies that the plume extent is reduced and no seabed contact above impact thresholds is predicted if a horizontal diffuser is incorporated.	8.13	Export pipeline FCGT discharge occurs via horizontally oriented 4” port on the manifold	Engineering drawings for Prelude PLET end tie in show the 4” FCGT discharge port is horizontal

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Use the chemical selection process for all chemicals planned to be released to the marine environment	Yes	Shell has adopted a chemical selection and approval process in accordance with Shell's chemical selection and approval guidelines (as indicated in Shell Australia Chemical Change Process and Shell Global Product Stewardship guidelines) to assess chemicals that may pose environmental impact via planned discharges. Following the chemical change process (as detailed in Section) will minimise to ALARP levels the impact of those chemicals that are used and discharged.	7.5	Refer to EPS 7.5.	Refer to EPS 7.5
Administrative and Procedural Controls	Implement monitoring of water and sediment quality to detect/manage impacts from chemicals in activity discharges	No	The pipeline FCGT and dewatering discharges are 'one off' activities and it is not practicable to use results of monitoring to adjust discharge methodology. The DTH drilling does not involve use of drilling fluids and is too shallow to intersect hydrocarbon bearing strata so discharges will not include any chemicals. Implementing vessel-based marine monitoring programs in remote offshore locations involves substantive logistic, resourcing and financial effort/costs and introduces HSE, including environmental, risks. Modelling shows that, with the adopted controls and the rapid dispersion expected at the oceanic location, the proposed discharges pose minor to slight residual impact consequence. Hence, cost of implementing this control is considered grossly disproportionate to any environmental benefit.	N/A	N/A	N/A
Administrative and Procedural Controls	Monitor potential impacts to sediment quality from DTH drilling discharges via onboard sampling of cuttings	No	Shell is committed to completing sediment quality surveys in the Activity Area prior to operations to provide updated baseline information to support impact assessment throughout the operations and decommissioning phases of the project and to inform the eventual title relinquishment process (see Section 10.4.2). Modelling of drilling discharges shows that, with the adopted controls (including no drilling fluids) and the rapid dispersion expected at the oceanic location, the drilling discharges pose minor residual impact consequence. Analysis results for onboard cuttings samples would not be available in time to inform meaningful additional discharge	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			management during drilling and would not improve/add to an understanding of pre-operations sediment quality provided by the proposed survey(s). Hence, cost of implementing this control is considered grossly disproportionate to any environmental benefit.			
Administrative and Procedural Controls	Undertake in-field pre-operations baseline water quality, sediment quality and benthic habitat study	Yes	A scientifically robust pre-operations water quality, sediment quality and benthic habitat sampling design will be implemented to enable verification of the predicted level of impacts of operational phase activities and discharges. This monitoring could also be used to inform adaptive management over the whole project lifecycle, namely the operations, decommissioning and title relinquishment phases. Suitably qualified personnel (e.g. external independent consultants) will be engaged to design and carry out the monitoring. The design will also consider where likely expected impacts are predicted given prevailing conditions onsite. Further details of the pre-operations baseline study are described in Section 10.4.2.	4.5	Refer to EPS4.5	Refer to EPS4.5
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity discharges. No additional or alternative controls were identified that could further reduce the impacts without disproportionate effort and cost. Therefore, the impacts are considered to be reduced to ALARP.						

9.10.5 Acceptability of Impacts

Table 9-61: Acceptability of Impacts – Activity Discharges

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Physical Environment	Water quality		No significant impacts to water quality during the Activity.	Yes	Activity discharges above impact thresholds to water and sediment quality are predicted to extend < 1 km from the discharge location. However, discharges are expected to rapidly dilute or disperse in the open ocean environment. Shell will implement the control measures and performance standards listed in Table 9.57 to manage impacts to water and sediment quality to ALARP and acceptable levels. The magnitude of potential impacts to the marine environment is Slight, given the offshore location, short term duration and absence of particularly sensitive marine ecosystems at the Activity location and immediate surrounds.
	Sediment quality		No significant impacts to sediment quality during the Activity.	Yes	
Biological Environment	Habitats and Communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	Benthic communities within the Activity Area that activity discharges may impact are broadly represented in the region and are not of high environmental sensitivity (no impacts to shoals).
		Shoal and Banks	No direct impacts to named banks and shoals. No loss of coral communities at named banks or shoals as a result of indirect/offsite impacts[51]	Yes	Modelling predicted that activity discharges, including cold commissioning and drill cuttings discharges will not impact any sensitive receptors, such as shoals and banks.
	Threatened and migratory species	Marine mammals Marine reptiles Sharks, rays and other fish	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 9-62Table 7-14).	Yes	Most threatened and migratory fauna species predicted to be influenced by planned activity discharges are air-breathing vertebrates, which are unlikely to be directly affected as their skin is relatively impermeable and they breathe air. Therefore, direct impacts can reasonably be expected to be limited to avoidance behaviours. Non–air-breathing species are not anticipated to be present in significant numbers nor be exposed to discharge concentrations that may adversely impact on individuals. Giving regard to the Conservation advice for the dusky sea snake and the risk of pollutants affecting the dusky sea snake, project discharges

[51] As defined in the Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE 2013).

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
			No significant impacts to threatened or migratory fauna.		including pipeline FCGT, dewatering, drilling cuttings and grout discharges, will not occur in areas where the dusky sea snake species or species habitat may occur. Modelled potential impacts to water quality from FCGT and dewatering discharges are restricted to within 100 m of the discharge point (located at water depths of more than 240m). Therefore, no significant impacts are anticipated.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that occur within the Activity Area.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from activity discharges, given that no significant impacts to culturally significant marine species are expected.
	Fishing		No negative impacts to targeted fisheries resource stocks that result in demonstrated loss of income for commercial fisheries. Temporary displacement of fishing activities within the Activity Area (excluding PSZs) is acceptable. Permanent exclusion of fishing activities from PSZs is acceptable.	Yes	Activity discharges have a short duration and localised. Therefore, impacts to targeted fish resources will be localised and displacement is expected to be insignificant at a stock level.

The residual impact from activity discharges was assessed as Slight, which is inherently acceptable (Table 9-59).

Principles of ESD

The potential impacts from activity discharges are consistent with the principles of ESD because:

- Environmental values and sensitivities within the Activity Area will not be impacted.
- The precautionary principle has been applied by using chemical selection procedures that will ensure the most environmentally acceptable chemicals are used and the quantity discharged to the environment is minimised.

Relevant Requirements

Managing the potential impacts from activity discharges is consistent with relevant legislative requirements, including:

- Compliance with international maritime conventions, including:
- MARPOL:
    - Annex I: regulations for the prevention of pollution by oil
    - Annex II: regulations for the control of pollution by noxious liquid substances in bulk
- Compliance with Australian legislation and requirements, including:
- Navigation Act 2012 (Cth) and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
    - Marine Order 91 (Marine pollution prevention – oil)
    - Marine Order 93 (Marine pollution prevention – noxious liquid substances)
- OPGGS Act Section 460(2) – a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with… the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.
- Policies, strategies, guidelines, conservation advice, and recovery plans for threatened species (Table 9-62).

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation above demonstrates that significant impacts to threatened and migratory species from activity discharges is not credible.

Commonwealth Marine Area

Impacts and risks on the Commonwealth marine environment could not credibly exceed any of the significant impact criteria, as listed in Table 8-1.

Table 9-62: Summary of Alignment of the Potential Impacts from the Activity Discharges Aspect of the Petroleum Activities with Relevant Requirements for MNES

MNES	MNES Acceptability Considerations (EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
Threatened and Migratory Species	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	Predictive modelling demonstrates that dilution in the receiving environment is high and the area is well flushed (RPS 2023; RPS 2023a). The predicted maximum extent of cold commissioning discharges to 1 mg/L at a 95th percentile confidence level is limited to ~430 m and these discharges expected to disperse rapidly.
	Conservation advice on *Balaenoptera borealis* (sei whale) (DoE 2015c)	

MNES	MNES Acceptability Considerations (EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Project
	Conservation advice fin whale (*Balaenoptera physalus*) (TSSC 2015b)	The predicted maximum extent of drilling cuttings is up to 386 m for high exposure thresholds. Note: One of the controls prevents the use of drilling muds (untreated sea water only) further reducing the impact. Transiting marine fauna species may pass through the activity discharges plume but given the high rates of dilution, short duration and lack of known aggregation areas for these species no impact is predicted.
	Recovery plan for Marine Turtles in Australia 2017– 2027 (CoA 2017b)	
	Conservation advice on *Rhincodon typus* (whale shark) (DoE 2015e)	
Commonwealth Marine Area	Significant impact guidelines for Commonwealth marine environment (Table 8-1)	Water quality impacts by activity discharges are expected to be limited. Impacts are not considered to be significant in the context of the significant impact criteria for the Commonwealth Marine Area given the nature and scale of the impacts and the characteristics of the local receiving environment (open offshore waters with regionally well represented soft and bare sandy sediments). It is considered that the impacts associated with activity discharges will not result in a significant adverse impact on marine ecosystem functioning or integrity, social amenity or human health. Shell has sought to reduce potential impacts by selecting and implementing the controls and EPSs listed in Section 9.10.4.

External Context

There have been no objections or claims raised by relevant persons while preparing this EP regarding activity discharges. Shell's ongoing consultation program will consider objections and claims made by relevant persons when further assessing impacts (see Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of impacts and risks from drilling discharges determined the residual impacts rankings were Minor (Table 9-59). As outlined above, the acceptability of the impacts has been considered in the context of:

- the established acceptability criteria for the liquid discharges aspect
- ESD
- relevant requirements
- MNES
- external context (i.e. stakeholder claims)
- internal context (i.e. Shell requirements).

Shell considers residual impacts of Minor or lower to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met. Shell considers the potential impacts from activity discharges associated with the Activity to be ALARP and acceptable.

9.10.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No Significant Impacts to water and sediment quality from activity discharges.	Demonstrated implementation of EPSs for activity discharges.
No measurable impacts to sediment quality or water quality in the region from liquid discharges during the Crux project.	
No direct loss of coral communities (coral colony) at Goeree Shoal, Eugene McDermott Shoal, Vulcan Shoal or other sensitive benthic community will occur as a result of Activity discharges.	
Direct impacts to benthic habitats from Activity discharges will be limited to < 0.05% of the total Project Area (as defined in the OPP).	
Impacts from Activity discharges from the Crux project on the continental slope demersal fish communities KEF limited to <1% of the total area of the KEF.	
No injury or mortality of listed threatened or migratory MNES species as a result of activity discharges.	Fauna observations and incident reports demonstrate no injury or mortality of threatened and migratory MNES species as a result of activity discharges.

9.11 Atmospheric Emissions

9.11.1 Aspect Context

Atmospheric emissions have the potential to impact local and regional air quality such as oxides (such as nitrogen oxides (NO_x), sulfur oxides [SO_x], carbon monoxide [CO]), particulate matter (PM) (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOCs) (such as benzene, toluene, ethylbenzene, xylenes [BTEX], formaldehyde, etc.), ozone-depleting substances (ODS) and other harmful to human health gases (e.g. hydrogen sulfide). Project vessels may use ODS but these will be contained within a closed rechargeable refrigeration system—there is no plan to release ODS to the atmosphere.

Atmospheric emissions will be generated by project vessels from internal combustion engines (e.g. equipment, generators) and incineration activities (e.g. onboard incinerators). The pile drilling spread (set up on the substructure) and topsides will also use fuel for engines and generators. Engines on project vessels and these facilities use MDO and MGO, except for the topsides HTV, which uses IFO. Atmospheric emissions generated during activities include SO_x, NO_x, and VOCs. SO_x and PM are heavily influenced by the fuel type used and its relative sulfur content—MGO usually has a lower sulfur and PM content than MDO or IFO. However, all marine fuel types need to meet sulfur content of ≤0.50% m/m or IMO approved alternative measure. Cold commissioning, such as the HPLT (see Section 6.10.1.6) and contingency activities (see Sections 6.11.1.4 and 6.11.4) could release negligible atmospheric emissions. Given the slow-release rates and volumes associated with these activities, insignificant impacts can reasonably be expected; hence, will not be discussed further within this EP. GHG emissions are covered in Section 9.12.

On the basis that concurrent activities will occur within the local marine environment airshed, the potential for cumulative impacts of atmospheric emissions is acknowledged. Several Crux project vessels may operate within the vicinity of the Prelude FLNG facility. These include project vessels supporting the export pipeline installation activities–limited to vicinity of the Prelude-end PLET and assumes up to two weeks (see Section 6.9.5) and Prelude flexible riser and umbilical installation activities for a duration of approximately six weeks (see Section 6.9.6). Note that these two installation activities are unlikely to coincide. This EP, Prelude FLNG EP and Ichthys Project Offshore Facility (Operation) EP (Ichthys FPSO EP) (INPEX 2018) assessed potential atmospheric emission impacts to be Slight or Low, given the offshore remote context and lack of environmental sensitivities that may be impacted by emissions of atmospheric pollutant. The potential cumulative impacts are considered in this assessment (see Section 9.11.2.1). Other Activities covered under this EP were considered, however, given the distance from the Prelude FLNG and other facilities, no additional additive and cumulative effects can reasonably be expected. The PMCT works occurring on Prelude FLNG will not emit material additional air emissions to that which already occurs from the Prelude FLNG facility (Refer Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002]).

9.11.2 Description and Evaluation of Impacts

The predicted concentrations of atmospheric emissions at identified receptors and ambient air quality impacts associated with the Activity are expected to be of low magnitude. Air emissions associated with the Activity will increase NO_x, SO_x and $PM_{2.5}$ within the local airshed. These emissions may also deposit on the water surface with potential impacts on sea water, seabed sediments and other habitats for aquatic vegetation. The potential impacts to these receptors from emissions are considered negligible due to the low magnitude of emissions, location and water depths.

Atmospheric emissions may reduce the air quality immediately near the emissions source. Emissions from engines, generators and equipment may be toxic, odoriferous or aesthetically unpleasing, and will in resulted reduce air quality.

Given the offshore remote context and the low volumes of atmospheric emissions that will be generated, environmental sensitivities that may be impacted by emissions of atmospheric emissions include only the physical environment (air quality). No impacts on the biological, socioeconomic and cultural environment are reasonably foreseeable.

Given the above assessment, no adverse environmental effects are anticipated and the residual impact consequence for local air quality is considered to be Slight.

9.11.2.1 Cumulative Impacts

Overlapping atmospheric emission plumes from Prelude FLNG, Ichthys FPSO and Crux project vessels may occur. In 2020, Shell conducted cumulative air modelling impact assessment based on the atmospheric emissions from Prelude FLNG and Ichthys FPSO facilities. The cumulative modelling results predicted that the maximum concentrations at the closest receptor—Browse Island—are well below the associated ambient air quality standards for normal and exceptional case scenarios examined (Shell 2020). Refer to the Prelude FLNG EP [Shell document number: 2000-010-G000-GE00-G00000-HE-5880-00002] for a full summary of the modelling inputs, methodology and results.

As described in Section 9.11, atmospheric emissions resulting in potential overlapping concurrent plumes are likely to have a limited and small number of project vessels working within 1 km of the Prelude FLNG over an intermittent and short duration (<2 months total duration). The potential for cumulative impacts of atmospheric emissions is acknowledged although considered unlikely to be significant. This is based on atmospheric emissions from the Activity within the vicinity of the Prelude FLNG may result in a localised reduction in air quality in the immediate vicinity of the source, however this Activity will be limited to a short duration of project vessels within the vicinity of the Prelude FLNG. In addition, atmospheric emissions are unlikely to overlap with other marine users due to the PSZs around primary sources of emissions, and the remoteness of the Activity Area. Therefore, no change to the overall consequence level due to cumulative atmospheric emission impacts can reasonably be expected.

Occupational health effects associated with emissions of air pollutants are excluded from the scope of this EP and will be covered in the Crux Project occupational health management program and procedures. These have been extensively modelled in the design phases of the project and mitigated through design and operating procedures.

9.11.3 Impact Assessment Summary

Table 9-63 lists the highest residual impact consequence ranking of the relevant environmental receptor groups.

Table 9-63: Atmospheric Emissions Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	−1	L	Slight
Biological Environment	N/A	N/A	N/A
Socioeconomic and Cultural Environment	N/A	N/A	N/A

9.11.4 ALARP Assessment and Environmental Performance Standards

Table 9-64: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Remove all equipment containing ODS.	No	ODS is rarely found on vessels and there is only a low potential for ODS releases. If there is ODS-containing equipment (e.g. refrigerators) it will be managed as per Marine Order 97: Marine Pollution Prevention – Air Pollution. Based on cost to replace all equipment and only a low potential for ODS releases.	N/A	N/A	N/A
Elimination	Do not undertake incineration during activities.	No	Health and safety risks outweigh the benefit, given the offshore location. Waste incineration in accordance with regulations is a permissible maritime activity.	N/A	N/A	N/A
Substitution	Use renewable energy (e.g. solar, wind, wave) instead of fossil fuels for power generation and project vessel propulsion.	No	Using solar, wind or wave energy does not have the required reliability. Also requires additional space and capital investment, which are not currently justified. The contracted vessels will comply with the Shell marine vessel assurance process.	N/A	N/A	N/A
Substitution	Use lower emissions vessels to reduce pollutants associated with fuel combustion.	No	Not practically feasible at present. The contracted vessels are specialised and have limited availability. Vessel assurance will comply with legislative requirements.	N/A	N/A	N/A
Engineering	Install a mooring arrangement for support vessels to use when on standby.	No	Installing mooring arrangements for project vessels can typically reduce fuel consumption while on standby. However, given the limited and short duration of project vessels on standby, the anticipated reduction in emissions through this proposed control measure would not be significant.	N/A	N/A	N/A
Engineering	Use of hybrid power options for vessel propulsion.	No	Vessels equipped with hybrid power options use a dual-feed energy storage system. This system	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			includes battery packs that store energy when demand is low and deliver it back when demand increases, reducing fuel consumption and atmospheric emissions. Contracted vessels are specialised, and no hybrid power options are currently available within the proposed project fleet. Two contracted vessels are scheduled to retrofit this technology; however this may not be installed prior to the execution of Activity.			
Administrative and Procedural Controls	Vessel engines to use low-sulfur content fuel (≤0.5% m/m S) or an IMO approved alternative measure to reduce sulfur oxide emissions.	Yes	The MARPOL Annex VI requirement, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 97 requires that all fuel used by a vessel for propulsion or operation and carried on the vessel must have a low sulfur content (≤0.5% m/m S), unless the vessel uses an IMO approved measure that achieves an equivalent air quality outcome.	9.1	Use only low-sulfur fuel (≤0.5 m/m S) or an IMO approved alternative measure (e.g. EGCS fitted) to reduce sulfur oxide emissions.	Sulfur content of fuel oil/ diesel, % w/w as verified in bunker receipts. A copy a maintained EGCS record book (if relevant).
Administrative and Procedural Controls	Project vessels (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsequent Marine Orders.	Yes	Marine Order 97 requires specified marine vessels to possess the applicable pollution prevention and energy efficiency certificates. These certificates include Engine International Air Pollution Prevention Certificate (EIAPP), IAPP and an International Energy Efficiency (IEE) Certificate. In addition, all vessels >400 t (gross) are required to carry a Ship Energy Efficiency Management Plan (SEEMP). These requirements are also recognised and enforced in the Shell Marine Assurance Process and procedures.	9.2	Specified project vessels are required to have this valid documentation, as required by vessel class, size and type: • EIAPP certificate • IAPP certificate • IEE certificate • SEEMP.	Marine Assurance Record confirming SEEMP and IAPP, EIAPP, IEE certificates are in place for project vessels (where required by vessel class, size and type).
				9.3	Waste from incineration managed in accordance with MARPOL Annex VI.	A copy of the completed garbage record book or official recording system that captures

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
						incinerate waste records. Records of an IMO type approval certificate for each incinerator in use, demonstrating the incinerator is designed for operation within the limits of Regulation 16 of MARPOL Annex VI.
				9.4	ODS managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air, as required by vessel class, size and type.	A copy of the current and maintained ODS Record Book or recording system.
Administrative and Procedural Controls	Maintenance management system	Yes	Contractor vessels will implement the vessel-based maintenance management system for their vessel. Implementing such systems assists in equipment operating as efficiently as possible which supports in reducing air pollutants to ALARP during the field activities.	9.5	Vessel maintenance program is implemented for project vessels equipment that provides a status on the maintenance of equipment.	Records confirm contractors maintenance system schedule is adhered to. Shell marine assurance positive vetting records demonstrate contractor vessel maintenance systems are being implemented.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Demonstration Statement						
Based on the impact assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential impacts associated with Activity atmospheric emissions. No additional or alternative controls were identified that could further reduce the impacts without disproportionate effort and cost, or are permissible and regulated under MARPOL and relevant regulations. Therefore, the impacts are considered to be reduced to ALARP.						

9.11.5 Acceptability of Impacts

Table 9-65: Acceptability of Impacts – Atmospheric Emissions

Receptor		Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory			
Physical Environment	Air Quality	No significant impacts to air quality.	Yes	Impacts to air quality from atmospheric emissions during the Activity will be localised. Given the remoteness of the Activity Area, there is no potential for significant environmental impacts to occur.

The assessment of atmospheric emissions determined the impact magnitude to be Slight (Table 9-63). Given that air quality in the area is generally expected to be very high and the lack of sensitive human receptor populations, the residual impact consequence ranking is assessed as Slight (Magnitude: −1, Sensitivity: L) and therefore, acceptable (Table 9-65). Impacts on air quality have also been considered in the following context.

Principles of ESD

The potential impacts from atmospheric emissions are considered acceptable and consistent with the principles of ESD because:

- The environmental values/sensitivities within the Activity Area regionally are not expected to be significantly impacted.
- The precautionary principle has been applied to the impact assessment.

Relevant Requirements

Managing the potential impacts from atmospheric emissions is consistent with relevant legislative requirements, including:

- Air quality in the Crux regional airshed complies with the current NEPM Ambient Air Quality Standards (National Environment Protection Council 1998) and the key changes to the ambient air quality measure (National Environment Protection Council 2021).
- Marine fuel oil used by project vessels supporting operations complies with 1 January 2020 MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012* (Cth), the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and subsequent Marine Orders, which require vessels ≥400 t to have a valid IAPP certificate and use low-sulfur fuel (≤0.5% m/m S content) or IMO approved alternative measure.
- Implementing recognised industry standard practice, such as:
  - preventive maintenance system
  - equipment selection in design to achieve emissions efficiencies.

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation of atmospheric emissions from the Activity considers that no credible significant impacts and risks to threatened and migratory species will result from combustion of fuels and wastes conducted as part of the activity.

Table 9-66 summarises the alignment of the activities with management plans, recovery plans and conservation advice for threatened and migratory fauna.

Commonwealth Marine Area

The potential impacts and risks from atmospheric emissions from the petroleum activities on the Commonwealth marine environment are predicted to not exceed any of the significant impact criteria, as listed in Table 8-1. Hence, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-66: Summary of Alignment of the Potential Impacts from the Atmospheric Emissions of the Petroleum Activities with MNES

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Demonstration of Alignment as Relevant to the Activity
Threatened and migratory species	None applicable to atmospheric emissions	N/A
Wetlands of International Importance	None applicable to atmospheric emissions	N/A
Commonwealth Marine Area	No significant impacts on air quality	Criteria for significant impacts and risks to air quality over the Commonwealth marine area where the activity will operate are not considered likely to be exceeded by atmospheric emissions from the activity.

External Context

To date, no objections or claims about atmospheric emissions have been raised by relevant persons. Shell's ongoing consultation program will consider statements and claims made by relevant persons when further assessing impacts (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of the potential impacts from atmospheric emissions determined the residual impact rankings to be Slight (Table 9-63). As outlined above, the acceptability of the potential impacts and risks from this aspect have been considered in the context of:

- the established acceptability criteria for impacts and risks for this aspect
- ESD
- relevant legislative requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

The potential residual impacts are deemed to be Slight, which Shell considers to be inherently acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to the atmospheric emissions aspect.

Shell considers the potential impacts from atmospheric emissions associated with the Activity to be ALARP and acceptable.

9.11.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No Significant Impacts to the airshed surrounding the Activity Area as a result of the Activity.	Demonstrated implementation of EPSs for activity atmospheric emissions.
Atmospheric emissions associated with all drilling rigs, project vessels and the Crux platform to comply with MARPOL Annex VI requirements as applicable.	

9.12 Greenhouse Gas Emissions

9.12.1 Aspect Context – Description of Source

Greenhouse Gas (GHG) emissions trap heat in the atmosphere contributing to global temperature increases and are defined in the National Greenhouse and Energy Reporting Act 2007 (Cth) ("NGER Act") to include carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Under the NGER Act, other greenhouse gases include perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF6). GHG emissions are measured in CO2-equivalent (CO2-e) to standardise their impact.

GHG emissions are classed as:

- Scope 1: direct emissions produced from sources within the boundary of an organisation and as a result of that organisation's activities,
- Scope 2: indirect emissions when importing steam, heating, cooling, or electricity for use; and
- Scope 3: indirect emissions, from sources not controlled by the company, other than electricity (WRI 2004).

Shell estimates the total Scope 1 GHG emissions for the duration of the Activity are ~280kt CO2-e (Table 9-67), averaging ~93kt CO2-e annually for 3 years. This calculation is based on the forecast fuel usage using the NGER Act Emissions and Energy Threshold Calculator 2023–2024 [52]. Actual Scope 1 GHG emissions will depend on factors like fuel usage and operational conditions.

Table 9-67: Estimated Scope 1 GHG emissions for the Duration of the Activity

Work Packages	Estimated Fuel Amount (kL)	GHG Gases (~t CO_2-e)			Estimated Total Scope 1 GHG emissions (~t CO_2-e)[53]
		CO_2	CH_4	N_2O	
Crux substructure installation	7,180	19,366	28	111	19,505
Topsides installation	574	1,597	2	9	1,609
Export pipeline installation and cold commissioning	12,940	34,900	50	200	35,150
Prelude-end flexible riser and umbilical installation	1,841	4,966	7	28	5,001
Generators (Topsides and Temporary Drill Rig)	16,925	45,666	65	261	45,992
General topsides support and PMCT works (ASV, support/supply vessels and other sources used on the Prelude FLNG for PMCT works)	63,000[54]	169,911	237	974	171,122
TOTAL	102,460	276,406	389	1583	278,379

Shell does not consider the Activity will result in any Scope 2 GHG emissions and estimates only negligible Scope 3 GHG emissions.

Further, Shell has considered indirect consequences in accordance with Policy Statement "indirect consequences" of an action: Section 527E of the EPBC Act (as required by NOPSEMA) and does not consider the Activity will result in any significant indirect GHG emissions for the reasons set out in Appendix H.

The GHG lifecycle analysis (Scopes 1–3) that will inform the assessment of GHG emissions for production operations will be included in the future Crux Completions, Hot Commissioning, Start-up, and Operations EP/s. That analysis will include an assessment of any consequences from the GHG emissions of Shell's customers (i.e. the Scope 3 GHG emissions Shell Group reports).

[52] https://www.cleanenergyregulator.gov.au/NGER/Forms-and-resources/Calculators

[53] Estimates are based on the total forecast fuel usage and may vary based on numerous factors (see Section 9.12.1). Actual fuel usage for the Activity will be monitored, recorded and reported, where required (refer to Section 10.4.1).

[54] Estimate based on fuel consumption of 90kl over multiple vessels per day which occurs over an estimated 700 days.

9.12.2 Description and Evaluation of Impacts of GHG Emissions

Shell recognises the existence of climate change and that GHG emissions, which include carbon dioxide (CO_2), are contributing to climate change. Shell also acknowledges that urgent action is required to address climate change.

The international scientific community views GHG emissions as contributors to climate change, primarily through global temperature increases. There is broad acceptance that GHG emissions have been accumulating since the industrial revolution, impacting climate.

Projecting GHG emission impacts is complex due to variables like surface pressure, wind, temperature, humidity, and rainfall. Isolated climate events cannot be solely attributed to specific temperature increases. While individual projects, like Crux, contribute incrementally to global GHG levels, directly linking any incremental GHG contribution to specific impacts of climate change is speculative and unreliable.

It is not feasible to meaningfully link the GHG emissions associated with the Activity to climate change impacts globally and its impact on potential Australian receptors. Nonetheless, this impact assessment is framed by reference to the incremental contribution that this Activity will make to Australian and global GHG emissions.

For the Activity, the estimated annual Scope 1 GHG emissions are equivalent to about 0.02% of Australia's and 0.0002% of global GHG emissions in 2023. The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian and global GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected (see Table 9-70). It will nevertheless manage its GHG emissions and any potential impacts to ALARP.

Table 9-68 presents the estimated annual average CO_2-e emissions for the Activity and contributions compared to annual average CO_2-e emissions estimates for Australia and globally in 2023.

Table 9-68: Activity Contributions Compared to GHG Emissions National and Global Inventories

	Activity	Australian GHG Inventory 2023	Global GHG Estimate 2023
Estimated average annual CO_2-e emissions (Mt)	0.09[55]	432.9[56]	37,400[57]
Average annual Activity Contributions (%)	N/A	0.02	0.0002

9.12.2.1 Impacts of Global GHG Emissions on the Physical and Biological Environment

BOM and CSIRO have observed the following impacts of global climate change on the Australian physical environment (BOM and CSIRO 2022):

- Australia's climate has warmed;
- Oceans around Australia are acidifying and have warmed;
- There has been an increase in extreme fire weather, and in the length of the fire season, across large parts of the Country, especially in southern Australia; and
- Rainfall between April and October has declined across parts of southwestern Australia.

The State of the Climate Report (BOM and CSIRO 2022) forecasts that Australia may experience impacts of global climate change such as:

- Increasing sea and air temperatures (more hot days and marine heatwaves; fewer cool extremes);
- Fewer tropical cyclones, but a greater proportion of high–intensity storms with increased rainfall;
- Longer fire season and more dangerous fire weather;
- Rising sea levels and ocean acidification; and

[55] Based on total estimated Activity Scope 1 GHG emissions, divided by the duration of the activity (3 years).

[56] *Source: DCCEEW 2024m*

[57] Source: IEA 2024

- Decreasing rainfall across southern and eastern Australia with a longer period of drought.

9.12.2.1.1 Habitats and Communities

The IPCC reports that the global mean sea level has increased by 0.20 m between 1901 and 2018 (IPCC 2023). The IPCC (2023) predicts that it could rise between 0.15 m and 0.29 m further by 2050[58] (medium confidence), leading to coastal inundation and habitat loss. This may affect mangroves, offshore islands, salt marshes, and coastlines (Ward et al. 2016). Increased CO2 absorption by oceans and freshwater bodies, raises water acidity impacting aquatic organisms (Steffen et al., 2009).

Australia's average sea surface temperature has warmed by more than 1°C since 1900 (IPCC 2023). Marine heatwaves are more frequent and intense (Ruthrof et al. 2021) threatening marine community structure and coral bleaching events (BOM and CSIRO, 2022). Coral reefs could decline by a further 70–90% at 1.5°C of global warming (high confidence) (IPCC 2023).

The IPPC (2023) predicts that near-term risks for biodiversity loss as a result of global climate change are moderate to high, especially in kelp, seagrass and warm-water coral reefs (high to very high confidence). These changes undermine the coral reef's ability to support marine life. (Hoegh-Guldberg et al., 2018).

9.12.2.1.2 Threatened and Migratory Species

The potential incremental GHG emissions from the Activity are unlikely to have a significant impact on marine parks, threatened and migratory species or the Commonwealth Marine Environment.

Marine Parks

The Australian Marine Parks – North-west Marine Parks Network Management Plan 2018 (DNP 2018b) considers the effects of climate change and the potential impact on marine park values such as habitats, KEFs and marine fauna species. Implementing the EPO listed in Section 9.12.6 and the control measures outlined in Table 9-71 will manage the GHG emissions from the Activity. The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian (0.02%) and global (0.0002%) GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. The Activity is therefore unlikely to have a significant impact on marine parks or associated conservation values and are therefore considered acceptable.

Threatened and Migratory Species

Table 9-72 lists the relevant EPBC publications that recognise climate change as a potential threat and summarises the demonstration of alignment. The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian (0.02%) and global (0.0002%) GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. The Activity is therefore unlikely to have a significant impact on threatened or migratory species and are therefore considered acceptable.

Commonwealth Marine Environment

The associated potential incremental impacts of the Activity on the Commonwealth marine environment were assessed against the significant impact criteria for MNES, and Shell considers they are not significant.

Table 9-72 lists the species and associated EPBC publications which recognise global climate change as a potential risk to this receptor. Table 9-69 describes the potential impacts to key animal groups.

[58] relative to 1995–2014

Table 9-69: Overview of Potential Climate Change Impacts to Taxa

Taxa	Potential Impacts
Marine Mammals	Marine mammals most sensitive to climate change generally show marked feeding and habitat specialisation (Albouy et al. 2020). The EPBC publications that recognise climate change as a potential threat relevant to marine mammals, are associated with whales (blue, fin and sei). Whales may also be affected by climate change through changes in distribution and abundance of their prey (CoA 2015a; WWF n.d.a). Changes in ocean temperatures, upwellings, acidification, and melting Antarctic Sea ice may impact krill availability, the major food source for these whales (CoA 2015a; DoE 2015c; TSSC 2015b). Climate change may also affect their migratory timing, habitat occupancy, breeding schedules, reproductive success, and survival (van Weelden et al. 2021).
Marine Reptiles	The EPBC publications that recognise climate change as a potential threat to mammal reptiles are associated with marine turtles and the dusky sea snake. Climate change may alter turtle dispersal patterns, food webs, species range, primary sex ratios, habitat availability, reproductive success and survivorship (CoA 2017b). Possible impacts to marine turtles include increased air temperatures (altered embryo development) and increased sea levels rise (nesting beach stability and foraging ground distributions) (TSSC 2008a; Lockley and Eizaguirre 2021). Climate change and severe weather, including frequent and severe heatwaves; high average water temperatures; and severe cyclones and storms are identified as threats to the dusky sea snake. These threats can result in the reduction of dusky sea snake habitat, caused by marine heatwaves, ocean acidification, coral bleaching and increased wave action. Higher water temperatures can also periodically create lethal thermal conditions for the dusky sea snake (DCCEEW 2024n).
Sharks, rays and other fish	The EPBC publications that recognise climate change as a potential threat to sharks, rays and other fish are those associated with sharks (namely whale sharks and white sharks). Most sharks and rays are ectothermic, with their biology and metabolism influenced by the ambient water temperature. Ocean temperature directly affects physiological and metabolic functions in sharks, including digestion, growth and reproduction. Warmer water decreases oxygen solubility, increasing metabolic rates and thereby limiting oxygen availability (Pearce 2022). Climate change may also affect whale sharks through changes in prey distribution and abundance. As ocean water warms, juvenile whale sharks may shift their range and feeding aggregation locations to follow prey (WWF 2024; Grose et al. 2020).
Birds	Numerous EPBC publications recognise climate change as a potential threat to shorebirds and seabirds. Climate change may cause advanced spring migration, changes in habitat, higher disease transmission, earlier egg-laying time, reduced food availability, and population decline (Xiaohan et al. 2022).

9.12.2.1.3 Protected Areas

The Australian Marine Parks – North-west Marine Parks Network Management Plan 2018 (DNP 2018b) considers the effects of climate change and the potential impact on marine park values such as habitats, KEFs and marine fauna species. The management plan acknowledges that the potential impacts of climate change on the marine environment are complex and may include changes in sea temperature, sea level, ocean acidification, sea currents, increased storm frequency and intensity, species range extensions, or local extinctions. These changes have the potential to impact marine park values (DNP 2018b).

In the Marine Bioregional Plan for the NWMR (DSEWPaC 2012), climate change-related pressures are assessed as 'of potential concern' for various species and features, including marine turtles, inshore dolphins, sawfish, sea snakes, whale sharks, dugongs, seabirds and shorebirds, KEFs and shipwrecks that may occur in the NWMR.

9.12.3 Impact of Global GHG Emissions Assessment Summary

While there are observed and predicted impacts of global climate change (and associated global GHG emissions) to physical and biological receptors, it is not feasible to directly link GHG emissions from an individual project or activities to specific impacts of climate change to these receptors. The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian and global GHG

emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. It will nevertheless manage its GHG emissions and any potential impacts to ALARP.

Table 9-70 lists the highest residual impact consequence ranking of the relevant environmental receptor groups.

Table 9-70: GHG Emissions Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Evaluation – Planned Impacts			
Physical Environment	0	L	No impact to the overall consequence level reasonably expected
Biological Environment	0	L	No impact to the overall consequence level reasonably expected
Socioeconomic and Cultural Environment	N/A	N/A	N/A

9.12.4 ALARP Assessment and Environmental Performance Standards

The control measures Shell proposes to implement to manage to the incremental contribution that this Activity will make to Australian and global GHG emissions to ALARP are set out below.

Table 9-71: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Eliminate	Eliminate all GHG emissions generating activities.	No	Almost all GHG emissions from the Activity are generated through combusted fuel by project vessels. There is only a small global fleet of vessels capable of executing the major activities in this EP. Since these vessels are largely very restricted in their availability and their power and propulsion systems are already designed and built based on marine hydrocarbon-based fuels, there are no feasible alternatives which eliminate GHG emissions associated with executing the activities.	N/A	N/A	N/A
Substitution	Use renewable energy (e.g. solar, wind, wave) instead of fossil fuels for power generation and project vessel propulsion.	No	While it would be desirable to use renewable energy to power the project vessels, a suitable fully electric and battery-operated fleet is not currently available. The contracted vessels will comply with the Shell marine vessel assurance process.	N/A	N/A	N/A
Substitution	Use a 20% biofuel blend.	No	Mechanical limitations of the available vessels, logistics (no appropriate supplier within the coastal hubs to support), and the cost of the product outweighs the small incremental gain in GHG emissions reduction.	N/A	N/A	N/A
Engineering	Use of hybrid power options for vessel propulsion.	No	Vessels equipped with hybrid power options use a dual-feed energy storage system. This system includes battery packs that store energy when demand is low and deliver it back when demand increases, reducing fuel	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			consumption and GHG emissions. Although this technology is available, the various vessel operators that provide services to offshore projects, have either not yet adopted it within existing service vessels (i.e. retrofitted such technology) due to cost, schedule or engineering constraints, or vessels that do have hybrid power options either do not operate in the region, or may not be suitable for the specific tasks required to be executed by the project. Shell may contract a vessel or vessels which include hybrid power options if the vessel/s are technically capable to perform the required tasks. However, this commitment cannot be made across all vessels/scopes due to the limitations noted above.			
Administrative and Procedural Controls	Vessel route planning.	Yes	Vessel route planning reduces GHG emissions by optimising the routes and activities of project vessels.	10.1	Vessel route planning will be carried out as per marine assurance requirements.	Vessel route plans available in line with marine assurance requirements.
Administrative and Procedural Controls	Vessel specific biofouling management and/or risk assessment.	Yes	Implementing biofouling controls reduces the potential for project vessel water drag. Hence, project vessel hull integrity improves vessel fuel efficiency.	6.2	Refer to EPS 6.2.	Refer to EPS 6.2.
				6.3	Refer to EPS 6.3.	Refer to EPS 6.3.
				6.4	Refer to EPS 6.4.	Refer to EPS 6.4.
Administrative and Procedural Controls	Report GHG emissions to the Clean Energy Regulator (CER), where required by the NGER Act.	Yes	Shell and its contractors will comply with the reporting requirements under the NGER Act. GHG emissions will be reported annually to the CER, where required under the NGER Act.	10.2	Shell will report Scope 1 GHG emissions annually to CER, where required under the NGER Act.	A copy of the annual NGER report or receipt, where Shell is required under the NGER Act.
Engineering, Administrative and Procedural Controls	Greenhouse Gas and Energy Management Plan (GHGEMP) for the Crux Project execute phase	Yes	Shell uses GHGEMPs to manage significant sources of GHG emissions to ALARP throughout project lifecycles. These plans are mandatory during the early project periods to define phase, and a different version is used	10.3	The GHGEMP for execute phase shall be developed and implemented. Scope shall include;	A copy of the GHGEMP for execute phase demonstrating alignment with EPS. In addition;

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			during operations to continuously manage emissions. For the Crux project, Shell will adopt an execute phase GHGEMP to reduce emissions to ALARP, which will; • summarise the design GHG abatement options and measures considered, including those implemented and not implemented to support future operations. • list key management measures to continue to reduce GHG emissions throughout execute phase to ALARP, including seeking contractor input on options adopted and rejected. • summarise GHG targets for key remaining execute phase. • describe key roles and responsibilities of resourcing and implementation of the GHGEMP. • review emissions performance through quarterly performance monitoring and reporting (PMR) process. The GHGEMP for the execute phase is expected to be completed by end of Q1 2025 due to needs for inputs and assurance associated with the plans development and will apply to the remainder of the execute phase up until 6 months post SURU where the operations GHGEMP and associated processes will go live. Given the activities covered by this GHGEMP are all typically once off and the overall duration will not exceed 3 years, it is not appropriate to have an annual review cycle of improvement, but rather this will be met through review of monthly PMR records and feedback to		• summarise the design GHG abatement options and measures considered, including those implemented and not implemented to support future operations. • list key management measures to continue to reduce GHG emissions throughout execute phase to ALARP, including input on options considered and adopted/rejected by contractors. • summarise GHG targets for key remaining execute phase. • describe key roles and responsibilities of resourcing and implementation of the GHGEMP. • review emissions performance through quarterly performance monitoring and reporting (PMR) process. The GHGEMP will be developed before the end of Q1 2025.	Records such as Shell or contractor procedures detail key management measures to continue to reduce GHG emissions throughout execute phase to ALARP and associated records of the implementation. Record requesting contractors working in the Activity Area to provide a list of GHG reduction measures being implemented, and those considered but not currently implemented. Shell and contractor records of GHGEM monitoring through use of relevant records such as fuel bunkered. PMR reporting forms and evidence provided by contractors for fuel combusted (refer to Table 10-4).

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			contractors on improvement actions as deemed necessary. This control measure and associated EPS will therefore also be replicated in the Crux completions, hot commissioning, start-up and operations environment plan.			
Administrative and Procedural Controls	Project vessels (as appropriate to vessel class) will comply with MARPOL Annex VI (Prevention of air pollution from ships), the *Navigation Act 2012*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsequent Marine Orders.	Yes	Reduces GHG emissions through operating and maintaining vessels in accordance with industry standards and regulatory requirements.	9.2	Refer to EPS 9.2.	Refer to EPS 9.2.
				9.3	Refer to EPS 9.3.	Refer to EPS 9.3.
ALARP Demonstration Statement						
Based on the impact assessment outcomes, Shell considers the control measures proposed are appropriate to manage the incremental contribution that this Activity will make to Australian and global GHG emissions, to ALARP. No additional or alternative controls were identified that could further reduce the impacts without grossly disproportionate effort and cost.						

9.12.5 Acceptability of Impacts of the Activity

The assessment of risks from the incremental contribution that this Activity will make to Australian and global GHG emissions is consistent with:

- principles of Ecological Sustainable Development (ESD);
- relevant legislative and industry requirements;
- relevant requirements in relation to Matters of National Environmental Significance (MNES);
- internal and external context; and
- the defined acceptable level of GHG emissions as set out in Section 8.

Principles of ESD

The Activity aligns with the principles of ESD in several key ways to minimise the environmental impacts and promote sustainability:

1. Principle of integration: This principle emphasises the need to balance long-term and short-term economic, environmental, social, and equitable considerations in decision making. The Crux Project has integrated measures to reduce GHG emissions, while factoring in safety considerations and balancing other project trade-offs such as cost and availability of alternatives. The Crux Offshore Project Proposal was subject to public comment and regulatory scrutiny, ensuring community involvement and addressing concerns.

2. Precautionary principle: This principle requires that where there are "threats of serious or irreversible environmental damage, lack of full scientific certainty should not postpone measures to prevent environmental degradation". While it is not feasible to meaningfully link the GHG emissions associated with the Activity to climate change impacts globally and its impact on potential Australian receptors, this impact assessment is nonetheless framed by reference to the incremental contribution that this Activity will make to Australian and global GHG emissions.

3. Principle of inter-generational equity: This principle ensures that the health, diversity, and productivity of the environment are maintained or enhanced for the benefit of future generations. Crux Activities meet this principle by ensuring GHG emissions do not exceed the defined acceptable level and comply with all relevant laws, thus protecting future generations.

4. Conservation of biological diversity and ecological integrity: This principle emphasises the importance of conserving the biological diversity and ecological integrity in decision-making. The Crux Offshore Project Proposal thoroughly assessed potential environmental impact in accordance with relevant laws (OPGGS Act and OPGGS(E) Regulations). The assessment followed Shell's requirements to identify and minimise negative environmental, social and health impacts while optimising positive impacts. This framework has been continued through the execution of the Activities in this EP (refer to Sections 6, 8 and 8.3).

5. Improved valuation, pricing and incentive mechanisms: This principle promotes the use of valuation, pricing and incentive mechanisms to support sustainable practices. The Crux Project considers global policies and actions related to GHG emissions and complies with Australian legislation, including the Safeguard Mechanism. ALARP principles are used to support risk assessment and decision-making, ensuring environmental risks are minimised and managed effectively.

Relevant Legislative and Industry Requirements

The Activity is consistent with the strategy and frameworks put in place by the Australian Government to support Australia's transition to net zero.

DISR's 'Future Gas Strategy' (DISR 2024) (the DISR Strategy) provides a comprehensive framework for how gas will support Australia's transition to net zero. It balances the need for reliable energy supply with the goal of reducing GHG emissions, ensuring public and regulatory involvement, and aligning with international commitments. The NGER Act and Safeguard Mechanism play crucial roles in monitoring and managing GHG emissions, supporting Australia's broader climate goals.

The DISR Strategy provides a framework which recognises that Australia is, and will remain, a reliable trading partner for energy, including LNG and low emission gases. The DISR Strategy emphasises Australia's ambition to become a renewable energy superpower by developing new, low GHG emissions

energy exports to support the energy security and decarbonisation efforts of its trade partners. The DISR Strategy provides an in–depth analysis of gas supply, consumption, and GHG emissions. The public consultation which shaped the DISR Strategy revealed the barriers and opportunities in gas supply and consumption for Australian households, businesses and international trade partners. The DISR Strategy acknowledges that the role of gas will evolve as Australia strives to reach net zero by 2050. Even in net zero scenarios, Australia and the world will need gas through to 2050 and beyond. Australia's commitment under the Paris Agreement includes reducing net GHG emissions to 43% below 2005 levels by 2030, and achieving net zero emissions by 2050 (DCCEEW 2023i). The Climate Change Act 2022 (Cth) legislates these targets, with a multi-year emissions budget set at 4,353 Mt CO2-e from 2021 to 2030.

The NGER Act provides a national framework for reporting GHG emissions, energy production and energy consumption. Its objectives are to:

- inform government policy;
- inform the Australian public;
- help meet Australia's international reporting obligations;
- assist Commonwealth, state and territory governments to implement GHG reduction projects; and
- avoid duplicating similar reporting requirements in the states and territories.

Under the NGER Act, corporations that meet certain thresholds are required to report on GHG emissions, energy production and energy consumption. This reporting captures data about energy flows and energy transformations occurring throughout the economy. The NGER Act aligns with the GHG Protocol, a globally accepted set of standards for accounting for GHG emissions.

The Safeguard Mechanism under the NGER Act ensures Australia's largest emissions intensive industries measure, report and reduce their Scope 1 GHG emissions. It was established to ensure that GHG emissions reductions delivered through the Emissions Reduction Fund are not offset by increases elsewhere in the economy. It applies a decline rate to facilities' baselines so that they are reduced predictably and gradually over time on a trajectory consistent with achieving Australia's emission reduction targets of 43% below 2005 levels by 2030 and net zero by 2050.

Key elements of the mechanism include (DCCEEW 2023h):

- Facilities with net GHG emissions exceeding 100,000 t CO2-e per year must keep GHG emissions at or below set baselines;
- If a facility exceeds its baseline, it must manage excess GHG emissions, such as by purchasing and surrendering Australian Carbon Credit Units;
- A requirement to offset 100% reservoir CO2 from new reservoirs feeding existing LNG facilities;
- Facilities must meet reporting and record-keeping requirements, including audits;
- Penalties for non-compliance.

While the Safeguard Mechanism does not apply to this Activity, Crux gas and condensates will feed the existing Prelude FLNG facility, which is a Safeguard Mechanism facility. Given this, the Safeguard Mechanism requirement to offset of 100% reservoir CO2 from new reservoirs feeding existing LNG facilities will be addressed in more detail in the assessment of GHG emissions in the future Crux Completions, Hot Commissioning, Start-up, and Operations EP/s.

Matters of National Environmental Significance

The potential incremental GHG emissions from the Activity are unlikely to have a significant impact on marine parks, threatened and migratory species or the Commonwealth Marine Environment.

Marine Parks

The Australian Marine Parks – North-west Marine Parks Network Management Plan 2018 (DNP 2018b) considers the effects of climate change and the potential impact on marine park values such as habitats, KEFs and marine fauna species. Implementing the EPO listed in Section 9.12.6 and the control measures outlined in Table 9-71 will manage the GHG emissions from the Activity. The incremental increase in GHG

emissions from the Activity will be negligible in the context of Australian (0.02%) and global (0.0002%) GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. The Activity is therefore unlikely to have a significant impact on marine parks or associated conservation values and are therefore considered acceptable.

Threatened and Migratory Species

Table 9-72 lists the relevant EPBC publications that recognise climate change as a potential threat and summarises the demonstration of alignment. The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian (0.02%) and global (0.0002%) GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. The Activity is therefore unlikely to have a significant impact on threatened or migratory species and are therefore considered acceptable.

Commonwealth Marine Environment

The associated potential incremental impacts of the Activity on the Commonwealth marine environment were assessed against the significant impact criteria for MNES, and Shell considers they are not significant.

Table 9-72: Summary of Alignment of the Potential GHG Emission Impacts from the Activity with Relevant Requirements for MNES

MNES	MNES Acceptability Considerations (Significant Impact Guidelines, EPBC Management Publications)	Demonstration of Alignment as Relevant to the Activity
Threatened and Migratory species – Marine Mammals	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	It is not feasible to meaningfully link the GHG emissions associated with the Activity to climate change impacts globally or its impact on potential MNES receptors. Shell considers the incremental contribution that this Activity will make is consistent with the Significant Impact Guidelines and the EPBC management publications that identify climate change as a threat. The control measures outlined in Table 9-71 will minimise the potential impacts of the incremental contribution of the GHG emissions associated with this Activity to ALARP. Shell has therefore assessed that no impact is reasonably expected to threatened or migratory species and the potential impact of the Activity is therefore considered acceptable.
	Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* (CoA 2015a)	
	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	
	Conservation advice *Balaenoptera physalus* fin whale (TSSC 2015b)	
Threatened and Migratory species – Marine Reptiles	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	
	Recovery plan for Marine Turtles in Australia 2017–2027 (CoA 2017b)	
	Approved conservation advice for *Dermochelys coriacea* (Leatherback Turtle) (TSSC 2008a)	
	Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n)	
Threatened and Migratory species – Birds	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	
	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a)	
	Wildlife Conservation Plan for Seabirds (CoA 2020a)	
	Conservation Advice for Abbott's Booby - *Papasula abbotti* (TSSC 2020b)	
	Conservation Advice for *Limnodromus semipalmatus* (Asian dowitcher) (DCCEEW 2024h)	
	Approved Conservation Advice on *Rostratula australis* (Australian Painted Snipe) (TSSC 2013)	
	National Recovery Plan for the Australian Painted Snipe (*Rostratula australis*) (COA 2022)	

MNES	MNES Acceptability Considerations (Significant Impact Guidelines, EPBC Management Publications)	Demonstration of Alignment as Relevant to the Activity
	Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW 2024g)	
	Conservation Advice for *Tringa nebularia* (common greenshank) (DCCEEW 2024k)	
	Conservation advice *Calidris ferruginea* curlew sandpiper (DCCEEW 2023f)	
	Conservation advice *Numenius madagascariensis* eastern curlew (DCCEEW 2023e)	
	Conservation Advice *Falco hypoleucos* Grey Falcon (TSSC 2020a)	
	Conservation advice *Calidris ferruginea* curlew sandpiper (2023f)	
	Conservation advice *Calidris canutus* red knot (DCCEEW 2024c)	
	Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW 2024a)	
	Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW 2024b)	
	Conservation Advice for *Xenus cinereus* (terek sandpiper) (DCCEEW 2024k)	
	Conservation advice *Charadrius leschenaultii* greater sand plover (DCCEEW 2023g)	
	Conservation Advice *Falco hypoleucos* Grey Falcon (TSSC 2020a)	
	Conservation Advice for *Phaethon rubricauda westralis* (Indian Ocean red-tailed tropicbird) (DCCEEW 2023j)	
	Conservation Advice *Charadrius mongolus* lesser sand plover (TSSC 2016d)	
	Conservation Advice *Erythrotriorchis radiatus* (red goshawk) (DCCEEW 2023d)	
	Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW 2024j)	
	Approved Conservation Advice for *Limosa lapponica menzbieri* (Yakutian bar-tailed godwit) (DCCEEW 2024f)	
	Conservation advice *Limosa lapponica baurei* (Alaskan bar-tailed godwit) (DCCEEW 2024e)	
Threatened and Migratory species – Sharks and Rays	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	
	Conservation advice *Rhincodon typus* whale shark (DoE 2015e)	
	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC 2013b)	
Commonwealth Marine Environment	Significant impact guidelines for Commonwealth marine environment (Table 8-1)	
Marine parks	Australian Marine Parks – North-west Marine Parks Network Management Plan 2018 (DNP 2018b)	

Internal and External Context

While there are no Scope 2 GHG emissions and negligible scope 3 GHG emissions associated with this Activity, the Shell Group has an important role to play in the energy transition and aims to lead where it has competitive strengths, sees strong customer demand, and identifies clear regulatory support from governments. In this context, Shell Australia's delivery of the Crux Project is an important part of delivering on the Shell Group's LNG Strategy and target to be a net-zero emissions energy business by 2050.

Australia is well-positioned to lead in the energy transition due to its resources, export markets, and skilled workforce. The Shell Group collaborates with governments and partners to support low-carbon energy production. Fossil fuels currently meet over 80% of global energy demand. As demand for energy continues to grow, driven by rising populations and increased prosperity, the world must transition from fossil fuels to low-carbon energy in a balanced way to achieve net-zero emissions, including by increasing electrification and renewable energy. The transition to net zero will not be linear, as different countries take different approaches and move at different paces.

The Global Stocktake Agreement of December 2023 recognises that transitional fuels, such as LNG, "can play a role in facilitating the energy transition while ensuring energy security" [59]. The Shell Group believes that LNG will play a critical role in the energy transition, including replacing coal in electricity generation and in heavy industry. The global LNG market is expected to grow by 40% from 2015 to 2040, mostly driven by industrial decarbonisation in China and strengthening demand for energy supply in other Asian countries.

Some benefits of LNG include:

- **Reduced Air Pollution:** Emits lower amounts of harmful compounds compared to coal.
- **Supporting Renewable Energy:** Provides stability to electricity grids and can be ramped up or down quickly.
- **Industrial Decarbonisation:** Essential for high-temperature processes where electrification is challenging.
- **Energy Security:** Easily transported and provides a secure energy supply.

The Shell Group is committed to reducing GHG emissions and has made good progress towards its targets and ambitions. By the end of 2023, Shell Group had achieved more than 60% of its target to halve emissions from its operations by 2030, compared with 2016. Shell Group was one of the first companies to set a target to achieve near-zero by 2030. It continues to keep its methane emissions intensity well below 0.2% and has reduced its total methane emissions by 70% since 2016. Shell Group is also working with partners, industry and universities to develop and implement technologies that reduce methane emissions associated with the use of LNG.

Shell Group has also:

- set a new ambition to measure its progress, to reduce customer emissions from the use of its oil products by 15-20% by 2030 compared with 2021 (Scope 3, Category 11)[60].
- set a target to reduce the net carbon intensity of its products by 15-20% compared to 2016 by 2030 (6.3% reduction achieved by the end of 2023)[61].

[54] Shell Group's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and NCI targets over the next ten years. However, Shell Group's operating plans cannot reflect our 2050 net-zero emissions target, as this target is currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell Group's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell Group may not meet this target.

[60] Customer emissions from the use of Shell's oil products (Scope 3, Category 11) were 517 million tonnes carbon dioxide equivalent (CO2e) in 2023 and 569 million tonnes CO2e in 2021. This ambition does not apply directly to the Crux project as it relates to customer emissions from oil products which are not produced at Crux.

[61] The net carbon intensity of emissions associated with the Crux Project will be considered when measuring progress towards this target. The target will be delivered by the Shell Group on a net portfolio basis and reflects anticipated changes in the Shell Group's sales of oil and gas products, and changes in sales of low and zero-carbon products- such as biofuels, hydrogen and renewable electricity.

- set a target to eliminate routine flaring in upstream operations by 2025[62].
- planned to invest $10-15 billion in low-carbon energy solutions between 2023- end 2025, in areas including electric vehicle charging, biofuels, renewable power, hydrogen and carbon capture and storage[63]. In 2023 alone, Shell invested $5.6 billion in low-carbon energy solutions.

Shell Australia is one of Australia's largest producers of LNG and a significant contributor to the delivery of the Shell Group's LNG Strategy. Shell Australia's contribution to meeting growing LNG demand through delivery of the Crux Project will play an important part in meeting the Shell Group target to be a net-zero emissions energy business by 2050 and its other GHG emission reduction targets.

Acceptability Summary

For the reasons set out above, the assessment of risk, level of analysis and evaluation are commensurate to the magnitude of the impacts and risks arising from GHG emissions attributable to the Activity.

Shell estimates the total Scope 1 GHG emissions for the duration of the Activity are ~280 kt CO2-e, averaging ~93 kt CO2-e annually for 3 years. For Crux, the estimated annual Scope 1 GHG emissions are equivalent to about 0.02% of Australia's and 0.0002% of global GHG emissions in 2023. Shell does not consider the Activity will result in any Scope 2 GHG emissions and estimates only negligible Scope 3 GHG emissions.

It is not feasible to meaningfully link the GHG emissions associated with the Activity to climate change impacts globally and its impact on potential Australian receptors. Nonetheless, this impact assessment is framed by reference to the incremental contribution that this Activity will make to Australian and global GHG emissions.

The assessment of risks from the incremental contribution that this Activity will make to Australian and global GHG emissions has been considered in the context of:

- principles of Ecological Sustainable Development (ESD);
- relevant legislative and industry requirements;
- MNES;
- internal and external context; and
- defined acceptable level of GHG emissions as set out in Section 8.

The incremental increase in GHG emissions from the Activity will be negligible in the context of Australian and global GHG emissions and therefore Shell has assessed no impact to the overall consequence level reasonably expected. It will nevertheless manage its GHG emissions and any potential impacts to ALARP.

9.12.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
GHG emissions associated with the Activity will be minimised.	Environmental performance standards and measurement criteria within Table 9-71 will demonstrate compliance with this EPO.

[62] Subject to the completion of the sale of Shell Petroleum Development Company of Nigeria Limited (SPDC). The target is consistent with the World Bank Zero Routine Flaring by 2030 initiative, which targets routine flaring of gas during oil production (upstream operations). While this target does not apply to the Crux project, Shell intends to minimise flaring to ALARP and acceptable levels.

[63] Investment in the Crux Project is not part of the Shell Group's investment in low-carbon energy. However, the Shell Group's investment in low-carbon energy solution will contribute to reducing the net carbon intensity of the products the Shell Group sells, including as from the Crux Project, on a net portfolio basis.

9.13 Minor Releases

9.13.1 Aspect Context

Incidental dropped solid objects or minor spills can be accidentally released to the marine environment from project vessels (including ROVs), substructure (including temporary work platforms, scaffolding, drilling rig set-up etc.) and topsides (including platform deck and modules) (collectively referred to as minor releases).

Improper storage and handling of solid objects may result in accidental losses to the marine environment. Solid objects may include:

- equipment (e.g. hard hats, tools, installation aids)
- materials (e.g. supplies, infrastructure parts)
- hazardous wastes (e.g. oil-contaminated materials [e.g. sorbents, filters, rags], chemical containers, paint solvents and containers, light tubes and batteries)
- non-hazardous domestic and industrial wastes (e.g. aluminium cans, bottles, paper/cardboard, scrap steel [such as LMU cut-off stubs]).

All wastes generated (other than permitted waste discharge streams addressed elsewhere in this EP) are transported to shore for re-use, recycling, treatment or disposal by a licensed waste contractor. Note: Any waste management and disposal within international jurisdictions is out of scope for this EP.

The waste management strategy for the Activity is designed to optimise segregation of waste in the offshore location and minimise contamination of recovered waste destined for recycling or disposal. All non-hazardous and hazardous solid waste will be managed in accordance with the relevant waste management procedure and the project vessel-specific waste management plans and procedures. Waste segregation on vessels is established and maintained to realise efficiencies in storage, transport, treatment, recycling and/or disposal. This is done by providing labelled bins, skips or other appropriate receptacles used to commingle similar waste streams in accordance with their classification. The disposal of non-hazardous and hazardous wastes will be tracked to confirm they are disposed of at an appropriately licensed waste facility. The management and disposal of any quarantine risk material will be in accordance with the relevant requirements of the *Biosecurity Act 2015* (Cth). Shell's extensive operational experience indicates most accidental releases of solid objects to the marine environment are typically relatively small-scale and infrequent. The potential environmental impacts from the accidental loss of solid objects to the marine environment depends on the nature and amount of the solid object, and the sensitivity of the environmental receptors that may be impacted. Some solid objects (e.g. paper, cardboard) will readily degrade in the marine environment and pose little environmental risk. Other solid objects are more persistent in the environment, particularly plastics.

Minor spills of hydrocarbon (e.g. equipment/generator fuel, lubricants) and non-hydrocarbon (e.g. synthetic hydraulic fluid, cold commissioning chemicals, brine, cleaning fluids, cooling agents, and paint) liquids may also occur. Refer to Section 9.14 for emergency events which may occur as a result of vessel collision, bunkering failure and Section 9.10 for contingency activities (e.g. wet buckle event).

Minor spills into the marine environment have the potential to occur from:

- mechanical failure or damage of equipment, such as tank, hose, quick disconnect system or pipework;
- inadequate transfer, bunding, storage and handling;
- firefighting foam released during an incident; and
- dropped objects (e.g. swinging load during lifting activities).

If the spill is not contained on deck, a release to the marine environment would likely disperse rapidly (minutes to hours) to below harmful concentrations and be restricted to around the spill location and contained within the Activity Area.

9.13.2 Description and Evaluation of Impacts and Risks

9.13.2.1 Physical Environment

Minor releases may cause localised water contamination near the release location through a release of toxins and chemicals, depending on the nature of the discharge, however volumes of the hazardous components are

generally low. This may result in toxic effects; however, given the dynamic nature of the offshore receiving environment and the small nature and scale of most potential solid releases and minor spills, any such effects can reasonably be anticipated to be short term and highly localised. Modelling of small volumes of hydrocarbons (e.g. Shell 2010) indicate rapid dilution in the offshore marine environment, with impacts limited to the immediate vicinity of the contamination. The implications to potentially sensitive receptors due to a reduction in water and sediment quality are discussed further in Section 9.13.2.2 and are not assessed further in the context of the physical environment.

9.13.2.2 Biological Environment

9.13.2.2.1 Habitats and Communities

Habitats and benthos within the Activity Area are generally not considered to be sensitive or of high conservation value and are well represented within the region with the exception of one KEF—continental slope demersal fish communities—which partially overlaps the export pipeline corridor. Project activities within the vicinity of the KEF will be limited to approximately three days (pipelay vessel travelling at ~2–3 km per day).

The area of potential seabed disturbance due to release of a heavier solids would be restricted to the Activity Area (e.g. accidentally dropped equipment). Damage to substrates within the Activity Area and associated infauna and epifauna may occur, but such impact is expected to be restricted to the size of the dropped object. The release of microplastics has the potential to contribute to the overall amount of marine microplastics in the ocean, which can have various impacts on marine fauna as they are absorbed by plants and animals and accumulate in the food chain. However, given the very small amounts that could potentially be released, the consequence of any impacts is considered to be negligible.

Minor spill volumes are not expected to impact the KEF—continental slope demersal fish communities or sediment quality due to the water depths.

Although a minor release may be detectable, it is expected that it would not substantially impact habitats or significant portions of the benthic environment.

9.13.2.2.2 Threatened and Migratory Species

Marine Mammals, Marine Reptiles, Birds, Sharks, Rays and Other Fish

Marine debris has been identified as a threat for a range of vertebrate fauna species, including marine turtles, birds, marine mammals and sharks and rays, and is listed as a key threatening process under the EPBC Act. Persistent solids (e.g. plastics) are of particular concern, as the threat to fauna may remain long after the release. In offshore marine environments, degradation rates of plastics vary based on geographical location, temperature, light intensity, hydrostatic pressure, and marine sediments (Oluwoye et al. 2023). Large plastics have the potential to break down to form microplastics. Once in the environment, microplastic particles can be absorbed and ingested by fauna and bioaccumulate (DAWE 2021). Potential impacts of marine debris on key fauna species include (CoA 2018):

- entanglement, potentially resulting in restricted mobility, drowning, starvation, smothering and wounding
- ingestion (particularly of plastics) leading to physical blockage of digestive systems, leading to starvation
- acute or chronic toxic effects.

The National Plastics Plan (DAWE 2021) includes supporting global action to address marine plastic debris, including implementing the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (CoA 2018). This threat abatement plan identifies EPBC Act listed species for which there are scientifically documented adverse impacts resulting from marine debris. Marine turtles and seabirds may be at risk from plastics. Marine debris may cause entanglement or be mistaken for food and ingested (CoA 2020a; CoA 2017b), causing damage to internal tissues and potentially preventing feeding activities. In the worst instance this could be lethal to an individual animal. Marine debris has been identified as threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017b). While the threat abatement plan (CoA 2018) does not list explicit management actions for non-related industries, management controls will reduce the risk of release of solid objects. Marine debris has not been identified as a specific threat for sea snakes that may occur near the Activity Area (TSSC 2010a, TSSC 2010b and DCCEEW 2024n).

The Conservation Management Plan for the Blue Whale (CoA 2015a) identified marine debris as a threat to cetaceans. The blue whale may be present within the Activity Area but is likely to be limited to transient and migratory individuals. Plastics may cause problems with cetaceans once ingested or entangled, resulting in a loss of reproductive fitness or mortality (CoA 2015a).

Given the small portion of the whale shark BIA that overlaps with the Activity Area, and the transient nature of this species, any potential interaction with the minor release would likely occur on an individual level and is considered unlikely to result in any significant impacts at a population level.

Many other vertebrate species considered vulnerable to debris impacts occur seasonally or are expected to occur in low densities (e.g. transiting the area).

Changes to water quality caused by a minor spill could potentially lead to short-term impacts on transiting marine fauna. Transiting marine fauna is expected to occur in low density within the OA. Recovery plans and conservation advice for numerous protected species identify marine pollution and contamination impacts as threats to the species. Minor spills are unlikely to have widespread ecological effects on threatened or migratory fauna, given the nature of the substances, the limited and minor volumes that could be released, and the dispersive nature of the open-ocean environment of the Activity Area. 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 any accidentally released hydrocarbons is considered unlikely given the expected limited and small potential volumes and short exposure times. The Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA 2017b) identified pollution as a threat. However, pollution sources were primarily related to agricultural, terrestrial industrial and domestic sources. The accidental minor spills are expected to be of very short duration and localised with no to negligible persistence in the environment. Therefore, population-level effects are considered unlikely to occur from a minor release of a hazardous substance.

Impacts to marine species including fish, birds, mammals and reptiles from the minor release of non-hazardous substance is considered unlikely because of the significant distance of sensitive habitats from the Activity Area. Significant impacts are considered unlikely at an individual level and are not expected to occur at a population level or decrease the habitat quality to the extent that species are impacted.

9.13.2.3 Socioeconomic and Cultural Environment

Marine species of cultural significance, as established in Sections 7.4.1.2.1 and 7.4.1.2.2, are unlikely to be significantly impacted from this aspect. For the assessment of impacts to marine species that may be of cultural significance, refer to Section 9.13.2.2.2. No specific feedback or concerns were raised during consultation for this EP regarding potential impacts on Indigenous cultural heritage features and values from this aspect. Given the Dark Blue residual risk to marine species, significant impacts to socioeconomic and cultural environment receptors are not anticipated.

9.13.3 Risk Assessment Summary

Table 9-73 lists the highest residual risk ranking of the relevant environmental receptor groups.

Table 9-73: Minor Release Evaluation of Residual Risks

Environmental Receptor	Consequence	Likelihood	Residual Risk
Evaluation – Unplanned			
Physical Environment	Slight	E	**Dark Blue**
Biological Environment	Slight	E	**Dark Blue**
Socioeconomic and Cultural Environment	Slight	E	**Dark Blue**

9.13.4 ALARP Assessment and Environmental Performance Standard

Table 9-74: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Elimination	Eliminate waste generation.	N/A	Waste generation cannot be eliminated from the offshore facilities or project vessels. Hence, this control is not considered feasible.	N/A	N/A	N/A
Elimination	Eliminate lifting in field.	N/A	Reduces the risk of dropped objects. Lifting activities are required to conduct the activities covered under this EP (e.g. install infrastructure and transfer supplies). Consequently, lifting is an integral activity and cannot be completely eliminated. Hence, this control is not considered feasible.	N/A	N/A	N/A
Elimination	Eliminate ROV activities.	N/A	Eliminates accidental releases to the marine environment due to hydraulic equipment failure. ROVs contain small volumes (typically less that 10L) of hydraulic fluids to operate moving parts. These systems are inspected and maintained on a routine basis, therefore the risk of failure and release is very low. Using ROVs in the installation and cold commissioning activities reduces seabed disturbance, length of time in field, safety and environmental risks. Hence, implementing control does not reduce the environment impacts to ALARP.	N/A	N/A	N/A
Substitution	Stock polyfluoroalkyl substances (PFAS)-free fire extinguishers on the topsides.	Yes	PFAS are persistent, bioaccumulate, and have adverse health effects on humans and wildlife. Safer and environmentally friendly alternatives are available, and efforts are being made to reduce their use and release into the environment.	8.4	Refer to EPS 8.4.	Refer to EPS 8.4.
Substitution	Use alternative materials that will produce less waste.	N/A	The materials selected for the infrastructure are based on their overall performance, availability, and compatibility with project requirements. Implementing alternative materials would not provide significant environmental benefits and may compromise the efficiency and safety of	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			the operations. Hence, implementing this control is not technically feasible.			
Engineering	Designated waste storage areas available on project vessels.	Yes	Wastes to be properly stored, secured, adequately contained and transported to avoid the risks of accidental overboard discharge or release, especially during adverse weather.	11.1	Designated waste storage facilities on vessels are available to enable waste to be secured and stored.	Assurance against waste management facilities, equipment and practices demonstrates that appropriate waste storage facilities have been provided and maintained.
Engineering	Designated waste storage areas available on the topsides platform.	Yes	Wastes to be properly stored, secured, adequately contained and transported to avoid the risks of accidental overboard discharge or release, especially during adverse weather.	11.2	Designated waste storage facilities on the topsides platform are available to enable waste to be secured and stored.	Assurance against waste management facilities, equipment and practices demonstrates that appropriate waste storage facilities have been provided and maintained.
Engineering	Designated chemical and hydrocarbon storage areas available on project vessels.	Yes	Reduces the risk of accidental discharge to the marine environment by providing bunding and controlling the storage chemicals and hydrocarbons. Chemicals will be stored in bunded areas. As far as practicable, Bunds should be able to contain at least 110% of the volume of the largest container stored within the bund. This ensures that any spills or leaks are fully contained, preventing minor spills to the ocean.	11.3	Chemicals will be stored in bunds which will be able to contain at least 110% of the volume of the largest container stored.	Contractor quarterly inspection records demonstrate chemicals are stored in bunds which contain at least 110% of the volume of the largest container stored.
Engineering	For the topsides, treat potentially oil contaminated water collected in the open drains system with an oil-water separator before discharge.	Yes	Captures any oil that might be present on the topsides decks before it is discharged to the ocean. The system is an inherently low risk system that will mostly receive rainwater. The oil water separator system (V-26501) is designed to be able to capture the contents of the greatest hydrocarbon inventory tank on the topsides. The topsides design has bunding for the diesel tote tank and waste oil tank, which minimises the potential for significant hydrocarbons to end up in the open drains system.	7.2	Refer to EPS7.2	Refer to EPS7.2
	Project vessels will maintain a Garbage	Yes	Project vessels are required to have their own Garbage Management Plan/Procedure (or equivalent) to manage	11.4	Project vessels (to which MARPOL Annex V / Marine	Garbage Management Plan (or equivalent) is

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Management Plan (or equivalent) (as required by vessel class, size and type).		wastes generated and stored onboard. All wastes that are not permitted for discharge are sent ashore for re-use, treatment, recycling and/or disposal as appropriate. This control measure is in accordance with *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) and Marine Orders 94 and 95.		Order 95 applies) have a current Garbage Management Plan (or equivalent).	sighted on the vessel and is maintained.
				11.5	Project vessels to comply with Marine Orders 94 and 95 (marine pollution prevention – packaged harmful substances/garbage), specifically: • no planned disposal of domestic waste, solid wastes or maintenance wastes overboard from vessels (other than planned discharges permitted by this EP) • food wastes discharges macerated to < 25 mm particle size.	Garbage record book maintained for vessel as per Marine Order 95 demonstrates that there were no unpermitted discharges of solid waste as part of the petroleum activities.
Administrative and Procedural Controls	Implement waste management procedures on the substructure (e.g. drilling rig) and topsides.	Yes	Effective waste management procedures will reduce the likelihood of an unplanned release. Ensures environmental impacts of waste disposal minimised through management according to waste type at the disposal facility, in accordance with licensing requirements	11.6	Waste management procedures are in place and implemented which supports good practice and prevents accidental discharge by focusing on: : • waste segregation and storage • safe handling and transport of waste • appropriate waste disposal classification (e.g. re-use, recycling, landfill). • The disposal of non-hazardous and	Incidents records demonstrate no wastes are discharged to the ocean from the activity. A copy of the waste management procedure. Contractor quarterly inspection records of waste management onboard vessels demonstrating waste management procedure being implemented. Contractor waste records of safe transport and handling of waste.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
					hazardous wastes will be tracked to confirm they are disposed of at an appropriately licensed waste facility.	Contractor waste manifests confirm disposal to appropriate disposal facilities.
Administrative and Procedural Controls	Implement chemical management procedures on the project vessels, substructure (e.g. drilling rig) and topsides platform.	Yes	Reduces the risk of chemical containers being accidentally dropped to sea by controlling the storage and handling of chemicals on project vessels.	11.7	Contractor Chemical management procedures will be implemented as far as practicable and include controls to reduce the risk of accidental chemical release to the marine environment: • safe handling and storage aligned with EPS11.3 • spill response and emergency procedures • disposal considerations.	A copy of the chemical management procedure (or similar) that include details of the EPS 11.8 requirements. Contractor quarterly inspection records of implementation of the plan.
Administrative and Procedural Controls	Spill kits available in high-risk areas	Yes	Reduces the risk of a minor release to the marine environment by controlling the clean-up of chemicals.	11.8	Spill kits are located near high-risk chemical storage or use areas.	Contractor quarterly inspection records confirms that spill kits are stocked and ready for use.
Administrative and Procedural Controls	Shipboard Oil Pollution Emergency Plan (SOPEP) or equivalent (appropriate to class).	Yes	SOPEP (or equivalent) shall be in place for all project vessels as required by class in accordance with as per AMSA Marine Order 91. This control measure enables the efficient and prompt response to unplanned hydrocarbon releases, thereby reducing potential impacts to the marine environment.	11.9	Vessels have a valid SOPEP (appropriate to class) to respond to spills.	A valid SOPEP (appropriate to class) in place
Administrative and Procedural Controls	The management and disposal of any quarantine risk material will be in accordance with relevant requirements	Yes	The management and disposal of any quarantine risk material in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth) will reduce the risk of impact from inappropriate disposal to the marine environment.	11.10	Any quarantine risk material is managed and disposed of in accordance with relevant requirements of the *Biosecurity Act 2015* (Cth).	Records demonstrate that any quarantine risk material is managed and disposed of in accordance with relevant requirements of the

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
	of the *Biosecurity Act 2015* (Cth).					*Biosecurity Act 2015* (Cth).
Administrative and Procedural Controls	Implement procedures for lifting operations.	Yes	Impacts to the marine environment are minimised by preventing dropped objects during lifting operations.	11.11	Crane and lifting procedures implemented. Procedures will include controls, as appropriate, to reduce the risk of dropped objects entering the marine environment: • lifting equipment certification and inspection • preventive maintenance on cranes • lifting crew competencies • heavy-lift procedures • weather considerations.	The crane and lifting procedures align with EPS 11.12 requirements. Contractor quarterly inspection records of implementation of crane and lifting procedures.
Administrative and Procedural Controls	Dropped objects recovered where safe and practicable to do so.	Yes	Potential impacts to the marine environment are minimised by preventing and retrieving dropped objects unless the environmental consequences of the dropped object are negligible or there are safety concerns.	11.12	Dropped objects to ocean are recovered where safe and practicable to do so.	Incident documentation details assessment and outcomes of recovery of dropped objects.
Administrative and Procedural Controls	Vessel planned maintenance system.	Yes	Planned maintenance reduces the likelihood of ROV hydraulic equipment failure resulting in an accidental release. The consequence remains unchanged. The benefits outweigh the costs associated with implementing this control. Using ROVs during the Activity reduces seabed disturbance, length of time in field, safety and environmental risks. Hence, implementing this control reduces the environment risk to ALARP.	9.5	Refer to EPS9.5	Refer to EPS9.5
Administrative and Procedural Controls	Prohibit project vessels from operating in areas where the dusky sea snake is known or likely to occur.	Yes	The Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n) lists the risk of other pollutants affecting the dusky sea snake and its habitat as a threat to the dusky sea snake. Consistent with the conservation advice, their preferred habitat is reefs and shoals which do not occur within the	3.8	Refer to EPS 3.8.	Refer to EPS 3.8.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			Activity Area. Shoals do occur adjacent to the Activity Area though. Therefore, Shell has adopted a control consistent with an EPO outlined in the Crux OPP, to exclude vessels operating over any named Shoals adjacent to the Activity Area. This reduces the risk of minor releases being discharged in locations where the dusky sea snake habitat may occur.			
ALARP Demonstration Statement						
Based on the risk assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential risk and impacts associated with minor releases. No feasible additional or alternative controls were identified that could further reduce the risks and impacts. Therefore, the risks and impacts are considered to be reduced to ALARP.						

9.13.5 Acceptability of Risks

Table-9-75: Acceptability of Risks – Minor Releases

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Physical Environment	Water quality		No significant impacts to water quality during the Activity.	Yes	Minor spills have the potential to reduce water quality at the discharge location. The proposed control measures in place ensure that that likelihood of minor spills being released into the environment are limited. Additionally, if a small spill were to occur, they would rapidly dilute/disperse in the open ocean environment with no potential for significant impacts anticipated.
Biological Environment	Habitats and Communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	Giving regard to the Conservation advice for the dusky sea snake and the risk of minor spills affecting the dusky sea snake, it is noted that minor spills will cause highly localised affects. By adopting the precautionary principle and restricting access of vessels to adjacent shoals, where the dusky sea snake habitat may occur, these unplanned risk pathways are reduced to ALARP and acceptable levels. (refer to EPS 3.8). Marine debris (including plastics) is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (Table 7-14). Marine fauna can ingest or be entangled by solid objects, but impacts would be anticipated to be restricted to a small number of individuals, if any. In addition, plastics will erode, fracture into microplastics and bioaccumulate within marine fauna if ingested. Filter feeders may also ingest microplastics through their intake of ocean water, or indirectly by consuming prey (that have microplastics within the body cavity). Given the remote location and the lack of significantly diverse
	Threatened and migratory species	Marine mammals Marine reptiles Birds Sharks, rays and other fish	No mortality or injury of threatened MNES fauna from the Activity. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement. plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
					benthic communities or habitats that support the congregation of threatened species within the Activity Area, any accidental release of objects to the environment would not be expected to interact with or affect a significant number of threatened or migratory MNES species, including the dusky sea snake. Shell will implement MARPOL standards for project vessels and waste management procedures internal controls to manage the Activity wastes and reduce the likelihood of wastes being accidentally released to the marine environment. The quantities of unplanned solids (including plastics) released into the marine environment can be anticipated to be limited. Consistent with Table 8-1, the unlikely event of individuals of marine species impacted is not considered to cause a significant impact to MNES.
Socioeconomic and Cultural Environment	Indigenous Cultural Heritage Features		No impacts to Indigenous cultural heritage features.	Yes	There are no known Indigenous cultural heritage features that occur within the Activity Area.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	No significant impacts to Indigenous cultural values will occur from this aspect, given that no significant impacts to culturally significant marine species are expected.

The assessment of risks from minor releases determined the residual risk rating of Dark Blue (Table 9-73). As outlined above, the acceptability of the potential risks of impacts has been considered in the following context.

Principles of ESD

The potential risks of impacts from minor releases are consistent with the principles of ESD because:

- The environmental values/sensitivities within the Activity Area are not expected to be significantly impacted.
- The precautionary principle has been applied to the risk assessment.

Relevant Requirements

Managing the potential risks of impacts from minor releases is consistent with relevant legislative requirements, including:

- MARPOL Annex V as ratified by the Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth)
- Navigation Act 2012 (Cth) and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
  - Marine Order 94 – Marine pollution prevention – packaged harmful substances
  - Marine Order 95 – Marine pollution prevention – garbage
- Biosecurity Act 2015 (Cth)
- Policies, strategies, guidelines, conservation advice, and recovery plans for threatened species (Table 9-76).

Matters of National Environmental Significance

Threatened and Migratory Species

The evaluation considers that no credible significant risks to threatened and migratory species are predicted to result from minor releases because of the limited number of fauna that could potentially be impacted.

Table 9-76 summarises the alignment of the petroleum activities with management plans, recovery plans and conservation advice for threatened and migratory fauna.

Commonwealth Marine Environment

The potential impacts and risks from minor releases are predicted to not exceed the Commonwealth marine environment significant impact criteria, as listed in Table 8-1. Hence, it is considered that the aspect does not pose a credible risk to the Commonwealth marine environment.

Table 9-76: Summary of Alignment of the Risks from the Minor Releases with MNES Relevant Requirements for

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Threats Relevant to the Project	Demonstration of Alignment as Relevant to the Activity
Threatened and Migratory Species	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	Pollution (persistent toxic pollutants)	Waste generated will be managed in accordance with standard maritime requirements, international conventions (MARPOL), relevant Marine Orders and Shell's internal management system requirements. This management reduces the likelihood of the accidental release of waste into the marine environment. The frequency, quantities and nature of minor releases are considered Unlikely (C) to result in significant impacts to threatened/migratory species or the Commonwealth marine environment (Table 8-1).
	Conservation advice on fin whale (*Balaenoptera physalus*) (TSSC 2015b)	Pollution (persistent toxic pollutants)	
	Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (CoA 2015a)	Habitat modification including presence of oil and gas platforms/rigs, marine debris infrastructure and acute/chronic chemical discharge	
	Conservation advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n)		
	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	Marine debris	

MNES	MNES Acceptability Considerations (Significant Impact Criteria, EPBC Management Publications/RPs/CA)	Threats Relevant to the Project	Demonstration of Alignment as Relevant to the Activity
	Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA 2017b)		
	Conservation advice on leatherback turtle (*Dermochelys coriacea*) (DEWHA 2008)		
	Conservation advice on whale shark (*Rhincodon typus*) (DoE 2015e)		
Commonwealth Marine Area	Significant impact guidelines for the Commonwealth marine environment (Table 8-1)	Marine debris	
	Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (CoA 2018)	Marine debris	

External Context

There have been no objections or claims raised by relevant persons regarding minor releases. Shell's ongoing consultation program will consider statements and claims made by relevant persons when undertaking future assessment of risks (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's Waste Strategy and Guidelines, environmental policy and ESHIA requirements. The EPOs, and the controls which will be implemented, are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

The assessment of potential risks from minor releases determined the residual risk rating to be Dark Blue (Table 9-6). As outlined above, the acceptability of the potential impacts and risks have been considered in the context of:

- the established acceptability criteria
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

Shell considers residual risks of Dark Blue or lower to be inherently acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to the minor releases aspect.

Shell considers the risk of impacts to the environment from the minor releases associated with the Activity to be ALARP and acceptable.

9.13.6 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No injury or mortality of listed threatened or migratory MNES species as a result of minor release to sea during the petroleum activities.	Incident reports demonstrate no mortality of EPBC Act listed threatened or migratory MNES as a result of minor release from the Activity within the Activity Area.
No incidents of spills or the release of equipment, materials or waste to the ocean from the activity.	Incident reports demonstrate no incidents of spills or the release of equipment, materials or waste to the ocean from the activity.

9.14 Emergency Events

9.14.1 Scenario Context

Scenarios that may lead to an emergency event[65] include:

- loss of containment (LOC) of fuel (e.g. IFO or MDO) as a result of a fuel tank rupture following a vessel collision within the Activity Area
- bunkering incident resulting in a release of fuel.

Table 9-77 lists the maximum credible spill volumes for each incident type, using AMSA's Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities (AMSA 2015). The maximum credible spill is the largest spill considered possible. Generally, it assumes a failure of one or two levels of spill prevention or control. Note: Grounding is not included due to the water depths and absence of submerged features in the Activity Area. Due to its persistence in the marine environment, an IFO release from a collision with the topsides HTV poses the worst-case impact in terms of extent of impact and thus was selected for detailed modelling to inform the risk assessment and contingency planning.

Table 9-77: Emergency Events: Maximum Credible Spill Volumes

Incident Type	Scenario	Maximum Credible Volume
Vessel collision (IFO release)	A vessel collision between a project vessel or third–party vessel with the topsides HTV could lead to a LOC and subsequent release of IFO if a fuel tank is ruptured. A vessel collision typically occurs due to factors such as human error, poor navigation, equipment failure or poor weather. It is noted that 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 unprotected fuel tank volume or 50% of the largest single fuel tank volume if double-hull protected. An indicative vessel, such as the *HYSY278*, has a 1,310 m^3 external double hull protected IFO fuel tank. Therefore, the largest IFO spill scenario volume across the activity vessel fleet is 655 m^3. Shell took a conservative approach and used a larger volume of 1,000 m^3 of IFO for the risk assessment, based on the previously modelled scenario by RPS (2018).	1,000 m^3
Vessel collision (MDO release)	Most of the project vessels will be fuelled by MDO. A vessel collision could lead to a LOC and subsequent release if a fuel tank is ruptured. The pipelay vessel, such as the *Audacia*, has been used to provide the largest MDO spill scenario volume across the project vessel fleet. The *Audacia* has a 1,118 m^3 external double hull protected equivalent MDO fuel tank. Therefore, the largest MDO spill scenario volume across the project vessel fleet is 559 m^3.	559 m^3
Bunkering (IFO/MDO/aviation fuel release)	A bunkering (refuelling) incident caused by failure of a coupling or fuel hose, or overfilling a tank could lead to a LOC and subsequent release of fuel. Spill volumes were determined from transfer hose inventory and spill prevention measures, including 'dry-break' or 'breakaway' couplings, rapid shutdown of fuel pumps and spill response preparedness, with 10 m^3 considered the maximum volume that could be released from the hose before shutdown. This incident type has not been assessed as it within the spatial extent of the larger spill volumes for vessel collisions.	10 m^3

9.14.2 Hydrocarbon Characteristics

The physical properties and boiling points of IFO and MDO are presented in Table 9-78 and Table 9-79, respectively.

Table 9-78: Physical Properties of IFO and MDO

Physical Properties	IFO	MDO
Density (kg/m^3)	967.0 (at 25° C)	829 (at 15° C)
API	14.8	37.6
Dynamic viscosity (cP)	2,324 (at 15° C)	4.0 at 25° C
Pour point (°C)	−10.0	−14
Hydrocarbon property category	Group IV	Group II
Hydrocarbon persistence classification	Persistent (heavy)	Light-persistent oil

Table 9-79: Boiling-point Breakdown of IFO and MDO

Oil Type	Volatiles (%)	Semi-Volatiles (%)	Low Volatiles (%)	Residual (%)	Aromatics (%)
Boiling point (°C)	<180 C4 to C10	180–265 C11 to C15	265–380 C16 to C20	>380 >C20	Of whole oil <380 BP
	Non-persistent			*Persistent*	-
IFO	1	14.4	20.8	63.8	5.9
MDO	6	34.6	54.4	5	

9.14.2.1 IFO

IFO is a medium oil characterised by high density (967 kg/m^3) and high viscosity (2,324 cP) (see Table 9-78). It consists mainly of low volatiles (20.8%) and persistent hydrocarbons (63.8%) (see Table 9-79). If released to the marine environment, the light volatiles (1%) are rapidly lost via evaporation while the residual component is expected to become semi-solid to solid at ambient temperatures (see Table 9-79). IFO does not tend to entrain into the upper water column based on the hydrocarbon characteristics.

Depending on the environmental conditions and its state of weathering, IFO can form stable or mesostable water-in-oil emulsions (emulsions) in which sea water droplets become suspended into the oil matrix (Fingas and Fieldhouse 2004). This process requires physical mixing (e.g. wave action) with the stability of the emulsion influenced by the properties of the hydrocarbon product, including viscosities and asphaltene/resin content. Emulsions generally have an average water content of approximately 80% after 24 hours and have been shown to remain stable for up to four weeks under laboratory and test tank conditions (Fingas and Fieldhouse 2004). Emulsions have an average water content of around 70% after 24 hours which decreases to approximately 30% after one week (Fingas and Fieldhouse 2004). Emulsions generally become unstable within three days, as shown under laboratory conditions. Emulsification of IFO will affect the spreading and weathering of the oil and increase the volume of oily material. If not within an emulsion state, the decay of IFO is more rapid in comparison to condensates and MDO as microbial decay is generally faster for hydrocarbons with higher viscosity.

The toxic potential of IFO is largely dependent on the properties of the blend, but generally contains <10% distillate with the remaining 90% composed of Heavy Fuel Oils (HFOs). The volatile and soluble components include those that are responsible for producing most of the aquatic toxicity due to its bioavailability to marine organisms. However, these volatile, non-persistent components are short-lived and susceptible to evaporation and degradation. The weathered portion of IFO would behave similarly to HFO. The residual components would eventually become insoluble in sea water and end up adhered to sediment or biota, reducing the risk of acute toxicity.

Once released, varying weathering processes (e.g. spreading, evaporation, dispersion, dissolution) act on the oil; the relative importance of these processes can change over time. Weathering tests were conducted to

illustrate the potential behaviour of IFO when exposed to the water surface under constant wind speeds of 5, 10 and 15 knots. The results indicated the highly persistent and viscous nature of IFO, which had a similar evaporative loss rate and negligible levels of entrainment for all wind speeds (RPS 2018).

9.14.2.2 MDO

MDO is a medium-grade oil (classified as a Group II oil) with a density of 829 kg/m^3 and a very low viscosity (Table 9-78). Because it is less dense than sea water and has low viscosity, it will spread quickly on the surface of the water to form a thin film.

MDO is volatile and will begin to evaporate as soon as it is exposed to air (see Table 9-79). The rate of evaporation depends on various factors such as temperature, wind speed, and humidity. MDO also has a strong tendency to entrain into the upper water column, especially where the water is turbulent or there are high wave actions. This can reduce removal by evaporation and cause the MDO to persist for longer, either in a dispersed or dissolved state. Any dissolved fractions can be harmful to marine life. The persistent fraction, although small, means that MDO could persist at low concentrations for an extended period (see Table 9-79). Within one or two months, this residual will degrade completely through the action of naturally occurring microbes.

9.14.3 Hydrocarbon Impact Thresholds

Hydrocarbons can exist as a range of phases in the marine environment—floating, entrained, dissolved and shoreline. Each phase can interact with the environment in diverse ways due to different pathways to receptors and impact mechanisms.

Impact thresholds for each phase were applied to the spill modelling and used to inform the assessment of potential impacts and risks. Table 9-80 describes the thresholds applied. These are aligned to the NOPSEMA Oil Spill Modelling Guidance Bulletin (NOPSEMA 2019). The low, moderate and high exposure zones represent ranges of hydrocarbon concentrations, grouped on the basis of scientific knowledge of the potential impacts of the various hydrocarbon phases on environmental receptors (Table 9-80). Section 7 presented the low exposure thresholds to delineate the Planning Area used to plan for the oil spill response, describe the environment and assess potential socioeconomic impacts. The moderate and high exposure thresholds define the adverse exposure zone within which ecological impacts may occur.

Table 9-80: Hydrocarbon Exposure Zones and Thresholds

Exposure Zone	Threshold	Justification
Floating		
Exposure zone Low (1–10 g/m^2)	1 g/m^2	The 1 g/m^2 threshold represents the practical limit of observing hydrocarbon sheen in the marine environment and therefore was used to define the outer boundary of the low exposure zone. This threshold is considered below levels that would cause environmental harm and is more indicative of the areas perceived to be affected due to its visibility on the sea surface. This exposure zone represents the area contacted by the spill and defines the conservative outer boundary of the Planning Area from a hydrocarbon spill.
Adverse exposure zone Moderate (10–25 g/m^2)	10 g/m^2	Ecological impact has been estimated to occur at 10 g/m^2 because this level of oiling has been observed to mortally impact birds and other wildlife associated with the water surface (French et al. 1996; French 2000). Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High (>25 g/m^2)	25 g/m^2	The 25 g/m^2 threshold is above the minimum threshold observed to cause ecological impact. Studies have indicated that a concentration of surface oil ≥25 g/m^2 would be harmful for most birds that contact the hydrocarbon at this concentration (Koops et al. 2004; Scholten et al. 1996). Exposure above this threshold is used to define the high exposure zone.
Shoreline		
Exposure zone	10 g/m^2	A threshold of 10 g/m^2 has been defined as the zone of potential 'low' exposure. This exposure zone represents the area visibly contacted

Exposure Zone	Threshold	Justification
Low (10–100 g/m^2)		by the spill and defines the outer boundary of the Planning Area from a hydrocarbon spill.
Adverse exposure zone Moderate (100–1,000 g/m^2)	100 g/m^2	French et al. (1996) and French-McCay (2009) have defined an oil exposure threshold of 100 g/m^2 for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore, which is based on studies for sublethal and lethal impacts. The 100 g/m^2 threshold has been used in previous environmental risk assessment studies (French et al. 2011; French-McCay 2004; French-McCay 2003; French-McCay et al. 2012; NOAA 2013). This threshold is also recommended in AMSA's foreshore assessment guide as the acceptable minimum thickness that does not inhibit the potential for recovery and below which is best remediated by natural coastal processes alone (AMSA 2015). Thresholds of 100 g/m^2 and 1,000 g/m^2 will define the zones of potential 'moderate' and 'high' exposure on shorelines, respectively. Contact within these exposure zones may result in impacts to the marine environment and coastal areas.
Adverse exposure zone High (>1,000 g/m^2)	1,000 g/m^2	
Entrained		
Exposure zone Low exposure (10–100 ppb)	10 ppb	The 10 ppb threshold represents the lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZG (2018) water quality guidelines. Due to the requirement for relatively long exposure times (>24 hours) for these concentrations to have an observable impact, they are only likely to affect those juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained oil plumes, or if entrained hydrocarbons adhere to organisms or are trapped against a shoreline for periods of several days or more. This exposure zone is not considered to have the potential to result in significant biological impacts. This exposure zone represents the area contacted by the spill and conservatively defines the outer boundary of the Planning Area from a hydrocarbon spill.
Adverse exposure zone Moderate (100–500 ppb)	100 ppb	The 100 ppb threshold is considered conservative in terms of potential for toxic effects leading to death for sensitive mature individuals and early life stages of species. This threshold represents a potential zone of acute exposure, which is more meaningful over shorter exposure durations. The 100 ppb threshold was selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High (>500 ppb)	500 ppb	The 500 ppb threshold is considered a conservative high exposure level in terms of potential for toxic effects leading to death for more tolerant species or habitats. This threshold represents a potential zone of acute exposure, which is more meaningful over shorter exposure durations. The 500 ppb threshold was selected to define the high exposure zone.
Dissolved		
Exposure zone Low (6–50 ppb)	6 ppb	The threshold value for species toxicity in the water column is based on global data from French et al. (1999) and French-McCay (2003 2002), which show that species sensitivity (fish and invertebrates) to dissolved aromatics exposure >4 days (96-hour LC50) under different environmental conditions varied from 6 ppb–400 ppb, with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Based on scientific literature, a minimum threshold of 6 ppb is used to define the low exposure zones (Clark 1984; Engelhardt 1983; Geraci and St Aubin 1988; Jenssen 1994; Tsvetnenko 1998). This exposure zone is not considered to have the potential to result in significant

Exposure Zone	Threshold	Justification
		biological impacts and conservatively defines the outer boundary of the Planning Area from a hydrocarbon spill.
Adverse exposure zone Moderate (50–400 ppb)	50 ppb	A conservative threshold of 50 ppb was chosen because it is more likely to indicate potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002). French-McCay (2002) predicts that an average 96-hour LC50 of 50 ppb could serve as an acute lethal threshold to 5% of biota. The 50 ppb threshold was selected to define the moderate exposure zone. Contact within this exposure zone may result in impacts to the marine environment.
Adverse exposure zone High (>400 ppb)	400 ppb	A conservative threshold of 400 ppb was chosen as it is more likely to indicate potentially harmful exposure to fixed habitats over short exposure durations (French-McCay 2002). French-McCay (2002) predicts that an average 96-hour LC50 of 400 ppb could serve as an acute lethal threshold to 50% of biota. The 400 ppb threshold was selected to define the high exposure zone.

9.14.4 Vessel Collision (IFO Release)

9.14.4.1 Overview of IFO Release Modelling

Shell commissioned RPS to undertake oil spill modelling for the IFO release vessel collision scenario (RPS 2018), as submitted with the Crux OPP. Table 9-81 summarises the model parameters used. A total of 300 deterministic model runs were undertaken using different metocean conditions over a 42-day period—100 during summer, 100 during winter and 100 during the transitional season. The aggregated deterministic results comprise the stochastic dataset, from which probabilities of contact above thresholds are determined. Shell considers all environmental receptors identified as potentially being contacted above 1% probability. This will identify more receptors than would be impacted by a given release, and hence it is environmentally conservative.

Table 9-81: Vessel Collision Scenarios used for Spill Modelling

Scenario		IFO	MDO
Location	**Latitude**	12° 57′ 52.46″	12° 57′ 52.46″
	Longitude	124° 26′ 33.21″	124° 26′ 33.21″
Depth (m)		Surface	Surface
Type		IFO-180 (IFO)	MDO
Duration		1 hour	
Total volume (m^3)		1,000 m^3	559 m^3
Number of modelled simulations		300 over three seasons (summer, winter and transition)	N/A

9.14.4.2 Summary of Vessel Collision (IFO release) Modelling Results

Figure 9-8 presents the predicted evolution of a spill from the deterministic simulation that resulted in the maximum oil volume across all shoreline receptors. Upon release, the oil forms a surface slick that is transported south by local wind, wave and surface currents. As described in Section 9.14.2.1, IFO does not tend to entrain into the water column so the bulk remains on the sea surface. Volatile components (36.2%), which are responsible for aquatic toxicity, are removed from the sea surface over several days. Dissolution of soluble aromatic compounds is low.

The modelled slick is predicted to impact the Bonaparte Archipelago after about seven days and 2.4% probability of reaching the Bonaparte Gulf. By this time surface water concentrations are predicted to have reduced to <25 g/m2; the maximum shoreline accumulated concentration is predicted to be <8,000 g/m^2 and the maximum length of shoreline impacted is 82 km.

Stochastic results are presented in Figure 9-9 and Figure 9-10. Most of the oil is predicted to remain on the surface with the low (1 g/m^2) and moderate (10 g/m^2) exposure threshold extending up to 1,853 km and 1,061 km respectively. The outer extent of the dissolved hydrocarbons at a low exposure threshold (6 ppb) extends up to 20 km. No sensitive receptors are predicted to be contacted at a moderate (50 ppb) or high (400 ppb) exposure thresholds for dissolved hydrocarbons.

The oil is predicted to mainly remain offshore with only a 2.7% probability of making landfall at Browse Island. Six KEFs and several shoals could potentially be reached; however, as the oil is predominantly on the surface, it would pass over them and not physically make contact. Commercial fisheries (Northern Prawn Fishery, Southern Bluefin Tuna Fishery, Western Skipjack Fishery and Western Tuna and Billfish Fishery) may potentially be contacted at low exposure threshold levels. BIAs for turtles (flatback, green, hawksbill, leatherback, loggerhead, olive ridley) may also be potentially contacted at moderate exposure thresholds.

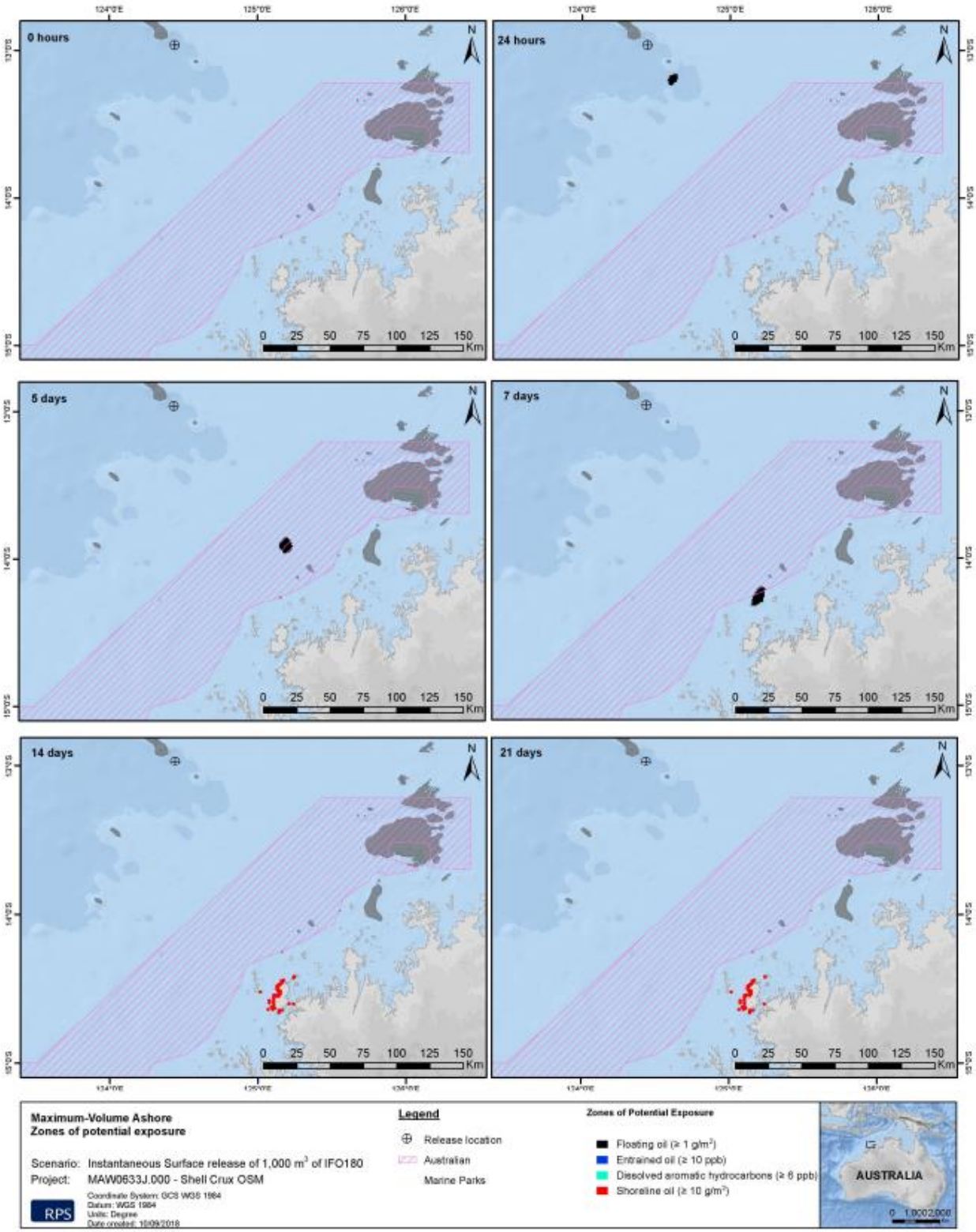


Figure 9-8: Predicted Extent of Floating, Dissolved and Shoreline Threshold Concentrations Resulting from a 1-hour Surface Release of IFO at the Crux End (Replicate simulation with maximum volume ashore).

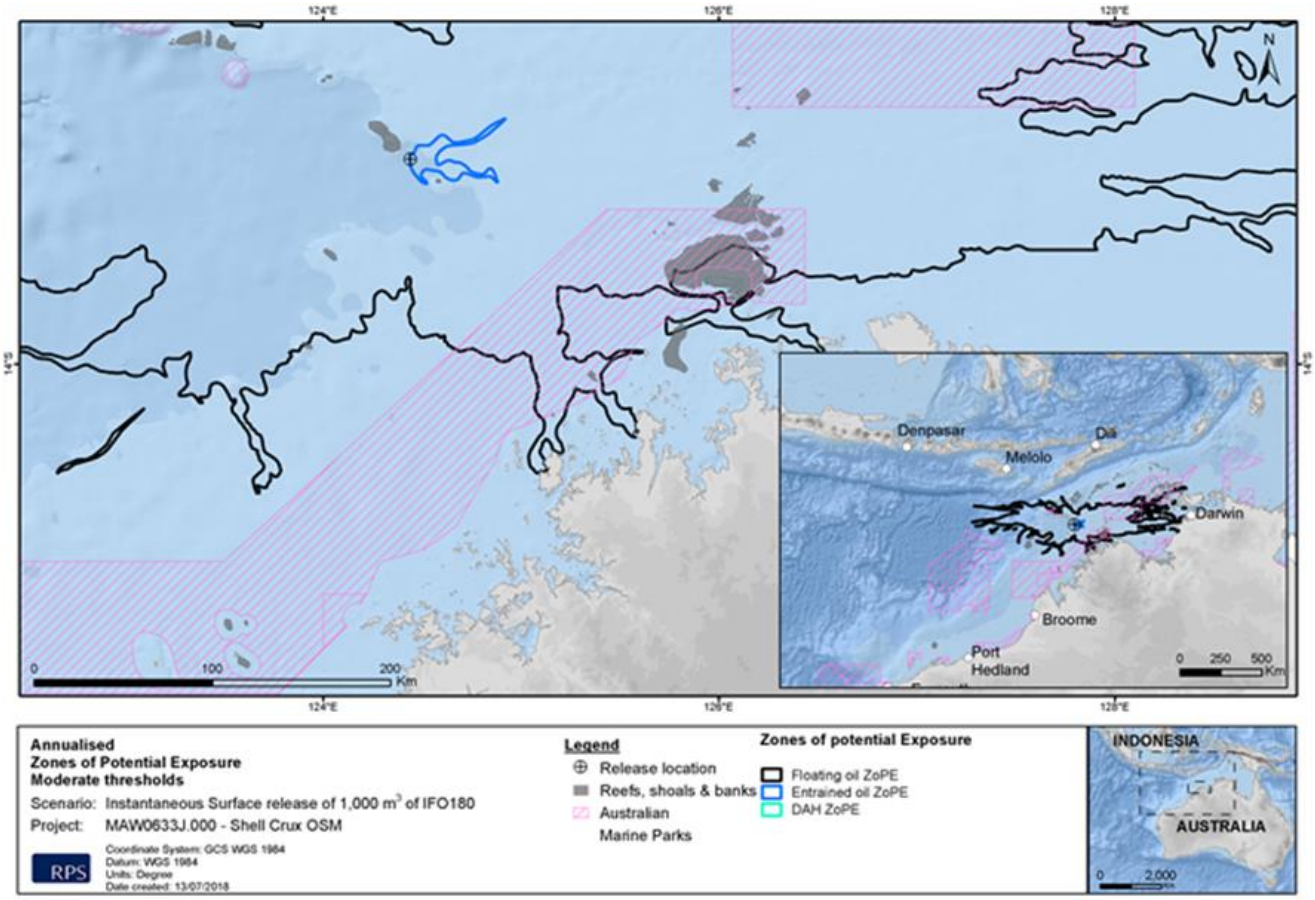


Figure 9-9: Annualised Zones of Potential for Floating, Entrained and Dissolved at Moderate Exposure Thresholds Resulting from a 1-hour Surface Release of IFO at the Crux End

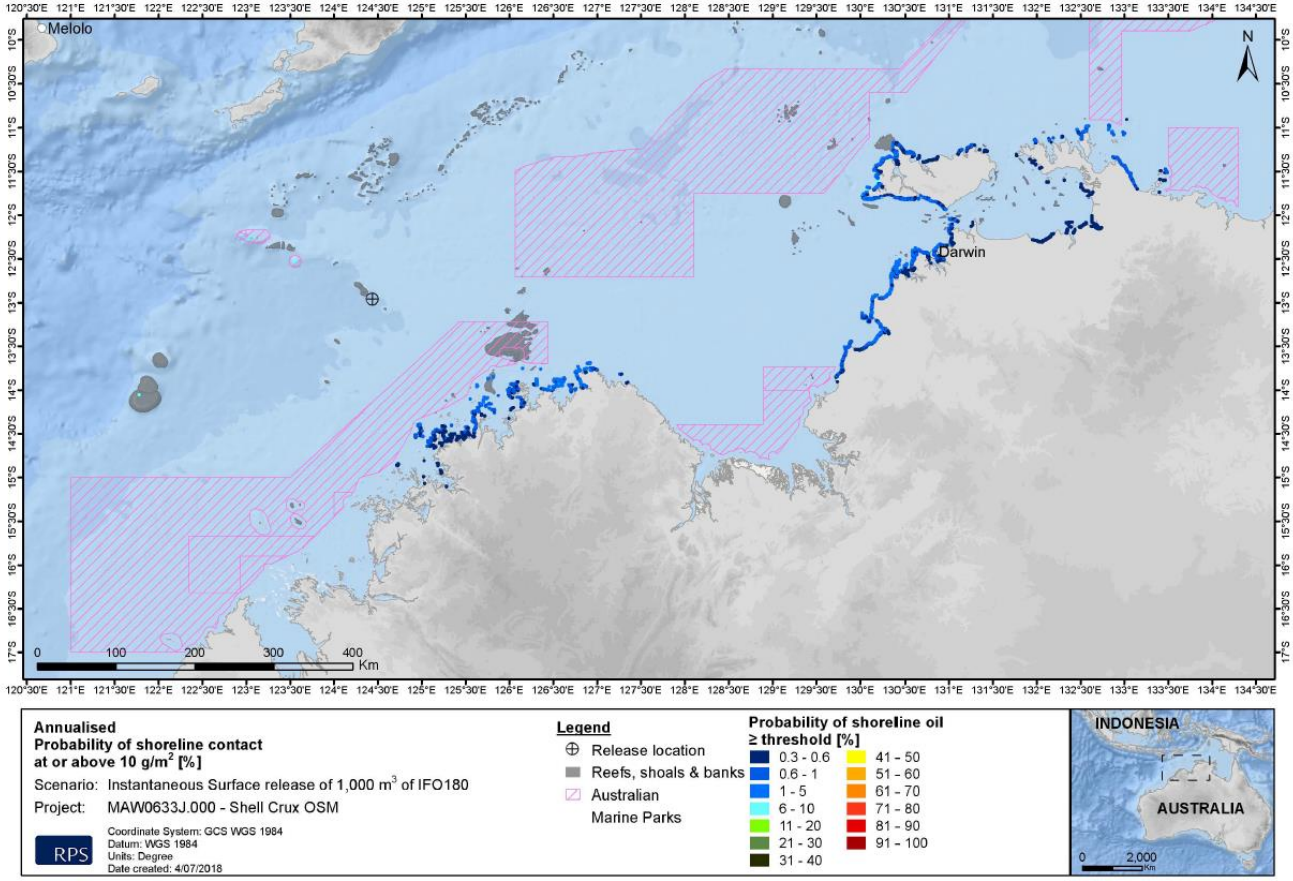


Figure 9-10: Annualised Zones of Potential Shoreline Accumulation Resulting from a 1-hour Surface Release of IFO at the Crux End

9.14.5 Vessel Collision (MDO release)

For the MDO vessel spill, WebGNONE (https://gnome.orr.noaa.gov/) was used to predict the behaviour of MDO when spilt to sea. Table 9-81 summarises the model parameters used. Figure 9-11 shows the oil budget for an instantaneous loss of 559 m^3 of MDO with a 10-knot wind. After 36 hours, 236 m^3 is removed from the sea surface through evaporation, 320 m^3 disperses naturally into the water column, a small amount is lost to sedimentation, leaving none left on the sea surface.

NERA Reference Case (NERA 2018) on Consequence Analysis for an Accidental Release of Diesel was applied to determine the MDO Planning Area (see Figure 9-12). NERA Reference Case (NERA 2018) details the modelling studies using a diesel release volume of up to 700 m^3 that underpins the spatial extent of the MDO Planning Area. NERA Reference Case (NERA 2018) predicted that for MDO release volumes of up to 700 m^3, no surface impact above thresholds will likely occur beyond 150 km (spatial extent) from the source. The MDO Planning Area is within the spatial extent of the Planning Area (based on the worst-case IFO spill scenario).

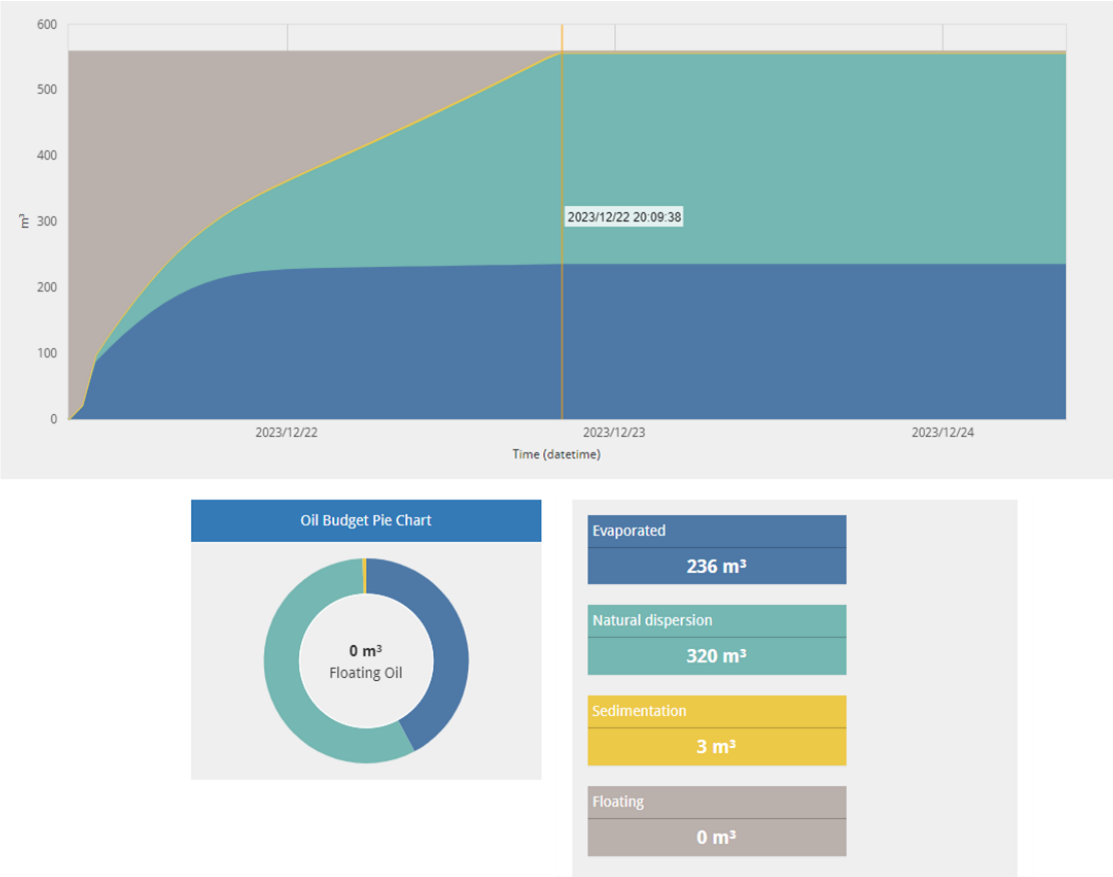


Figure 9-11: WebGNONE Oil Spill Budget for 559 m³ Instantaneous MDO LOC with Wind at 10 knots

Source: WebGNONE (https://gnome.orr.noaa.gov/)

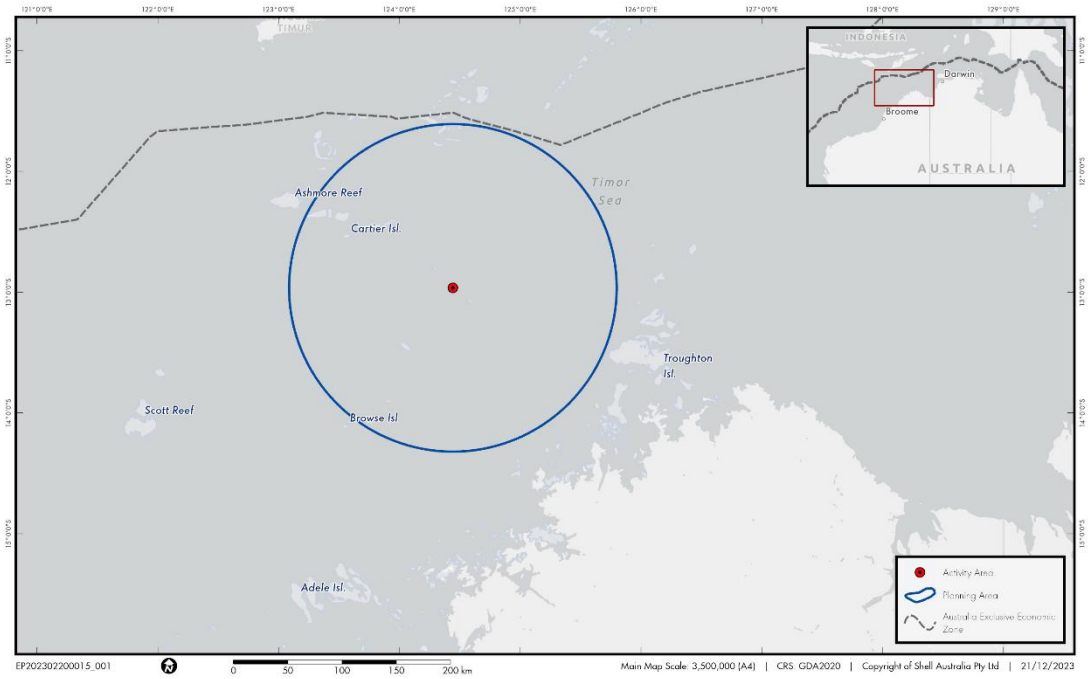


Figure 9-12: MDO Planning Area

Source: NERA Reference Case (NERA 2018)

9.14.6 Description and Evaluation of Impacts and Risks

This section lists the sensitive receptors that, based on the modelling, are predicted to potentially contact oil at concentrations at or above the moderate threshold.

9.14.6.1 Physical Environment

9.14.6.1.1 Water Quality

When oil is spilled into the sea it undergoes several physical and chemical changes, some of which lead to its removal from the sea surface, others which cause it to persist. Although spilled oil is eventually broken down in the marine environment, the time taken depends upon factors such as the amount of oil spilt, its initial physical and chemical characteristics, the prevailing climatic and sea conditions, and whether the oil remains at sea or is washed ashore (Bascosa et al. 2022).

Oil can affect marine biota in various ways through acute toxicity and sublethal chronic effects on morphology, physiology and behaviour, some of which may ultimately lead to death. Weathering influences the toxicity of oil and its constituents. Weathering processes include spreading, evaporation, dissolution, dispersion into the water column, formation of water-in-oil emulsions, photochemical oxidation, microbial degradation, absorption to suspended particulate matter, and stranding on the shore or sedimentation to the sea floor (Bacosa et al. 2022).

Relatively lighter, more volatile, mobile and water-soluble compounds will tend to evaporate quickly into the atmosphere. The lighter components of oil are usually the most harmful but are also those most readily lost through evaporation; the rate of evaporative loss increases with temperature (Singh et al. 2020). Consequently, weathered oil is generally less toxic than fresh oil; therefore, lethal concentrations of harmful components that could lead to death of marine organisms are relatively rare, localised and short-lived.

Dissolved compounds are acutely toxic to marine life, but they are also among the most volatile and readily biodegradable under most conditions. Not all toxic compounds are lost through evaporation—some, like heavy PAHs, are poorly soluble in water and more likely to adhere to particles and thus remain in the water or sediment. PAHs can be broken down by microbes over time. However, this process is often slow enough that these hydrocarbons may accumulate in invertebrates, such as shellfish. Vertebrates metabolise them rapidly (American Society for Microbiology [ASM] 2011).

Dispersion is the process by which oil is broken down into small droplets and entrains into the water column. Physical dispersion can only happen in the presence of adequate mixing energy (e.g. wave action, high-pressure leaks)—under turbulent conditions, dispersion can prevent oil from reaching the surface where it might otherwise evaporate. Dispersion can also drive floating oil into the water column and largely prevent it from forming surface slicks that can threaten birds and mammals. One advantage of dispersion is that oil breaks into tiny droplets with more surface area, which helps microbial degradation. A potential disadvantage is that it might increase exposure of some inhabitants of the ecosystem to the oil. Dispersion can be enhanced by adding chemical dispersants (ASM 2011).

Sunlight reacts with some oil constituents, especially PAHs, in a process known as photolysis. Photolysis is important because by breaking aromatic ring structures, it enhances the availability of such compounds to microbes and hence microbial degradation (Abel-Shafty and Mansour 2016). However, photo-oxidised PAHs have been shown to be substantially more toxic to water-dwelling organisms.

The importance of the degradation process is described in the ASM (2011) and used to inform the following discussion. Microbes that use oil as their source of energy have been around for hundreds of millions of years. Where oil is naturally present, the community of microbes that collectively feeds on all the different compounds contained in the oil is well established and diverse. Even where the background levels of oil are low, a few microbes with the capability of degrading oil always seem to be present.

When there is a spill of crude or refined oil, the bacteria capable of degrading hydrocarbons proliferate quickly. Microbial clean-up can be considered in terms of 'supply and demand'. The local community of microbes is already adapted to the background supply of oil. It takes a certain amount of time—a lag time—for their populations to increase in response to the influx of new resources. The surge of oil from a leak or spill can temporarily outpace the capacity of the local oil-degrading microbes. The oil remains until demand catches up to supply. Eventually, though, along with the physical and chemical processes discussed above, the microbes will 'take care' of the problem by consuming the oil compounds that are biodegradable (ASM 2020).

The ability to metabolise oil is displayed by many different types of microbes—some more versatile than others. Certain microbes highly prefer oil hydrocarbons over other energy sources and their numbers will increase faster than others in the community in response to an oil spill. Other bacteria are capable of using many different food sources and oil constituents are just one of many compounds these bacteria can use for growth. Such microbes can 'turn on' the necessary metabolic machinery in the presence of 'edible' oil hydrocarbons to switch over to the newly abundant food source (AMS 2011).

Microbes can also evolve enhanced capabilities for degrading oil. One of the most rapid ways this can happen is by horizontal gene transfer (HGT). HGT is a mechanism whereby microbes can share genes with each other—with HGT, a microbe that has the genetic instructions for producing oil-degrading enzymes can transfer copies of those genes to other microbes—even microbes of different species previously incapable of degrading oil components (French et al. 2022). In this way, microbes that were unable to use oil as a food source acquire that capability. The ability to share genes can greatly promote a local microbial community's capacity to clean up an oil spill. Although the process is well established, the extent to which it takes place after an oil spill is unknown.

Microbes can be relied on to biodegrade oil over time. However, the process may not be fast enough to prevent ecological damage. Even though oil-degrading microbes are found everywhere, their mere presence does not mean that environmental conditions are ideal for oil biodegradation. Environmental conditions, as well as the location, duration, and form of an oil spill strongly affect how quickly biodegradation will occur.

IFO is expected to form a surface slick with only a small proportion dispersing and dissolving into the water column. It may also form a water-in-oil emulsion and is relatively persistent (see Table 9-79). MDO is much lighter and readily evaporates from the sea surface (see Table 9-79). It also has a strong tendency to entrain into the upper water column especially in areas where the water is turbulent or there are high wave actions. This can reduce removal by evaporation and cause it to persist for longer either in a dispersed or dissolved state.

Many studies have been published describing the toxicities of whole hydrocarbons and hydrocarbon components. The common theme is that the observed toxicity of crude and refined hydrocarbons is primarily attributable to volatile and water-soluble aromatic hydrocarbons (BTEX, naphthalenes and phenanthrenes) and the higher molecular weight PAHs. BTEX is the collective name for the monocyclic aromatic hydrocarbons (MAHs)—benzene, toluene, ethyl benzene and xylene (Wang et al. 2023). These four compounds behave

similarly when released to the environment and thus they are usually considered as a group. BTEX compounds are acutely toxic to aquatic organisms if contact is maintained. They are relatively soluble in water; the solubility of benzene is about 1,400 mg/L and xylene about 120 mg/L. BTEX are generally neurotoxic to susceptible organisms, but because of their volatility, aquatic organisms typically only experience short exposure times, which may circumvent toxic effects. Weathering processes are extremely important in altering the toxicity of a spill. Neff et al. (2000) demonstrated rapid loss of BTEX via evaporation, which resulted in a reduction of acute toxicity of the water-accommodated fraction. Thus, with weathering processes and loss of the monocyclic aromatic hydrocarbon compounds, the PAHs become more important contributors to the toxicity of weathered hydrocarbons.

Bioaccumulation of petroleum hydrocarbons by marine organisms depends on biological availability (bioavailability), the length of exposure, and the organism's capacity for metabolic transformations of specific compounds. Dissolved hydrocarbons are the most bioavailable, followed by those in tissues of marine organisms (if the organisms are eaten) or associated with liquid and unweathered hydrocarbon droplets in the water column. Thus, bioavailability of PAH from particulate material is less than that from solution in the water (Pruell et al. 1987). As oil weathers, its viscosity and average molecular weight increases, decreasing the rate of partitioning of higher molecular weight PAHs from the hydrocarbon phase into the surrounding water, thereby decreasing the accessibility of these PAHs to aquatic organisms (McGrath et al. 2001).

Aliphatic hydrocarbons and BTEX compounds have a very low potential for bioaccumulation. In contrast, there is moderate potential for the low molecular weight PAHs to bioaccumulate. Crude oil may also contain high concentrations of phenol and alkyl phenols. Phenols have the potential to impart taint and odour to edible tissue at relatively low concentrations (Jones et al. 2022). However, phenols are a natural ingredient of the ocean, are synthesised by a wide variety of plants and microbes, and are also a product of plant material degradation. Phenol compounds are highly soluble and will dilute and degrade rapidly if released to the ocean. The combination of dilution, bio- and photo-degradation and evaporation will rapidly decrease dissolved phenol concentrations in the water column (AMS 2011).

Toxicity depends on the chemical compounds present, the exposure duration (acute or chronic), the organisms impacted and the environmental surroundings. Most hydrocarbons are considered non-specific narcotic toxins and their toxicity depends on attaining a critical volume or concentration in the tissues of aquatic organisms. The toxicity of hydrocarbons in mixtures is additive, so the toxicity of a complex mixture depends on the total concentration of bioavailable hydrocarbons and degradation products in the water to which aquatic organisms are exposed (AMS 2011).

Acutely toxic responses have a sudden onset after or during relatively high exposure, usually for short durations—within four days for fish and macroinvertebrates and shorter times (two days) for organisms with shorter life spans. The response may be lethal. In contrast, chronic responses involve endpoints that are realised over a relatively long duration, often one-tenth of the life span of an organism or more. A chronic toxic response is usually characterised by slow toxic progress and long continuance and may be measured in terms of reduced growth, reproduction or fertilisation at different life stages, and death (AMS 2011).

Toxicity test data are generally accepted to be highly conservative because they include several assumptions that are highly unlikely to be represented in the open ocean environment. Laboratory toxicity data can be considered conservative because:

- it assumes constant exposure to the toxicant at elevated concentrations is maintained (48–96 hours)
- it precludes the ability for 'fight or flight' response (species to move away)
- it precludes the effect of stress and lack of fitness from test species' diet (i.e. absence of natural diets and reduced feeding during testing)
- the actual cohort of test species represents the fitness of natural populations.

Water column contamination changes rapidly in space and time. Toxicity to aquatic organisms increases with time of exposure, such that organisms may be unaffected by brief exposures to the same concentration that is lethal at long exposures. Toxicity data indicate that the 96-hour LC50 (which may serve as an acute lethal threshold) for dissolved aromatics averages ~50 ppb. Thus the equivalent lethal exposure dosage threshold is 4,800 ppb hours (96 hours × 50 ppb; French-McCay et al. 2003).

9.14.6.1.2 Sediment Quality

Sediment quality is not expected to be significantly affected by any of the worst-case scenarios that release IFO or MDO. Hydrocarbon contaminants (e.g. PAHs) from surface releases are unlikely to reach the seabed due to the water depth and low natural sedimentation rates in the region. The MDO release from a loss of fuel from a vessel scenario would undergo rapid evaporation of volatiles following release.

The IFO release from a loss of fuel from a vessel scenario has a relatively low portion of volatiles, which are expected to evaporate quickly following release. The remaining IFO may sink to the seabed if exposed to considerable sedimentary particles; however, this is considered very unlikely to occur in the open sea due to the low density of the residual IFO relative to sea water and the naturally low sedimentation rates. Residual IFO near shorelines may be exposed to higher sediment loads and be more likely to sink. Stranding of residual IFO on shorelines can lead to contamination of sediments with high-molecular weight hydrocarbons. These compounds are typically much less toxic than low-molecular weight hydrocarbons (Olayinka et al. 2019).

9.14.6.2 Biological Environment

9.14.6.2.1 Habitat and Communities

Mainland Coastlines

Modelling predicted that only the Kimberley and the Joseph Bonaparte Gulf coasts could be exposed to hydrocarbons between 10 and 25 g/m^2. Maximum predicted accumulated concentration was 7,777 m^3 at Joseph Bonaparte Gulf coast, which also registered the maximum total volume ashore at 523 m^3. The predicted minimum time for visible oil to reach the shoreline (Kimberley coast) was seven days, indicating the spill would undergo considerable weathering before reaching a shoreline. The largest length of actionable shoreline oil (defined as >10 g/m^2) is predicted to reach up to 99 km (Joseph Bonaparte Gulf).

Sandy beaches and subtidal reefs are the dominant shore types. All these locations have the potential to contain habitat for EPBC Act listed reptiles and seabirds but also habitat for polychaetes, molluscs, marine crustaceans, semiterrestrial crustaceans and insects. Any shoreline impact will be weathered hydrocarbon residue of low toxicity with very limited potential to adversely affect biological resources. Wave action and water column mixing within the nearshore environment will enhance weathering of the IFO and remove stranded oil from beaches.

Nearshore benthic communities are typically more diverse than those found in the deepwater habitat of the Activity Area; this diversity is often due to the presence of primary producers, such as seagrasses, macroalgae, zooxanthellate corals and mangroves.

Most seagrasses within the area are subtidal, although there may be relatively small areas of intertidal seagrasses along the WA and NT coastlines. Seagrass in the subtidal and intertidal zones have different degrees of exposure to hydrocarbon spills. Subtidal seagrass is considered unlikely to be exposed to spilled hydrocarbons, as these hydrocarbons will concentrate at the surface. Intertidal seagrasses are vulnerable to smothering by floating oil slicks, which can lead to death if it coats their flowers, leaves and stems (Dean et al. 1998; Taylor and Rasheed 2011). Long-term impacts to seagrass are unlikely unless hydrocarbons are retained within the seagrass meadow for a sustained period (Wilson and Ralph 2011). Toxicity effects can also occur if soluble fractions of hydrocarbons are absorbed into tissues (Runcie et al. 2010). The potential for toxicity effects of entrained hydrocarbons may be reduced by weathering processes, which should lower the content of soluble aromatic components before contact occurs.

Like seagrasses, the potential impacts to macroalgae depend on the exposure pathway; most macroalgae in the region are subtidal, although intertidal macroalgae may be present. Studies of subtidal macroalgal assemblages exposed to fuel oil spills have shown that impacts from exposure is slight (Edgar et al. 2002; Lobón et al. 2008). Effects of exposure to oil on intertidal macroalgae are more variable; some studies reported little evidence of impacts (Díez et al. 2009), while others show significant impacts (De Vogelaere and Foster 1994). Recovery of intertidal macroalgae has been shown to occur faster in areas where oil has been left to degrade naturally compared to areas subject to intensive clean-up operations (De Vogelaere and Foster 1994). Given the potential for shoreline contact is predicted to be very low in all the worst-case spill scenarios, impacts to macroalgae are considered to be highly unlikely.

Subtidal and intertidal zooxanthellate corals occur widely throughout the Timor Sea, including around offshore reefs and islands, bank and shoals, and the mainland coast. Shallow subtidal and intertidal corals may be

coated by stranded floating hydrocarbons during low tides, which may subsequently be refloated by incoming tides. Impacts from physical coating of corals appears to also depend on coral morphology. Coral species more likely to retain oil coatings (e.g. due to polyp morphology, or gross morphology with high surface area to volume ratios such as branching corals) have been shown to be more susceptible to impacts (Shigenaka 2001). Exposure to dissolved and entrained hydrocarbons may result in acute and chronic toxic effects, with longer exposure periods typically leading to greater potential for death (Shigenaka 2001). Corals may also ingest entrained oil particles, potentially leading to uptake of hydrocarbons into coral tissue (Loya and Rinkevich 1980).

Intertidal mangrove habitats occur throughout much of Kimberley and NT coastline, and are highly susceptible to oil pollution (NOAA 2014). Given the distance between potential release locations and the nearest mangroves, any spilled hydrocarbons reaching mangroves will be highly weathered. Mangroves are vulnerable to contact with floating hydrocarbons, such as weathered IFO, which may coat prop roots and pneumatophores (aerial roots that support oxygen uptake) (Duke and Archibald 2016). Exposure can result in direct effects such as yellowed leaves, defoliation and death, and indirect effects such as reduced recruitment and increased sensitivity to other stressors (NOAA 2014). Like seagrasses, mangroves can also be affected by entrained and dissolved aromatic hydrocarbons either in the water or sediment.

Benthic communities

Because IFO and MDO remain in the surface waters, the only benthic habits that could be impacted are those nearshore. Acute or chronic exposure through contact and/or ingestion can result in toxicological impacts. However, the presence of an exoskeleton (e.g. crustaceans) reduces the potential for impacts from hydrocarbon absorption through the surface membrane. Invertebrates with no exoskeleton and larval forms may be more prone to impacts. Localised impacts to larval stages may occur, which could affect population recruitment that year. Tainting is considered unlikely to occur, but if it did it is expected to be localised and low level with recovery expected.

Shoals and Banks

The Timor Sea region contains numerous named shoals and banks. Modelling predicted that some of these may have the potential to be reached by floating oil, but not by in-water oil, from the worst-case vessel spill. As these shoals are below the sea surface, floating oil has the potential to pass above them and hence the potential for impact is considered unlikely.

Offshore Reefs and Islands

Several offshore reefs and islands were identified by the modelling study results as potentially being contacted by hydrocarbons above impact exposure thresholds, albeit at very low probabilities (<3%). These include Admiralty Gulf Islands, Cape Londonderry Islands, Cassini Island, Croker Island, East Vernon Island, Eclipse Archipelago, Jones Island, Lawson Island, McCluer Island, Melville Island, Napier Broome Bay Islands, North West Vernon Island, Oxley Island, Peron Islands, Roche Islands and Reefs, Stewarts Islands, Troughton Island, Long Reef, Sandy Inlet and Scott Reef South. These islands and reefs often host biological communities that are distinct from coastal islands and the mainland. Like the shoals and banks, offshore reefs and islands typically host light-dependent ecosystems characterised by benthic primary producers. Unlike shoals and banks, offshore reefs and islands may be exposed to floating hydrocarbons (in addition to entrained and dissolved hydrocarbons). Stochastic modelling of the loss of IFO scenario predicted a low probability of shoreline accumulation above impact exposure thresholds at several offshore islands and reefs, including Bathurst Island (4.5%) and Browse Island (5.7%).

The shorelines of offshore reefs and islands typically comprise intertidal reef flats and sandy beaches; shoreline types such as rocky shores, estuaries and mangroves typically do not occur. Given the modelling results estimated the minimum time to contact would be at least 148 hours for an emergent receptor (Hibernia Reef), any residual oil reaching the shoreline of an offshore island or reef would be highly weathered. Stranding of floating oil on offshore islands and reefs may result in a band of weathered oil between the low- and high-water marks on shorelines and intertidal corals. This may result in impacts to fauna in these habitats, such as nesting turtles and wading birds. Section 9.14.6.2.3 for a discussion of potential impacts to these taxa.

Plankton

Potential impacts to phytoplankton and zooplankton from the worst-case hydrocarbon spills are expected to consist of short-term acute toxic effects (Volkman et al. 1994). Planktonic communities are characterised by

relatively rapid turnover rates of short-lived biota. The high turnover rate will lead to rapid recovery as the spilled hydrocarbons decay in the environment. Within plankton communities, there is evidence from laboratory studies that some taxonomic groups, particularly zooplankton (e.g. copepods) may be more sensitive to hydrocarbon pollution (Almeda et al. 2013; Jiang et al. 2010). Few reliable studies have shown any impacts of hydrocarbon spills on planktonic communities, with most studies concluding that impacts from hydrocarbon pollution cannot be distinguished from natural variability (Abbriano et al. 2011; Davenport et al. 1982; Varela et al. 2006). Many marine species have planktonic larval phases (e.g. corals, many species of fish). Organisms with planktonic larval phases typically produce very high numbers of larvae. A worst-case credible spill may result in increased mortality of planktonic larvae (which are subject to high natural mortality); however, this is not expected to result in population, habitat or species scale impacts.

9.14.6.2.2 Key Ecological Features

The KEFs with predicted relatively high likelihoods of contact above impact exposure thresholds include:

- ancient coastline at 125 m depth contour
- carbonate bank and terrace system of the Sahul Shelf
- continental slope demersal fish communities
- Ashmore Reef and Cartier Islands and surrounding Commonwealth waters
- Seringapatam Reef and Commonwealth waters in the Scott Reef complex
- pinnacles of the Bonaparte Basin.

Only two of these KEFs could potentially be impacted (the remainder are entirely subtidal)—Ashmore Reef and Cartier Islands (6% probability) and surrounding Commonwealth waters, and Seringapatam Reef and Commonwealth waters in the Scott Reef complex (3% probability). Given the modelling results estimated the minimum time to contact would be at least 123 hours, any residual oil reaching the shoreline would be highly weathered. Stranding of floating oil on offshore islands and reefs may result in a band of weathered oil between the low– and high– water marks on shorelines, extensive tidal sand flats and intertidal corals. This may result in impacts to fauna in these habitats, such as nesting turtles, sea snakes and wading birds. Section 9.14.6.2.3 for a discussion of potential impacts to the

9.14.6.2.3 Threatened and Migratory Species

Marine Mammals

A range of cetaceans potentially occur within the adverse exposure zones for the worst-case credible spill scenario. These are described in Section 7.3.3.1. Cetaceans exposed to hydrocarbons may exhibit avoidance behaviour. Geraci (1988) documented apparent avoidance of floating hydrocarbons by bottlenose dolphins, suggesting that at least some cetaceans could potentially detect and avoid surface slicks. However, observations during spills have recorded whales and dolphins travelling through and feeding in oil slicks. During the Deepwater Horizon spill, cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al. 2017). Cetaceans observed during the spill response for the Montara oil spill included false killer whales, bottlenose dolphins, spotted dolphins and spinner dolphins (Watson et al. 2009).

Cetaceans exposed to surface, entrained or dissolved aromatic hydrocarbons above impact exposure thresholds may suffer external oiling, ingestion of oil and inhalation of toxic vapours (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). Cetaceans in coastal waters (e.g. coastal dolphin species and humpback whales at the northern limit of their migration) are at lower risk of potential impacts than cetaceans in offshore water due to the oil weathering before it reaches coastal waters. Impacts from direct exposure can reasonably be expected to irritate eyes and mucous membranes. Some protection is provided by thick skin and blubber. Entrained hydrocarbons may be ingested by cetaceans during feeding, particularly by baleen whales. Some species of baleen whale (e.g. blue whales), may be seasonally present during their migrations. However, significant feeding during migration is not expected (although opportunistic feeding may occur).

Dugongs are known to occur in coastal waters and around offshore islands within the adverse exposure zones predicted by the stochastic spill modelling. There is a lack of studies examining the effects of hydrocarbon spills on dugongs, although the direct impacts of exposure to hydrocarbons may be similar to cetaceans. Like

cetaceans, dugongs are expected to be resilient to direct impacts due to their thick skin and blubber. Suitable dugong habitat is associated with seagrass meadows, which are typically restricted to shallow waters around the mainland coast and islands. The distance of dugong habitat from the worst-case credible spill release locations means that any oil that reaches dugong habitat will be highly weathered.

Marine Reptiles

Modelling predicted overlap of an oil spill with the known distribution of several species of marine turtles and sea snakes. Saltwater crocodiles were also identified as potentially occurring within the adverse exposure zone; given the preferred habitat for saltwater crocodiles is freshwater rivers and estuaries, impacts to this species from the worst-case hydrocarbon spills are considered likely to be only transiting individuals.

Marine turtles may be exposed to floating hydrocarbons when at the sea surface (e.g. breathing, basking), and are not expected to avoid floating hydrocarbon slicks (NOAA 2010). Exposure to floating or entrained hydrocarbons may result in external oiling, which could result in impacts such as inflammation or infection (Gagnon and Rawson 2010; Lutcavage et al. 1995; NOAA 2010). Dissolved hydrocarbons may result in toxic effects on marine turtles; however, their relatively impermeable skin reduces the potential for these impacts.

Stochastic modelling identified a number of shoreline habitats (sandy beaches and internesting habitat) that may have the potential be exposed to hydrocarbons above impact exposure thresholds. Many of these are classified as habitat critical for the survival of marine turtles in the Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA 2017b). Significant breeding and nesting activity occur at these locations throughout the region. Shorelines with the greatest potential for hydrocarbon accumulation were the Bonaparte Archipelago, Bigge Island, Joseph Bonaparte Gulf, the Kimberley Coast and Bathurst Island. A spill reaching coastal waters during peak periods for turtle nesting may have increased potential to cause impacts. Nesting female turtles and hatchling turtles moving from the nest to the sea may be exposed to weathered oil, potentially resulting in oiling. Given the highly weathered state of the oil, though, it is considered that this would not have the potential to result in significant impacts.

Sea snakes have similar exposure pathways to spilled hydrocarbons as marine turtles (although sea snakes will not be exposed to shoreline hydrocarbon accumulation). Potential impacts are expected to be comparable and may include irritated eyes and mucous membranes. Sea snake deaths have been linked to exposure to hydrocarbon spills—dead sea snakes recovered from the region of the Montara oil spill showed high levels of petroleum hydrocarbons (including PAHs) in the trachea, lungs and stomach (Gagnon 2009). These results are consistent with exposure through ingestion and respiration of hydrocarbons. Ashmore Reef and Hibernia Reef are two of the few sites where the critically endangered leaf-scaled sea snake and short-nosed sea snake have been recorded, along with other species of sea snake. Both the leaf-scaled and snort-nosed sea snakes have not been detected at Ashmore Reef since 2001, despite increased survey effort. Both locations were identified by the stochastic modelling as potentially being exposed to hydrocarbons above impact exposure thresholds. Additionally, the dusky sea snake is known to occur at reefs and shoals including the Scott Reef complex (Scott Reef, North Scott Reef and Sandy Islet), Seringapatam Reef, Heywood Shoal, and at Ashmore Reef, Cartier Island and Hibernia Reef. Although the dusky sea snake has not been detected at Ashmore Reef, Cartier Island or Hibernia Reef since 2005 (DCCEEW 2024n).

Birds

Several seabird and migratory shorebird species have been identified as potentially occurring within the adverse exposure zone for the worst-case hydrocarbon spill scenarios. Additionally, BIAs for several seabird and migratory shorebird species occur throughout the adverse exposure zone, centred around offshore and coastal islands and mainland shorelines.

An MDO spill is unlikely to pose a significant risk due to its non-persistent nature. An IFO spill may result in a considerable mass of persistent floating oil. Foraging seabirds are particularly vulnerable to contact with floating hydrocarbons, which may mat feathers and lead to hypothermia (from loss of insulation) and ingestion of hydrocarbons (when preening to remove hydrocarbons). Both may result in death (Hassan and Javed 2011).

Typically, seabird foraging is concentrated around roosting locations, such as offshore and coastal islands. Potential roosting locations are considerable distances from the Activity Area, with the nearest significant roosting location (Cartier Island). Ashmore Reef (~106 km from the Activity Area) is a Ramsar-listed wetland that hosts significant seabird colonies and is an important stopping area for migratory shorebirds. Ashmore Reef is ~160 km from the Activity Area. Floating hydrocarbons reaching these locations would be significantly

weathered. Seabirds typically nest above the high-water mark and as such, are not likely to encounter stranded hydrocarbons.

Migratory shorebirds are seasonally abundant during summer months, and a spill during this period would have greater potential to impact these species. Migratory shorebirds are not likely to encounter floating oil at sea, but may be affected by shoreline accumulation of oil, or oil on shallow foraging habitats such as intertidal mudflats. Unlike seabirds, shorebird deaths due to hypothermia from matted feathers are relatively uncommon (Henkel et al. 2012). Indirect impacts, such as reduced prey availability and bioaccumulations of PAHs, may occur (Henkel et al. 2012).

Shark, Rays and Other Fish

Fish respire through gills, which may make them more vulnerable to dissolved hydrocarbon fractions than fauna with less permeable skins (e.g. cetaceans, marine reptiles, birds). Despite this apparent vulnerability, fish deaths are rarely observed to result from hydrocarbon spills (Fodrie and Heck 2011; ITOPF 2011), although instances of fish death from spills in confined areas (e.g. bays) have been recorded. These observations are consistent with fish moving away from hydrocarbons in the water (Hjermann et al. 2007). Stochastic modelling results indicated that hydrocarbons are predicted to be concentrated in surface waters. Therefore, demersal fish are unlikely to be directly affected unless they are near a subsea release, as they are likely to be associated with seabed features (e.g. shoals and banks, KEFs). Pelagic fish are more likely to encounter dissolved and entrained hydrocarbons above impact exposure thresholds but may move away from affected areas.

Exposure of fish to hydrocarbons may result in acute and chronic effects which may vary depending on a range of factors (e.g. exposure duration and concentration, life history stage, interspecies differences) and other environmental stressors (Westera and Babcock 2016). Environmental monitoring of pelagic and demersal fishes immediately following the Montara oil spill indicated that fish were exposed to hydrocarbons, although no adverse effects were detected (Gagnon and Rawson 2011, 2012). Further sampling and testing over time indicated that fish captured near the Montara wellhead were comparable to the tissue concentrations of those collected from reference sites (Gagnon and Rawson 2011, 2012).

Most marine fish species produce very high numbers of eggs, which then undergo a planktonic larval development phase. Early life history stages of fish (planktonic eggs and larvae) may be more vulnerable to hydrocarbon pollution than juvenile and adult stages, as these early life history phases cannot actively avoid water with high concentrations of hydrocarbons. Fish embryos and larvae may exhibit genetic and developmental abnormalities from long-term exposure to low concentrations of hydrocarbons (Fodrie and Heck 2011), although such long exposures may not represent actual conditions in nature. PAHs have also been linked to increased mortality and stunted growth rates of early life history (pre-settlement) stages of reef fishes, as well as behavioural impacts that may increase predation of post-settlement larvae (Johansen et al. 2017). Given the predicted temporal and spatial scales of the worst-case credible spill scenarios (as shown by a single deterministic run), and the typically high supply of eggs and larvae, it is considered unlikely that any of the worst-case credible spill scenarios will result in significantly reduced recruitment of fish due to hydrocarbon impacts during early life history phases. This conclusion is supported by studies of fish stocks following large-scale hydrocarbon spills, which have shown relatively little evidence of reduced recruitment at the scale of fish stocks/populations (Fodrie and Heck 2011).

Transitory and resident sharks may occur within the adverse exposure zones predicted by the stochastic spill modelling. Whale sharks may occur within the Activity Area (e.g. traversing during migration to and from aggregation off Ningaloo Reef) and a BIA for foraging whale sharks overlaps the Activity Area. Tagging studies by Meekan and Radford (2010) have shown whale sharks traversing the Timor Sea following the seasonal aggregation off the Ningaloo Coast. Whale sharks may be exposed to entrained and dissolved hydrocarbons by contact with their gills and ingestion during feeding. The large volume filter-feeding behaviour of whale sharks may result in a relatively high potential for exposure to entrained hydrocarbons compared to many other marine species (Campagna et al. 2011).

Tagging studies off Ningaloo Reef have shown that whale sharks disperse broadly (Meekan and Radford 2010; Wilson et al. 2006). Genetic studies of whale sharks have shown low genetic diversity, which suggests flow of genetic material through the movement of individual sharks over large spatial scales (Schmidt et al. 2009). On this basis, only a portion of the whale shark population in the Timor Sea would be within the area above the impact exposure threshold at any one time and impacts such as toxic effects leading to death if they were to occur, would be anticipated to affect only a small number of individuals.

Other oceanic (e.g. mako) and resident (e.g. reef) sharks will occur throughout the adverse exposure zone, although Heyward et al. (2017) noted that shark numbers were lower than expected, potentially due to fishing pressure. Potential impacts on other oceanic shark species are likely to be similar to fish. However, due to their relatively long lifespans and low reproductive output, recovery of shark abundances may take longer than for finfish species.

9.14.6.2.4 Protected Areas

Marine Parks

Modelling results of the worst-case credible spill scenarios predicted a range of Commonwealth (AMPs), state and territory marine parks may potentially be contacted above impact exposure thresholds (Table 9-81). These parks contain a range of environmental values such as marine biota, representative marine habitats and unique sea scapes (e.g. KEFs). Environmental values for these marine parks are described in Section 7.3.4.2 and discussed further in Sections 9.14.6.2.1 to 9.14.6.2.3 (Habitat and Communities, Key Ecological Features and Threatened and Migratory Species).

World, Commonwealth and National Heritage Places

Oil spill modelling predicts that no (>99% probability) shoreline contact at or above low exposure thresholds will occur at the Kakadu National Park (world heritage property and national heritage place), ~830 km from the Activity Area (RPS 2018). Therefore, no impacts to the heritage values are predicted to occur.

Two offshore islands and reefs listed as Commonwealth heritage places were identified by the spill modelling results as potentially being contacted by hydrocarbons at low thresholds—Ashmore Reef National Nature Reserve (<9% probability) and Scott Reef and Surrounds (~7% probability).

Spill modelling results predicted that the shorelines of the West Kimberley (national heritage place) have the potential to be contacted by shoreline-accumulated hydrocarbons above impact exposure thresholds. The West Kimberley national heritage place contains a range of shoreline types, including rocky shores, sandy beaches and mangroves. Potential impacts to these are discussed in Section 9.14.6.2.1 (Mainland Coastlines). Many of the heritage values of the West Kimberley national heritage place (see Section 7.3.4.4) are inland and would not be impacted by a hydrocarbon spill. The modelling study results predict the probability of shoreline accumulation at low threshold within the West Kimberley is low (2.4% probability). The modelled average maximum shoreline accumulation of spilled oil is <45 g/m^2.

Wetlands of International and National Importance

Several wetlands of international and national importance were identified in the results of the modelling studies as potentially being impacted by spilled hydrocarbons. Most of these are distant from the Activity Area and no contact (>99% probability) above the moderate exposure thresholds are predicted, such as Kakadu National Park and Cobourg Peninsula. The exception is Ashmore Reef, which is the closest Ramsar site to the Activity Area, ~128 km from the Activity Area. The migratory bird species associated with Ramsar sites are most vulnerable to floating oil and oil accumulations along the shoreline. All credible worst-case scenarios were identified as potentially resulting in shoreline accumulation at Ashmore Reef; however, the likelihood for contact by floating hydrocarbons is very low (≤2.4% probability). Potential impacts of spilled hydrocarbons on migratory shorebirds are discussed in Section 9.14.6.2.3 (Birds).

9.14.6.3 Socioeconomic and Cultural Environment

9.14.6.3.1 Cultural Heritage Features and Values

No known Indigenous cultural heritage features or values exist within the Activity Area and Shell has received advice that it is highly unlikely that tangible cultural heritage values will exist below 130 m water depth (Cosmos Archaeology 2023). The Planning Area may overlap Indigenous cultural heritage features. In the event of a spill, it is predicted that Indigenous underwater cultural features (such as KEFs and underwater archaeological sites) are unlikely to be impacted as oil tends to remain on the sea surface rather than entraining into the water column. Impacts to Indigenous cultural values, including land and sea Country and IPAs may result in the event of a significant spill of hydrocarbons. Indigenous People have inhabited northern Australia, particularly coastal regions, for a long time. As outlined in Section 9.14.6.2.1, shoreline contact above impact exposure thresholds is predicted to potentially impacting Indigenous cultural heritage features, including land and sea Country and IPAs. Hydrocarbon pollution and shoreline clean-up activities may disturb culturally significant

sites. Given the nature of the worst-case credible spill scenarios, the potential for shoreline accumulation above which clean-up activities would be effective is very low.

During the relevant persons consultation, no specific Indigenous cultural heritage features and values were identified within the Activity Area (as described in Appendix C). Consultation has confirmed that Indigenous people have strong connection to sea Country (as described in Section 7.4.2). Shell has also been made aware of the existence of songlines along the west Kimberly coastline, a culturally sensitive reef (located within the Kimberley region), as well as an ancient ceremonial site of the Bardi Jawi people underwater on the Dampier Peninsula coast (outside of the Planning Area). During consultation with the Larrakia People, it was identified that there is an underwater cultural site, called Lightning Man, located off Croker Island, northeast of Darwin, NT. Stochastic oil spill modelling predicts low level near shore and shoreline contact within the Planning Area where identified Indigenous cultural heritage features exist. Marine species of cultural significance are established in Sections 7.4.1.2.1 and 7.4.1.2.2. For an assessment of impacts to marine species that may be of cultural significance, refer to Section 9.14.6.2.3. Given the Dark Blue residual risk to marine species, significant impacts to cultural environment receptors are not anticipated. In the unlikely event of a Level 2 or 3 oil spill, Shell will enact the BROPEP and Browse Regional OSMP. This would involve notifying Indigenous Relevant Persons to inform of the spill and to obtain advice on Indigenous cultural features and values (see Table 10-8).

9.14.6.3.2 Marine Archaeology

Historical shipwrecks and sunken aircrafts within the Planning Area are unlikely to be impacted as oil tends to remain on the sea surface rather than entraining into the water column (see Section 7.4.3).

9.14.6.3.3 Fishing

Traditional Fishing

Traditional Indonesian fishing activity occurs within the MoU box, which intersects the Activity Area and is within the adverse exposure zones identified by the spill modelling results. Traditional Indonesian fishing is concentrated around banks, shoals, island and reefs (see Section 9.14.6.2.1) for discussion of potential impacts to these receptors). The worst-case credible spill scenario may have the potential to affect the biological resources targeted by traditional Indonesian fishers, such as fish and benthic invertebrates (e.g. sea cucumbers, trochus shells). Impacts to these biological resources may affect traditional fishers (e.g. reduced catch rates, displacement of fishing effort).

Traditional Indigenous fishers generally use waters within 3 nm of the coastline (NT Government 2015) and are not considered to be active within the offshore waters of the Activity Area. The worst-case credible spill scenario may have the potential to affect the biological resources targeted by Indigenous fishers, such as dugong, fish and marine turtles. Impacts to these biological resources may affect Indigenous People's ability to fish, hunt and gather biological resources (e.g. reduced catch rates and displacement of fishing, hunting and gathering effort).

Given the distance between the spill release location and the reefs targeted by traditional fishers, impacts to traditional fishing activities are considered to be moderate at worst.

Commercial Fisheries

A number of commercial fisheries operate within the adverse exposure zone determined from spill modelling results. The worst-case credible hydrocarbon spill scenarios may have the potential to result in a range of impacts to commercial fishing activities (ITOPF 2011), such as:

- displacing fishing effort from areas affected by a spill or spill response activities
- damaging fish stocks due to mortality
- closing fisheries by management agencies
- inability to sell catch due to perceived or actual fish tainting or contamination
- oiling of fishing gear, particularly by floating oil.

A significant hydrocarbon spill would likely result in the temporary closure of areas to fisheries within the area of adverse exposure. The spatial extent and duration of the closure would depend on the nature and scale of

the pollution resulting from the hydrocarbon spill. Given the large spatial extent of managed fisheries in the area predicted to potentially contacted above impact exposure thresholds, a spill resulting in a complete fishery closure is not considered a credible risk. Rather, the closure of areas to fishing is more likely to displace fishing effort; displacement from productive fishing areas may affect fishers in various ways. such as increased costs and reduced catch per unit effort.

Exposure of fish to hydrocarbons may result in tainting, which may render catches unsuitable for human consumption. Tainting may occur even a low levels of hydrocarbon exposure. Monitoring of fish for taint immediately after the Montara well was capped detected differences between individual fish were likely to have been exposed to hydrocarbons; however, these differences were not conclusively linked to oil contamination and fell within the range of 'normal' fish odours (Rawson et al. 2011). Samples collected at the same monitoring locations two and four months later were not distinguishable (Rawson et al. 2011). These results are consistent with other studies of fishery resources exposed to hydrocarbon pollution, which acknowledge the potential for impacts to fisheries resources but have shown little potential risk for consumers if suitable fisheries management actions are undertaken (Law and Hellou 1999; Law and Kelly 2004).

Fish caught in areas affected by a significant hydrocarbon spill may be perceived as being of poorer quality, even if no decrease in quality is evident. This may result in lower prices at the time of sale and subsequently lead to reduced income for commercial fishers.

9.14.6.3.4 Tourism and Recreation

Due to the Activity Area's remoteness, no known tourism activities currently occur in the area or its surrounds. Some tourism and recreation activities may occur at the remote offshore islands and reefs within the adverse exposure zones. These activities are expected to be exclusively nature-based tourism and impacts to the environmental values associated with these islands and reefs may impact tourism activities. Sections 9.14.6.2.1 and 9.14.6.2.4 describes the potential impacts to these receptors.

Mainland coastline and islands will typically host more recreation and nature-based tourist activities than offshore islands. Tourism activity is expected to be seasonal, with increased visitation during the dry winter months.

Impacts to tourism activities can reasonably be expected to be minor based on the likelihood and nature of contact to environmental values that support tourism activities. Impacts to these values may displace tourism activity, and potentially result in a minor loss of revenue for tourist operators (e.g. charter fishing cancellations due to fishery closures).

9.14.6.3.5 Defence

Defence activities within the offshore NAXA are considered unlikely to be affected by the worst-case credible hydrocarbon spills. Activities may be temporary displaced from areas where spill response operations are underway. Such displacement would be highly localised and temporary.

9.14.6.3.6 Ports and Commercial Shipping

Potential impacts to ports and commercial shipping from the worst-case credible spill scenarios are considered to be very minor (e.g. temporary displacement of other users from areas where spill response activities are underway). These impacts would be expected to be concentrated around the release location.

9.14.6.3.7 Indonesian Coastline

Oil spill modelling predicted that there is no shoreline contact (>99% probability) with Indonesian and Timor-Leste coastlines at or above low thresholds (10 g/m^2) (RPS 2018).

9.14.6.3.8 Offshore Petroleum Exploration and Operations

Petroleum activities in the region include the INPEX-operated Ichthys facility and the Montara development (~20 km south of the Activity Area). Reduction in water quality as a result of a worst-case credible spill may potentially affect the operation of these facilities if sea water at the facility is no longer suitable for intake (e.g. for use as cooling water or feed water for RO water generation). This may result in impacts (e.g. decreased production) to routine operations. A worst-case hydrocarbon spill response may result in competition for vessels.

9.14.7 Risk Assessment Summary

Table 9-82 lists the highest residual risk ranking of the relevant environmental receptor groups for emergency events.

Table 9-82: Emergency Events Evaluation of Residual Risks

Environmental Receptor	Consequence	Likelihood	Residual Risk
Evaluation – Unplanned Risks			
Physical Environment	Massive	B	**Yellow**
Biological Environment	Massive	B	**Yellow**
Socioeconomic and Cultural Environment	Massive	B	**Yellow**

9.14.8 ALARP Assessment and Environmental Performance Standards

Table 9-83: ALARP Assessment and Environmental Performance Standards

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
ALARP Assessment						
Substitution	Use renewable energy (e.g. solar, wind, wave) instead of IFO and marine diesel for project vessel propulsion.	No	While it would be desirable to use renewable energy to power the project vessels, a suitable fully electric and battery-operated fleet is not currently available. The contracted vessels will comply with the Shell marine vessel assurance process.	N/A	N/A	N/A
Substitution	Use alternate fuels instead of IFO and marine diesel for project vessel propulsion.	No	Alternative fuels that may replace IFO and marine diesel for project vessel propulsion include LNG, Hyrdrogen and Ammonia. The adoption of these alternate fuels for vessel propulsion may eliminate the risk of a marine diesel or IFO loss of containment event. Although this technology is emerging, there are many technical limitations for the wide scale adoption within offshore project vessels, including a lack of infrastructure such as bunkering facilities and fuel delivery methods being available. Various vessel operators that provide services to offshore projects, have either not yet adopted it within existing service vessels (i.e. retrofitted such technology) due to cost, schedule or engineering constraints, or vessels that use alternate fuels either do not operate in the region, or may not be suitable for the specific tasks required to be executed by the project. Additionally, by substituting IFO and/or marine diesel with alternate fuels, new types of spill risk associated with these alternate products are introduced.	N/A	N/A	N/A

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			Due to cost, engineering constraints and lack of availability of these technologies for use in offshore project vessel, the adoption of alternate fuels cannot be committed to for the Crux project.			
Engineering	Use of hybrid power options for vessel propulsion to reduce IFO and marine diesel fuel storage requirements.	No	Vessels equipped with hybrid power options use a dual-feed energy storage system, such as marine diesel-electric systems. These systems include battery packs that store energy when demand is low and deliver it back when demand increases. These systems may reduce fuel capacity/storage volume requirements on vessels and therefore result in a reduction in spill risk. Although this technology is available, the various vessel operators that provide services to offshore projects, have either not yet adopted it within existing service vessels (i.e. retrofitted such technology) due to cost, schedule or engineering constraints, or vessels that do have hybrid power options either do not operate in the region, or may not be suitable for the specific tasks required to be executed by the project. Shell may contract a vessel or vessels which include hybrid power options if the vessel/s are technically capable to perform the required tasks. However, this commitment cannot be made across all vessels/scopes due to the limitations noted above.	N/A	N/A	N/A
Substitution	Use radar/ Automatic Identification System (AIS)/ Automatic Radar Plotting Aid (ARPA) and associated alarms on project vessels and AIS	Yes	Using radar/AIS/ARPA and associated alarms on project vessels and AIS activated on topsides once installed allows early identification and notification of approaching vessels and is crucial for minimising the risk of vessel-to-vessel collision.	12.1	Project vessels are equipped with suitable and operational navigation and collision avoidance equipment, specifically: • ARPA • AIS	Marine Assurance records.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
	activated on topsides once installed.				• Associated alarms • radar, and/or • equivalent system.	
				12.2	Topsides equipped with AIS which is activated once installed.	Records demonstrate the topsides are equipped with AIS.
Engineering	Project vessels to comply with Marine Order 91 (International Oil Pollution Prevention [IOPP] certificates).	Yes	Refer to Table 9-48.	7.3	Refer to EPS 7.3.	Refer to EPS 7.3.
Administrative and Procedural Controls	Confirm the Crux drilling template (or equivalent) PSZ is in place.	Yes	A PSZ of 500 m will be established and gazetted around the Crux drilling template location, in accordance with the OPGGS Act (NOPSEMA 2015). Unauthorised marine users are prohibited from entering the PSZ and therefore it is a key safety measure to reduce potential interactions with the Activity and associated Crux infrastructure. Note: A PSZ for the Prelude FLNG turret (including riser base manifold, moorings and drill centre) was gazetted in 2015 (Commonwealth of Australia Gazette Notice: A441884).	12.3	Compliance with PSZ as per Part 6.6 of the OPGGS Act.	A copy of the Crux PSZ Gazette Notice. Incident report form used to record breaches of PSZ requirements.
Administrative and Procedural Controls	Implement bunkering procedures for hydrocarbons and chemicals.	Yes	The purpose of these bunkering procedures is to apply good practice and industry standards during bunkering operations. Contractor bunkering procedures will typically include the following, or equivalent standard of this, as far as practicable:	12.4	Contractor bunkering procedure will be implemented to minimise the risk of bunkering spills to the ocean, which includes (where applicable to vessel arrangements): • transfer hoses will have dry-break couplings, inspected and	A copy of the contractor bunkering procedures. A copy of the maintenance records of bunkering hoses, dry break couplings. Hose certifications. Bunkering records

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			• transfer hoses will have dry-break couplings, inspected and certified bunkering hoses, and this equipment will be maintained • drains plugged • approved bunker for specified volumes • designated receiving tanks and agreed pumping rates • direct communication between all involved • supervision at both ends • availability of spill kits on each vessel • vessel bunkering (via hose) to commence during daylight hours. Therefore, there may be situations where contractors vessel management system or vessel design constraints which mean it is not practicable to implement some specific measures listed above. In which case, contractors will be expected to demonstrate to Shell they are able to implement measures of an equivalent standard.		certified bunkering hoses, and this equipment will be maintained • drains plugged • approved bunker for specified volumes • designated receiving tanks and agreed pumping rates • direct communication between all involved • supervision at both ends • availability of spill kits on each vessel • vessel bunkering (via hose) to commence during daylight hours.	Records, such as checklists of bunkering operations which demonstrate; • drains plugged • approved bunker for specified volumes • designated receiving tanks and agreed pumping rates • direct communication between all involved • supervision at both ends • availability of spill kits on each vessel • vessel bunkering (via hose) to commence during daylight hours.
				12.5	A permit to work, job hazard analysis or equivalent process is implemented for bunkering.	A copy of the records that demonstrate a permit to work, job hazard analysis or equivalent process is implemented for bunkering.
Administrative and Procedural Controls	Project vessels equipped and crewed in accordance with Australian maritime requirements.	Yes	The project vessels within the Activity Area will adhere to the navigation safety requirements contained within the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), Chapter 5 of the International Convention for the Safety of Life at Sea 1974 (SOLAS Convention), International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), the Navigation Act 2012 (Cth)	1.2	Refer to EPS 1.2.	Refer to EPS 1.2.

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
			and any subsequent Marine Orders, which specify standards for crew training and competency, navigation, communication, and safety measures. Reduces the likelihood of vessel collision by operating the project vessels in accordance with industry standards and regulatory requirements, including minimum and working lighting for maritime safety.			
Administrative and Procedural Controls	Implement a vessel planned maintenance system.	Yes	Project vessels within the Activity Area are required to achieve 'Positive Vetting' in accordance with the requirements specified in the SEAM Standards – Transport Standard – Maritime Safety. A vessel planned maintenance system reduces risk of vessel collision and refuelling incidents because equipment is operating within planned maintenance requirements (such as DP systems).	9.5	Refer to EPS9.5	Refer to EPS9.5
Administrative and Procedural Controls	Manual of Permitted Operations (MOPO) to manage simultaneous operations (SIMOPs)	Yes	SIMOPs plans will be used during the implementation of the field activities to assist in the management of simultaneous operations. These are recognised tools used to support vessel activities, amongst other things, to prevent major accidents such as a major spill from a vessel collision. The MOPO describes what activities are allowable SIMOPS while the Field Management Plan describes its implementation and how marine SIMOPS are assessed and subsequently managed in the field via the Crux Field Coordinator.	12.7	Shell will manage vessel SIMOPs by developing and implementing the MOPO and field management plan, which will describe how marine SIMOPs are assessed and subsequently managed in the field via the Crux Field Coordinator to minimise the risk of vessel collision.	Crux Field Coordinator role in place where vessel SIMOPs risk exists in field MOPO developed Field Management Plan developed Records from Crux Field Coordinator demonstrate the MOPO and field management plan area implemented to manage vessel SIMOPs risks

Hierarchy of Controls	Control Measure	Adopted?	ALARP Discussion	EPS #	EPS	Measurement Criteria
Administrative and Procedural Controls	Shipboard Oil Pollution Emergency Plan (SOPEP) or equivalent (appropriate to class).	Yes	Refer to Table 9-74.	11.9	Refer to EPS 11.9	Refer to EPS 11.9
Administrative and Procedural Controls	For specific vessel-based campaigns, give advance notice to the AHO before the vessel arrives on location to enable a 'Notice to Mariners' to be issued before petroleum activities occur within the Activity Area.	Yes	Refer to Table 9-9.	1.1	Refer to EPS 1.1.	Refer to EPS 1.1
Administrative and Procedural Controls	Installed infrastructure locations provided to AHO for inclusion on nautical charts	Yes	Allows infrastructure to be marked on nautical charts so other marine users in the area are aware of its presence and can navigate to avoid interactions. Standard industry practice. The benefits outweigh the costs associated with implementing this control and are considered to reduce risks to an acceptable level.	1.3	Refer to EPS 1.3.	Refer to EPS 1.3.
Administrative and Procedural Controls	Accepted OPEP and OSMP.	Yes	Implements response plans to deal with an emergency event quickly and efficiently to reduce impacts to the marine environment.	N/A	N/A – refer to the NOPSEMA–accepted BROPEP (HSE_GEN_016765) and Browse Regional OSMP (HSE_PRE_016370) for the applicable EPS.	N/A
ALARP Demonstration Statement						
Based on the risk assessment outcomes and control measures adopted, Shell considers implementing the control measures appropriate to manage the potential risks and impacts associated with emergency events. No additional or alternative controls were identified that could further reduce the risks or impacts. Therefore, the impacts are considered to be reduced to ALARP.						

9.14.9 Acceptability of Risks

Table 9-84: Acceptability of Risks – Emergency Events

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	**Subcategory**				
Physical Environment	Water quality		No significant impacts to water quality.	Yes	Shell considers large-scale releases of hydrocarbons during the Activity to be unacceptable. Such spills have potential to result in significant environmental impacts. This has been reinforced through consultation with groups such as DAC and WGAC. Consequently, Shell will apply its considerable experience and knowledge in the offshore petroleum industry to ensure no such release occurs. Shell has applied a conservative approach to the identification and modelling of the credible worst-case hydrocarbon spills. This information was used to inform the evaluation of the environmental risks and is consistent with the precautionary principle. Shell will implement industry standard controls to manage the risk of emergency events (unplanned hydrocarbon spills). The Shell Browse Regional OPEP (HSE_GEN_016765) will support the Activity that is commensurate to the nature and scale of the hydrocarbon spill risks. For an assessment of acceptability and regard given to the Conservation Advice for the Dusky Sea Snake
	Sediment quality		No significant impacts to sediment quality.	Yes	
Biological Environment	Habitats and communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	
		Shoals and banks	No direct impacts to named banks and shoals. No loss of coral communities at named banks or shoals as a result of indirect/offsite impacts[34] associated with the Activity.	Yes	
		Offshore reefs and islands	No impacts to offshore reefs and islands.	Yes	
		WA and NT mainland coastlines	No impacts to WA and NT mainland coastline.	Yes	
	KEFs		No significant impacts to environmental values of KEFs.	Yes	
	Threatened and migratory species	Marine mammals Marine reptiles Birds Fish Sharks and rays	No mortality or injury of threatened MNES fauna. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna	Yes	
	Protected areas	Commonwealth Marine Area	No significant planned impacts to the Commonwealth marine area.	Yes	
		Marine parks	No impacts to the values of marine parks.	Yes	
		Wetlands of international and national importance	No impacts to the ecological values of wetlands of international and national importance.	Yes	
		World, Commonwealth or	No impacts to world heritage properties, Commonwealth heritage. places or national heritage places values.	Yes	

Receptor			Acceptable Level of Impact	Acceptable?	Acceptability Assessment
Category	Subcategory				
		National heritage listed places			(*Aipysurus fuscus*) see Table 9-85 below.
Socioeconomic Environment	Indigenous Cultural Features		No impacts to Indigenous cultural heritage features.	Yes	
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	
	Marine archaeology		No disturbance to historical shipwrecks, is acceptable.	Yes	
	Commercial fisheries		No negative impacts to targeted fish stocks resulting in demonstrated direct loss of income. Temporary displacement of commercial fishing activities within the Activity Area (excluding the PSZs) is acceptable.	Yes	
	Traditional fishing		No negative impacts to targeted fish stocks. Temporary displacement of traditional fishing activities within the Activity Area (excluding PSZs) is acceptable.	Yes	
	Tourism and recreation		No negative impacts to nature-based tourism resources resulting in demonstrated loss of income. Temporary displacement of tourism activities within the Activity Area (excluding PSZs) is acceptable.	Yes	
	Defence		Temporary displacement of defence activities within the Activity Area (excluding PSZs) is acceptable.	Yes	
	Ports and commercial shipping		Temporary displacement of commercial shipping within the Activity Area (excluding PSZs) is acceptable.	Yes	
	Indonesian coastlines		No impacts to Indonesian coastlines are acceptable.	Yes	
	Oil and gas industry		Temporary displacement of petroleum exploration activities and operations within the Activity Area (excluding PSZs) is acceptable.	Yes	

Table 9-85: Summary of Acceptability and Regard given to the Conservation Advice for Aipysurus fuscus (dusky sea snake) (DCCEEW 2024n)

Threat	Applicable Conservation Advice for *Aipysurus fuscus* (dusky sea snake)	Assessment of Acceptability and Regard given to Conservation Advice *Aipysurus fuscus* (dusky sea snake)
Fossil fuel exploration and extraction		
Oil Pollution	Use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake, including for development of the Torosa gas field and elsewhere across the Browse basin. This includes (but is not limited to) eliminating: • The risk of oil spill affecting the dusky sea snake and its habitat.	Shell follows scientifically informed spill response planning and associated regulations that enforce this. This is outlined within the BROPEP and Browse Regional OSMP. In regards to the listed impacts to dusky sea snakes, measures to reduce the risk and impact of oil spill to “ALARP” and “acceptable” are set out in Section 9.14 and 9.15 of this EP.
	Ensure there is an effective strategy and adequate local resources and knowledge in place to rapidly respond to a large unintentional oil spill from gas and oil projects in the Browse Basin.	Section 9.15 of the EP includes a detailed assessment of oil spill response strategies and spill impact mitigation assessment. Attachment 1 of the BROPEP (Basis of Design and Field Capability Assessment) includes a capability assessment for resource availability in the event of an emergency event oil spill. This includes an effective strategy and adequate local resources and knowledge in place to rapidly respond.
	Prioritise local storage of green dispersants – which are non-toxic, non-volatile, and naturally available or renewable – and local capacity for their use (Giwa et al. 2023).	Section 9.15 of the EP includes a detailed assessment of oil spill response strategies and spill impact mitigation assessment, including the use of chemical dispersants. Section 9.15.1 of the EP has been revised to consider the use of “green dispersants”. Note - in accordance with the National Plan for Maritime Environmental Emergencies (AMSA 2020), only those oil spill control agents, listed on the National Plan register of oil spill control agents can be employed to combat oil pollution incidents. To be accepted onto the register control agents meet efficacy, toxicity and biodegradability standards determined by AMSA. The dispersant selected for use, as listed within the EP is accepted for use under the National Plan register of oil spill control agents.
	Should an oil spill occur that may impact the known or likely distribution of the dusky sea snake: • Urgently use herding agents, bioremediation agents and mechanical means to contain and break down the oil. See Australian Maritime Safety Authority: oil spill control agents. • Urgently cap or otherwise isolate the source of the oil to prevent further contamination. • Immediately resource and mobilise multiple expert wildlife care teams to search for, and rehabilitate,	It is noted that not all response strategies are appropriate for application for every oil spill scenario. Given this, Shell utilises a Spill Impact Mitigation Assessment (SIMA) to consider the response strategies that may need to be implemented to provide the most effective response. The SIMA (both strategic and operational) takes into account the broad environmental context of the spill, including environmental values and sensitivities, and potential environmental outcomes for marine reptiles. The intent of the SIMA is to minimise the overall impact environmental impact of the spill (i.e. not just to minimise the impact to a single species). Measures to reduce the risk and impact of an oil spill to “ALARP” and “acceptable” are set out in Section 9.15 of the EP and the associated BROPEP; including consideration of a range of response strategies (such as dispersant application, source control and oiled wildlife response).

Threat	Applicable Conservation Advice for *Aipysurus fuscus* (dusky sea snake)	Assessment of Acceptability and Regard given to Conservation Advice *Aipysurus fuscus* (dusky sea snake)
	ill dusky sea snakes (and other threatened and priority taxa). Ensure there is sufficient expertise within the care team to assess the condition of sea snakes at sea for release or rehabilitation, effectively collect samples from live individuals for toxicology and pathology assessments, and safely collect and freeze deceased individuals for necropsy, pathology, and toxicology assessment.	Attachment 1 of the BROPEP (Basis of Design and Field Capability Assessment) includes a capability assessment for oiled wildlife response, including the provision of multiple trained oiled wildlife experts/advisors. The Browse Regional OSMP requires arrangements to be in place for suitably qualified personnel to implemented the Operational Monitoring Plan (OMP): Marine Fauna Assessment – Reptiles along with the Scientific Monitoring Plan (SMP) Marine Megafauna Reptiles, which both includes provision for the assessment of sea snakes to determine appropriate management and response actions during an oil spill event to minimise the potential impact to sea snakes. The OMP also includes provisions for necropsy and analytical testing of deceased sea snakes.
Conclusion of having had regard to the conservation Advice for Aipysurus fuscus (dusky sea snake)	The assessment of the conservation Advice for Aipysurus fuscus (dusky sea snake) shows that Shell has given regard to the applicable conservation advice in accordance with NOPSEMA and DECEEW requirements under the Streamlining Offshore Petroleum Environmental Approvals Program Report 2014[64].	

Principles of ESD

EPOs aligned with the principles of ESD and the precautionary principle have been adopted by putting in place extensive controls to prevent marine accidents. In the unlikely event of a spill, plans are in place to mitigate the impact and prevent serious or irreversible environmental damage.

Relevant Requirements

Managing the potential impacts and risks from emergency events is consistent with legislative requirements, including:

- compliance with international maritime conventions, including:
  - STCW Convention
  - SOLAS Convention
  - COLREGS
  - MARPOL: Annex I: prevention of pollution by oil and oily water.
- compliance with Australian legislation and requirements, including:
  - *Navigation Act 2012* (Cth) and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth):
    - Marine Order 21 (Safety of Navigation and Emergency Procedures)
    - Marine Order 27 (Radio Equipment)
    - Marine Order 30 (Prevention of Collisions)
    - Marine Order 71 (Masters and Deck Officers)
    - Marine Order 91 (Marine pollution prevention – oil).
  - OPGGS Act and OPGGS(E) Regulations:

[64] https://www.dcceew.gov.au/sites/default/files/env/pages/06872cd4-b755-4ecf-a4e7-dd16145e1384/files/offshore-program-report.pdf

  - accepted EP and OPEP for all petroleum activities associated with the Activity.

- implementation of recognised industry best practices, such as:
  - agreements in place with oil spill response service providers
  - development of SIMOPS plans.

Matters of National Environmental Significance

A worst-case hydrocarbon spill may have the potential to result in significant impacts for several MNES. Shell will put in place a range of measures during the Activity to ensure that spills of hydrocarbons that may have the potential to result in significant impacts to threatened and migratory species do not occur. Shell considers the residual risk to these MNES to be acceptable, after application of the key management controls proposed in this EP.

Marine Parks

Modelling results of the worst-case credible spill scenarios predicted that a range of Commonwealth (AMPs), state and territory marine parks may have the potential to be contacted above impact exposure thresholds.

Commonwealth Heritage Places

Although considered very unlikely, predictions from the stochastic spill modelling studies indicate hydrocarbons at low exposure thresholds may have the potential to contact the Ashmore Reef National Nature Reserve Commonwealth Heritage Place (<9% probability) and Scott Reef and Surrounds Commonwealth Heritage Place (~7% probability).

Threatened and Migratory Species

With controls in place, significant impacts (Table 8-1) to threatened and migratory species from a vessel spill are considered unlikely. Pollution from hydrocarbon spills is recognised as a threat in management plans, recovery plans and conservation advice for a number of threatened and migratory species.

Table 9-86 summarises the alignment of the Activity with these documents.

Wetlands of International and National Importance

Although considered very unlikely (due to the distance from the Activity Area), predictions from the stochastic spill modelling studies predict hydrocarbons above impact thresholds may have the potential to contact the Ramsar wetland at Ashmore Reef.

Commonwealth Marine Environment

The evaluation of impacts and risks indicates that significant impacts to the Commonwealth marine environment may have the potential to occur in the event of a significant hydrocarbon spill. Any widespread impacts to water quality could result in several marine species being affected.

Table 9-86: Summary of Alignment of the Risks from the Emergency Events with Relevant Requirements for EPBC Threatened Fauna

MNES	MNES Acceptability Considerations (Significant Impact Guidelines, EPBC Management Plans/RPs/CA)	Demonstration of Alignment as Relevant to the Activity
Marine Mammals	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	Shell has identified the potential for hydrocarbon pollution, and potential consequential habitat degradation, from an emergency event as a significant environmental risk. Shell has applied a range of controls that are intended to reduce the likelihood of such a release occurring, and mitigative controls to understand and
	Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* (CoA 2015a)	
	Approved Conservation Advice *Balaenoptera borealis* (sei whale) (DoE 2015c)	
	Conservation advice *Balaenoptera physalus* fin whale (TSSC 2015b)	
Marine Reptiles	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	

MNES	MNES Acceptability Considerations (Significant Impact Guidelines, EPBC Management Plans/RPs/CA)	Demonstration of Alignment as Relevant to the Activity
	Recovery plan for Marine Turtles in Australia 2017–2027 (CoA 2017b)	reduce the severity of potential impacts if such a release occurred. Large-scale emergency events pose a significant safety risk for Shell personnel. Control measures and considerable effort will be applied to the project design to reduce the likelihood of hydrocarbon releases occurring.
	Conservation advice on short-nosed sea snake (*Aipysurus apraefrontalis*) (TSSC 2010a) Conservation advice on leaf-scaled sea snake (*Aipysurus foliosquama*) (TSSC 2010b)	
	Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW 2024n) refer to	
Birds	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	
	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015a)	
	Wildlife Conservation Plan for Seabirds (CoA 2020a)	
	Conservation Advice for *Limnodromus semipalmatus* (Asian dowitcher) (DCCEEW 2024h)	
	Approved Conservation Advice on *Rostratula australis* (Australian Painted Snipe) (TSSC 2013)	
	Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW 2024g)	
	Conservation Advice for *Tringa nebularia* (common greenshank) (DCCEEW 2024k)	
	Conservation advice *Calidris ferruginea* curlew sandpiper (DCCEEW 2023f)	
	Conservation advice *Numenius madagascariensis* eastern curlew (DCCEEW 2023e)	
	Conservation advice *Calidris ferruginea* curlew sandpiper (2023f)	
	Conservation advice *Anous tenuirostris melanops* Australian lesser noddy (TSSC 2015e)	
	Conservation advice *Calidris canutus* red knot (DCCEEW 2024c)	
	Conservation advice *Calidris tenuirostris* great knot (DCCEEW 2024d)	
	Conservation Advice for *Phaethon rubricauda westralis* (Indian Ocean red-tailed tropicbird) (DCCEEW 2023j)	
	Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW 2024a)	
	Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW 2024b)	
	Conservation Advice for *Xenus cinereus* (terek sandpiper) (DCCEEW 2024k)	
	Conservation advice *Charadrius leschenaultii* greater sand plover (DCCEEW 2023g)	
	Conservation Advice *Phaethon lepturus fulvus* (white-tailed tropicbird, Christmas Island) (TSSC 2014d)	
	Conservation Advice *Charadrius mongolus* lesser sand plover (TSSC 2016d)	
	Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW 2024j)	

MNES	MNES Acceptability Considerations (Significant Impact Guidelines, EPBC Management Plans/RPs/CA)	Demonstration of Alignment as Relevant to the Activity
	Approved Conservation Advice for *Limosa lapponica menzbieri* (Yakutian bar-tailed godwit) (DCCEEW 2024f)	
	Conservation advice *Limosa lapponica baurei* (Alaskan bar-tailed godwit) (DCCEEW 2024e)	
Sharks and Rays	Significant impact guidelines for critically endangered, endangered, vulnerable and migratory species (Table 8-1)	
	Conservation advice *Rhincodon typus* whale shark (DoE 2015e)	
	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC 2013b)	
	Sawfish and river shark multispecies recovery plan (CoA 2015b)	
	Approved conservation advice for *Glyphis* (speartooth shark) (TSSC 2014c)	
	Approved conservation advice for *Pristis clavata* (dwarf sawfish) (TSSC 2009)	
	Approved conservation advice for *Pristis zijsron* (green sawfish) (TSSC 2008b)	
Commonwealth Marine Environment	Significant impact guidelines for Commonwealth marine environment (Table 8-1)	

External Context

To date, there are no unresolved objections or claims raised by relevant persons about emergency events. Shell's ongoing consultation program considers feedback and claims or objections made by relevant persons throughout the life of this EP. Where new impacts or risks are established these will be subject to the MOC process described in Section 10.1.3.

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Shell will continue to maintain an appropriate spill response framework, which includes regular testing of the response arrangements as per Section 10.8.

Acceptability Summary

Given the significant consequence of the risks associated with these worst-case hydrocarbon spills, Shell has undertaken an extensive, conservative risk assessment and will apply a range of controls consistent with relevant requirements and industry best practice.

As outlined above, the acceptability of the potential impacts and risks from unplanned spills associated with the Activity has been considered in the context of:

- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

Shell considers the risk of emergency events associated with the Activity to be ALARP and acceptable.

9.14.10 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
No emergency events[65] associated with the release of vessel fuel to the marine environment from the Activity.	Incident reports associated with spills to water which initiated the Emergency Response Team (ERT) and/or Incident Management Team (West) (IMT[W]).

[65] *Emergency events are incidents that result in the mobilisation of the Shell emergency response team.*

9.15 Oil Spill Response Strategies

9.15.1 Spill Impact Mitigation Assessment

As described in the Spill Impact Mitigation Assessment (SIMA) presented in the Browse Regional OPEP (HSE_GEN_016765) (the OPEP), not all response strategies apply for every spill scenario (Section 9.14.1) and a combination of response strategies may need to be implemented for an effective response.

For MDO releases, the success of various response strategies is considered to be limited based on the expected spreading, dispersion and evaporation rates in the marine environment making certain strategies, such as 'contain and recover' and 'surface dispersant application', ineffective. Whereas for IFO spills these strategies may be implemented as primary or secondary response strategies.

The available spill response strategies across multiple spill scenarios that are applicable to the Browse Region are assessed in the OPEP. An ALARP assessment of the oil spill response strategies that are applicable to the Activity are described in Table 9-87.

Capability, readiness and implementation requirements for the specific spill response strategies are addressed in the OPEP, which includes control measures and EPSs around the required level of performance of each response strategy, and hence are not repeated in this EP.

Table 9-87: ALARP Assessment of Oil Spill Response Capability

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
Monitor and Evaluate				
Modelling (oil spill trajectory, fate and weathering, metocean data, satellite imagery)	Processes: • AMOSC call-off procedure Equipment: • Automated Data Inquiry for Oil Spills (ADIOS2) on IMT(W) computers • In-house deterministic modelling Personnel: • Shell Geomatics team	Oil spill trajectory modelling can be commenced using AMOSC call-off contract with RPS group within 2 hours of IMT(W) being notified of the spill. The data would be used to inform IAPs and confirm the selection of other response strategies in the following days. Therefore, there is no environmental gain in improving the activation timeframe.	N/A	No alternative or additional controls were identified that could improve this response.
Surveillance – vessel	Processes: N/A Equipment: • Support vessels Personnel: • Trained vessel crew	Several support vessels will be present during the activity and can additionally be called to assist from Prelude. Shell has a access to marine vessel contractors to provide additional vessels for oil spill response activities if required. There is no environmental gain from providing additional vessels.	N/A	Increasing vessel surveillance capability is not considered to be warranted based on the limitations associated with visual observations made from a vessel platform. Aerial surveillance in conjunction with tracking buoy deployment is a more effective method of obtaining situational awareness. Vessel surveillance can be undertaken by using existing support vessels.
Surveillance – aerial	Processes: • Third-party call-off contract • Aerial surveillance observation log Equipment: N/A Personnel: • Trained aerial observers (AMOSC/ AMSA/Oil Spill Response Limited [OSRL])	Shell has third-party call-off contracts for helicopters and fixed-wing aircraft, which can be ready for mobilisation in 4-8 hours. Trained aerial observers are available within 24 hours.	Personnel trained in aerial observation could be on standby to provide higher quality data to the IMT(W). However, in the first 24 hours of the spill it is likely to cover a relatively small geographical area close to the release point. Therefore, initial untrained observations are considered to be adequate given the other data available to the IMT(W)	Untrained aerial observation opportunities exist via Shell crew change helicopters. This, in conjunction with tracking buoys and other monitor and evaluate data, is expected to provide sufficient information for the IMT(W) in the first 24 hours, until trained aerial observers are available.

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
			such as spill modelling, tracking buoy data etc.	
Tracking buoys	Processes: N/A Equipment: • Tracking buoys Personnel: • Trained vessel/FLNG crew for tracking buoy deployment	Tracking buoys are available for immediate deployment from various locations including the Prelude FLNG. No environmental benefits can be gained by increasing the number of buoys available or time to deploy.	Access to additional buoys is available from the shared stockpile located in Broome.	No alternative or additional controls were identified that could improve this response.
Surface Chemical Dispersant				
Vessel based dispersant	Processes: • Shell Surface Dispersant Application Guide Equipment: • 5 m^3 Dasic Slickgone and AFEDO spray set on each vessel at Prelude FLNG (3 vessels in field or en-route) Personnel: • vessel personnel trained in vessel application techniques	Based on the existing capability, Shell could commence vessel based dispersant application immediately subject to AMSA approval (where relevant). Additional supplies of dispersant can be obtained from stockpiles on the Australian mainland.	In accordance with the Conservation Advice for the dusky sea snake (DCCEEW 2024n) consideration has been given to the use of "green dispersants". Although not defined within the conservation advice dispersants are considered "green" if they are made from renewable sources, are non-volatile or are form naturally available solvents. However, in accordance with the National Plan (AMSA 2020), only those oil spill control agents, listed on the National Plan register of oil spill control agents can be employed to combat oil pollution incidents. To be accepted onto the register control agents meet efficacy, toxicity and biodegradability standards. The dispersant selected for use, Dasic Slickgone, is accepted for	In the event of a spill that was amenable, surface application of dispersant from vessels can be implemented immediately upon approval. In the event that additional stockpiles of dispersant are required they can be accessed from stockpiles in various locations across Australia.

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
			use under the National Plan register of oil spill control agents.	
Fixed Wing Aerial Dispersant (FWAD) application	Processes: • Shell Surface Dispersant Application Guide. • AMOSC/OSRL call-off procedure. Equipment: N/A Personnel: • Air attack supervisors and pilots.	Pre-positioning of aircraft and personnel (air attack supervisor) in particular could enable a faster response time resulting in quicker application of dispersant with more oil treated and hence an overall environmental benefit.	Additional costs associated with prepositioning aircraft and personnel are estimated to be in the order of 10s of thousands of dollars per day and are considered to be grossly disproportionate given the access to vessel-based dispersant application.	Shell has access to AMSA fixed wing aircraft wheels up in 4 hours and first implementation within 36 hours with supporting monitoring aircraft. Surface application of dispersant using vessels can be implemented much faster and therefore the costs associated with increasing FWAD capability are considered to be grossly disproportionate given the risk.
Contain and Recover				
Containment and recovery equipment (offshore boom and skimmer system)	Processes: • Shell Offshore Contain and Recover Guide Equipment: • FLNG support vessels • AMOSC stockpile (Broome) 400 m of offshore boom and skimmer system. • Waste storage capability Personnel: • AMOSC/AMSA/OSRL trained and experienced personnel.	Increasing a contain and recover response will results in the removal of more oil from the sea surface and therefore less will accumulate on shorelines resulting in less environmental impacts to shoreline receptors and less waste generation.	Additional dedicated vessels with offshore boom and skimmer systems would cost in the order of 10s of thousands of dollars per day and is not considered warranted given the availability of such equipment is not a limiting factor in the effectiveness of this strategy. The use of in-situ burning and supporting techniques such as herding agents is currently not established capability of personnel or equipment in Australia. Further, it is understood the fuel types in this EP are not suitable for its effective application either.	Shell has access to the AMOSC stockpile located at Broome (and other stockpiles elsewhere in Australia). The effectiveness of this response strategy is affected by sea state conditions and the thickness of oil at the sea surface; therefore it may only be applicable to an IFO spill. Maintaining booms and skimmers offshore is not practicable due to space limitations. The availability of contain and recover equipment is not a limiting factor and other response strategies could be implemented in faster timeframes (vessel-based dispersant) that would be more effective on IFO spills.

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
Shoreline Protection and Deflection				
Shoreline and nearshore booming equipment	Processes: • Browse Island Incident Management Guide (Browse Island IMG) Equipment: • AMOSC/OSRL specialised equipment Personnel: • AMOSC/OSRL trained and experienced personnel	Undertaking an improved shoreline protection and deflection response may reduce shoreline accumulation of oil thus reducing environmental impacts to shoreline receptors and waste generation. However, shorelines in the Browse Basin are difficult to access (remote, safety risks) and may not result in an overall environmental gain.	Access to additional booming equipment would cost thousands of dollars per day and is not considered warranted given the availability of such equipment is not a limiting factor in the effectiveness of this strategy.	Given the logistical and safety limitations with shoreline response in the Browse Basin, implementation of the response will take approximately one week to occur from the decision being made to commence (Note: This decision may be made by WA DoT as the control agency). Pre-positioning of booms may result in potential damage to sensitive locations and is not considered ALARP. Improving on this response is not considered to provide an environmental gain.
Shoreline Clean-up				
Shoreline Clean-up Assessment	Processes: • Shoreline Clean-Up Assessment Operational Monitoring Plan (OMP) • Browse Island IMG • Helicopter call-off contract Equipment: • Staging and accommodation facility Personnel: • AMOSC/OSRL trained and experienced personnel	Specialised shoreline assessment personnel can be deployed to remote shorelines from staging/accommodation facilities within 5–6 days. Undertaking quicker shoreline assessment would be beneficial to obtain pre-impact results; however, shorelines in the Browse Basin are difficult to access (remote, safety risks). Earlier deployment may not result in an overall environmental gain.	N/A	Shoreline surveys must be conducted systematically to be a crucial component of effective decision-making. Repeated surveys are needed to monitor the effectiveness and effects of ongoing treatment methods (i.e. changes in shoreline oiling conditions, as well as natural recovery). Improving the time for specialised personnel to access remote shorelines to make assessments is not warranted and will not result in an environmental gain. Note: The decision to commence this strategy may be made by WA DoT as the control agency.
Manual and mechanical removal (washing, flooding and flushing, sediment	Processes: Shoreline Clean-Up Assessment OMP • Browse Island IMG Equipment:	Predictive oil spill modelling indicates the largest volumes accumulating on shorelines is 7,777 g/m^2 of IFO at Bonaparte Archipelago, Kimberley PMZ and Kimberley Coast. Depending on the sensitivity of the shoreline	Costs for additional clean-up equipment are considered to be negligible and are not considered a limiting factor in the effectiveness of this strategy.	Shell has access to shoreline response kits. Given the logistical and safety limitations with shoreline response in the Browse Basin, implementation of the response will take approximately one week to occur from the decision being made to commence (Note: This decision may be made by WA DoT as the control agency).

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
reworking and surf washing)	• AMOSC/OSRL specialised equipment Personnel: • AMOSC/OSRL trained and experienced personnel	removal of accumulated oil using heavy machinery and/or large numbers of personnel may result in additional environmental damage. Access by heavy machinery would also be restricted at offshore islands.	Constraints are primarily in mobilising equipment and personnel safely rather than sourcing additional equipment.	Large-scale operations involving large numbers of personnel and/or heavy equipment may cause adverse environmental impacts at many of these sensitive shoreline locations and would not result in an environmental gain. Manual clean-up equipment, using smaller teams for longer periods would be more effective in most of the shoreline locations predicted to be contacted.
Oiled Wildlife Response				
Oiled wildlife response (OWR) implementation	Processes: • WA Oiled Wildlife Response Plan Equipment: • AMOSC OWR containers (2) and box kits • Australian National Plan for Maritime Environmental Emergencies OWR containers (4) • OSRL OWR equipment Personnel: • AMOSC/OSRL trained and experienced national and international OWR personnel	Given access to local OWR equipment and personnel (AMOSC) through existing arrangements, the response capability cannot be improved to result in an environmental gain unless an OWR kit is maintained offshore.	Any OWR will be undertaken in consultation with the relevant agencies e.g. WA DBCA, WA DoT and NT DEPWS. Such consultation is more likely to be a time limiting factor than accessing additional OWR resources.	Shell is a participating member of AMOSC with access to Mutual Aid arrangements. AMSA MoU and OSRL contracts give Shell access to national and international oiled wildlife expertise. The closest OWR container is in Fremantle and can be mobilised to Broome within 30 hours (by vessel). Additional containers and box kits are available from other locations within Australia (including Broome for the closest box kit). Maintaining a dedicated OWR kit offshore is not considered to be reasonable given the low likelihood of needing to implement an OWR and the requirement for trained OWR personnel.
Waste Management				
Waste management	Processes: • Oil Spill Waste Management Plan Template Equipment: • Assorted waste receptacles and trucks from waste contractor with additional stocks from subcontractors in	There are no limitations to obtaining the required waste storage capacity for this EP and no environmental benefit obtained by accessing additional waste storage capacity.	Costs for additional waste management resources are considered to be negligible.	Based on the Browse Regional OPEP, the volume of waste generated by the worst-case spill is up to 5,500 m^3. Decanting from contain and recover operations will also generate waste for disposal. Typically, this oily liquid waste would be held in the storage tanks of the support vessels and disposed of at an onshore facility.

Oil Spill Response Strategy	Resources	Environmental Gain from Increasing or Improving Resources	Alternatives considered	ALARP assessment
	Darwin, Broome and/or Dampier • Offshore storage in Darwin (635 m^3 capacity) Personnel: • Waste contractor personnel.			Based on Shell's waste contractor capability, the available resources are considered suitable for the worst-case spill scenario.

9.15.2 Aspect Context

This Section describes any new or unique environmental impacts or risks presented by implementing the emergency events response strategies included in the Browse Regional OPEP (HSE_GEN_016765), which may be enacted to respond to hydrocarbon and chemical spills as described in Section 9.14. If impacts and risks are adequately addressed in the preceding sections of this EP, as indicated in Table 9-88, they are not discussed further in this section.

Typically, environmental aspects, impacts and risks that arise from conducting the emergency response activities are similar to those already described in Sections 9.3 to 9.14 for the planned and unplanned activities, particularly for vessel-based operations. Where additional impacts or risks exist for the identified aspects, these are described in the following subsection. Table 9-88 summarises the aspects generated by implementing the spill response activities and identifies any that are new or unique aspects for further assessment.

Table 9-88: Spill Response Strategies and Associated Environmental Aspects Identified for Each (including those considered new or unique)

		Aspects Generated												
		Physical Presence	Lighting[2]	Noise	Seabed Disturbance	Disturbance to Ground[1]	Vessel Movements	Introduction of IMS	Discharges of Liquid Effluent	Planned Chemical Discharge[1]	Atmospheric Emissions	Greenhouse Gas Emissions	Waste Management	Emergency Events
Response Strategies	Monitor and Evaluate	✓		✓			✓	✓	✓		✓	✓	✓	✓
	Natural Recovery													
	Chemical Dispersant (Surface)	✓		✓				✓	✓	×	✓	✓	✓	✓
	Contain and Recover	✓		✓	✓			✓	×		✓	✓	✓	✓
	Protect and Deflect	✓		✓		×	✓	✓	✓		✓	✓	✓	✓
	Shoreline Clean-up		×			×			✓		✓	✓	✓	
	Oiled Wildlife Response	✓		✓				✓	✓		✓	✓	✓	✓
	Scientific/ Oil Spill Monitoring	✓		✓			✓	✓	✓		✓	✓	✓	✓

Notes:

✓ *The aspects and associated impacts and risks are already adequately addressed in this EP (Sections 9.3 to 9.13).*

× *There is an aspect of the response activity that may produce a new or unique impact/risk not already addressed in this EP.*

1 *New or different aspect not previously described in this EP*

2 *Due to daylight operations only for typical vessel-based activities, lighting impacts for stationary, non-operating vessels at sea during night will not present a credible impact to sensitive receptors.*

9.15.2.1 Chemical Dispersant (Surface) – Application

Dispersants are applied to hydrocarbon spills to enhance the breakdown of hydrocarbon droplets and enhance dispersion into the water column to:

- break up floating oil and reduce floating oil concentrations, thereby reducing the exposure of seabirds and surfacing marine fauna to hydrocarbons

- reduces the size of the entrapped oil droplets further aiding dispersion and enhancing biodegradation.

Dispersant application has the potential to increase in-water concentrations of hydrocarbons including soluble aromatic compounds and can result in a dispersant/oil mix in the water column. Although the elevated concentrations will generally be of short duration, impacts may occur on values and sensitivities in the water column (refer to Section 9.15.3.1).

9.15.2.2 Contain and Recover – Decanting Operations

Application of the Contain and Recover strategy is significantly limited by weather, logistics, and requires substantial temporary waste storage for recovered hydrocarbons. Recovered hydrocarbons will inevitably contain a large proportion of water in addition to recovered oil that may need to be decanted back to the sea to optimise the recovered oil fraction. Refer to the OPEP for further details.

9.15.2.3 Shoreline Clean-up and Protect and Deflect – Disturbance to Ground

Conducting shoreline protection and clean-up involves moving personnel and equipment, which includes the environmental aspect of ground disturbance. The objective of shoreline clean-up is to apply clean-up techniques that are appropriate to the shoreline type to remove as much oil as possible where there is a net environmental benefit in doing so. Various techniques may be used alone or in combination to clean up oiled shorelines, including shoreline clean-up assessment technique, natural recovery, absorbents, sediment reworking, manual and mechanical removal, and washing, flooding, and flushing. Considerations for selecting and implementing shoreline clean-up techniques are included in the OPEP.

Deploying booms to protect sensitive shoreline receptors, typically pre-emptively, introduces the potential for ground disturbance or damage to nearshore habitats such as intertidal reefs, mangroves, seagrasses and macroalgal communities that are present at offshore islands/shorelines, or along the WA and NT coastlines.

9.15.3 Description and Evaluation of Impacts

9.15.3.1 Surface Dispersant Application – Planned Chemical Discharges

Surface dispersant application has the potential to increase in-water concentrations of hydrocarbons, including soluble aromatic compounds. Associated environmental effects include an increase in the mass of entrained hydrocarbons with smaller droplet sizes affecting larger areas and increased bioavailability for marine organisms (e.g. fish, plankton, benthic invertebrates). The effects of entrained hydrocarbons on sensitive environmental receptors are discussed in Section 9.14.5. Although these elevated concentrations will generally be of short duration, impacts may occur on values and sensitivities in the water column. Particular values and sensitivities in the area that may be affected by the dispersant chemical, and oil/dispersant mix in the water column are described below.

9.15.3.1.1 Physical Environment

Water Quality

Environmental effects associated with dispersant application include a temporary reduction in water quality and exposure of marine biota to the inherent toxicity, biodegradability and bioaccumulation properties of dispersant chemical, which vary according to dispersant types. Additionally, dispersants combined with dispersed oil can increase the toxicity of spilled oil and this may affect sensitive receptors such as corals, seagrass, and macroalgae (Couillard et al. 2005).

Dispersant combined with hydrocarbons in the water column can be acutely toxic to marine biota (Couillard et al. 2005). The increase in toxicity results from the chemical dispersant making the hydrocarbons more readily bioavailable (ERM 2013, Fuller et al. 2009). The elevated concentrations will generally be of short duration; however, impacts may occur on sensitive values and sensitivities in the water column. (Magnitude: −2, Sensitivity: M).

Values and sensitivities that may be affected by the use of dispersants in the water column are described in the following sections.

9.15.3.1.2 Biological Environment

Benthic Communities

The Activity Area intersects dispersant application exclusion or restriction zones, as defined in the Section 4.5.5 of the OPEP. The closest sensitive reef (and potentially seagrass meadow) communities include around

Goeree Shoal (~8 km north north-west of the Activity Area in water depths of ~20 m), Eugene Mc Dermott Shoal (~8 km east south-east from the Activity Area in water depths of ~15 m), Vulcan Shoal (~17 km north north-west from the Activity Area in water depths of ~10 m), Heywood Shoal (~20 km east south-east from the Activity Area in water depths of ~15 m) and Browse Island (42 km south south-east from the Activity Area).

When the source of a spill is located within a dispersant exclusion zone, under certain environmental conditions and operational response circumstances, it may still be appropriate to use surface dispersants.

The extent of impacts from the use of dispersants will depend on the chemical dispersant type and dose rates, and external conditions (time of the year, weather and sea conditions, proximity of sensitive receptors and their life stage, etc.). These impacts will provide another consideration into the decision process on strategy selection (SIMA) and timing on a case-by-case basis at the time of the incident as described in the OPEP.

By design, the application of chemical dispersants will break up oil into smaller droplets so that they are dispersed, diluted and biodegraded more rapidly in the water column. As such, dispersant use increases the risk to benthic habitats primarily through increasing the concentration of bioavailable hydrocarbons in the water column and facilitates the dissolution of any soluble compounds (French-McCay and Payne 2001). In shallow water the temporarily increased concentrations of hydrocarbons within the water column may result in greater exposure of benthic habitat and sediments within the immediate response area. Most benthic habitats, including benthic fauna species have planktonic larval phases (e.g. corals, echinoderms, sponges etc.) and sessile filter feeders are at greater risk of toxicity from chemically dispersed hydrocarbons than untreated hydrocarbons, however the sensitivity range of most species is such that, except in the immediate area and only for a short period of time following the dispersant application, impacts are expected to be minimal.

Nearshore benthic communities are also impacted by the application of chemical dispersants on oil. Studies have shown that the effects of physical contact (smothering) on subtidal habitats by the oil/dispersant mix can cause sublethal stress and reduced growth rates in seagrass (Zieman et al. 1984, Peters et al. 1997) and are likely to cause a decline in metabolic rates and partial mortality in corals (Shigenaka 2001, Negri and Heyward 2000). Photosynthesis may also be impaired in symbiotic zooxanthellae along with impaired respiration rates (Peters 1981, Knap et al. 1985). Smothering of macroalgae can reduce or block diffusion of CO_2 across cell walls (O'Brien and Dixon 1976) resulting in mortality or partial mortality. Studies following the Deepwater Horizon incident showed long-term, non-acute effects of the spill on coral colonies up to seven years following the event (Girard and Fisher 2018).

A 25-year study documented by DeMicco et al. 2011 on the net environmental benefits of the use of dispersants on benthic communities including mangroves, seagrass and coral in a tropical environment observed mortality to invertebrate fauna, seagrass, and corals in the short term at both the dispersed oil and non-dispersed oil sites. In the long-term (10–25 years), as compared to the reference site, there was little to no oil detected and the ecosystem appeared to have returned to pre-dosing condition at the dispersed oil site. Although dispersant use resulted in short-term impacts, long-term disruption was not observed, and the area returned to pre-impact condition.

Therefore, residual impacts from the use of dispersants are expected to be low in nature and scale when assessed in isolation compared to the impact of the spill without dispersant application, and ranked as minor impact consequence (Magnitude: −2, Sensitivity: M).

Marine Fauna

Marine mammals may be exposed to dispersed oil within the water column externally (e.g. swimming through surface slick) or internally (direct ingestion or consumption of affected prey) (AMSA 2015, IPIECA 1995). The physical impacts from ingested hydrocarbons with subsequent lethal or sublethal impacts are applicable; however, the susceptibility of cetaceans varies with feeding habits. Baleen Whales are not particularly susceptible to ingestion of oil in the water column as they feed by skimming the surface (i.e. they are more susceptible to surface slicks). Toothed Whales and dolphins may be susceptible to ingestion of dissolved and entrained oil as they gulp feed at depth. As highly mobile species, in general it is not expected that these animals will be constantly exposed to concentrations of hydrocarbons in the water column for continuous durations (e.g. >48–96 hours) that would lead to chronic effects. Furthermore, Geraci and St. Aubin (1988) identified that several cetaceans are able to detect and avoid a variety of oils and therefore dispersed oil.

Fish, including sharks and rays, may be exposed to dispersed oil within the water column. Potential effects include damage to the liver and lining of the stomach and intestine, and toxic effects on embryos (Fodrie et al. 2014). Fish are most vulnerable to oil during embryonic, larval and juvenile life stages. However, very few studies have demonstrated increased mortality of fish as a result of oil spills (Fodrie et al. 2014, Hjermann et al. 2007, IPIECA 1999) and therefore dispersed oil.

Research on the toxic effects of oil/dispersant mixture on fish and crustacean larvae found that the median lethal concentration for total petroleum hydrocarbons was ~4.0 mg/L (4000 ppb), compared to hydrocarbons treated with chemical dispersants where it ranged from ~22 mg/L to 62 mg/L. For dispersant exposures alone, the median lethal concentration ranged from 17 mg/L to 50 mg/L (Couillard et al. 2005). The differences in the relative toxicity among the tests indicated that most petroleum hydrocarbons in the chemically enhanced test are in less acutely toxic forms than the components that dominate the untreated tests (Couillard et al. 2005).

Pelagic free-swimming fish and sharks are not expected to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons are typically insufficient to cause harm (ITOPF 2011). Pelagic species are also generally highly mobile and as such would not suffer extended exposure (e.g. >48–96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Fish that have been exposed to dissolved hydrocarbons can eliminate the toxicants once placed in clean water; hence, individuals exposed to a spill are expected to recover (King et al. 1996). Marine fauna with gill-based respiratory systems, including whale sharks, are expected to have higher sensitivity to exposures of entrained oil.

In any case, dispersant application as a response option will be strategically assess by the IMT including the development of a SIMA, which considers the net environmental benefit gained and will only be selected if the success of the response option outweighs environment impact.

If applied appropriately, dispersants can provide a net environmental benefit by limiting exposure of an oil spill to receptors of high environmental value. Chemical dispersant has been applied successfully for several large well control events, including Montara in 2009. As such, these practices are well understood within the industry. Elevated concentrations of dispersant are generally localised and of short duration, with dilution and dissipation being relatively rapid after application. Therefore, residual impacts from the use of dispersants are expected to be low in nature and scale when assessed in isolation compared to the impact of the spill without dispersant application, and ranked as minor impact consequence (Magnitude: −2, Sensitivity: M).

9.15.3.2 Decanting Operations/Contain and Recover – Discharge of Liquid Wastes

9.15.3.2.1 Physical Environment

Water Quality

In order to optimise recovery of floating hydrocarbon removed from the sea surface during Contain and Recover operations, it may be required to decant some of the oily water from temporary storage back into the ocean which may result in dissolved and entrained hydrocarbons being released back into the marine environment. This is not expected to lead to additional environmental impacts compared to the pre-application state of this strategy as the decanted water will be released at the spill site within already affected boomed areas and not elsewhere. Thus, no additional adverse environmental impacts are expected for water quality and marine biota and the residual impact consequence is assessed as nil (Magnitude 0, Sensitivity – L).

9.15.3.3 Shoreline Clean-up and Protect and Deflect– Disturbance to Ground and Lighting

9.15.3.3.1 Biological Environment

Disturbance to Intertidal Habitats and Marine Fauna

Conducting shoreline clean-up activities, including moving personnel and equipment, has the potential to cause damage to terrestrial and intertidal habitats, with subsequent impacts to dune/beach structure, flora such as mangroves and fauna such as turtles and birds (including nests). Invasive or frequent clean-up can also involve physical removal of substrates that could adversely impact habitats, fauna and alter coastal geomorphology and hydrodynamics. The impacts associated with undertaking shoreline clean-up may be more than if the product was left in place and remediated through natural processes (natural recovery). Leaving the product in place is a very common response option if continual human and vessel/vehicle traffic has the potential to generate greater impacts than the product itself. The optimal suite of response strategies will be determined through the SIMA process described in the OPEP.

The deployment of booms to protect shorelines and intertidal environments could potentially cause physical damage to coral reefs/intertidal ecosystems through the movement of the booms and/or anchors. A review of shoreline and shallow water habitats, and bathymetry, and the establishment of demarcated areas for access and anchoring will reduce impacts to nearshore environments.

9.15.3.4 Shoreline Clean-up and Protect and Deflect – Disturbance to Ground

Disturbance to Intertidal Habitats and Marine Fauna

Conducting shoreline clean-up activities, including moving personnel and equipment, has the potential to cause damage to terrestrial and intertidal habitats, with subsequent impacts to dune/beach structure, flora (e.g. mangroves) and fauna (e.g. turtles and birds [including nests]). Invasive or frequent clean-up can also involve physical removal of substrates that could adversely impact habitats and fauna and alter coastal geomorphology and hydrodynamics. The impacts associated with undertaking shoreline clean-up may be more than if the product was left in place and remediated through natural processes (Natural Recovery). Leaving the product in place is a very common response option if continual human and vessel/vehicle traffic has the potential to generate greater impacts than the product itself. The optimal suite of response strategies will be determined through the SIMA process described in the OPEP.

Deploying booms to protect shorelines and intertidal environments could potentially cause physical damage to coral reefs/intertidal ecosystems through boom and/or anchor movements. Reviewing shoreline and shallow-water habitats and bathymetry, and establishing demarcated areas for access and anchoring will reduce impacts to nearshore environments.

Shoreline clean-up and protect/deflect activities will be managed to minimise impacts on turtles (including hatchlings) and birds by minimising disturbance to nesting and feeding sites. Small boats or helicopters would be used to transfer oiled wildlife responders to shore, and they would be accommodated on nearby medium-sized vessels or facilities such as Prelude (if available). Assessing appropriate equipment and personnel numbers required to reduce habitat damage, along with establishing access routes/demarcation zones, and operational restrictions on equipment and personnel movements will limit sensitive habitat damage and damage to important fauna areas. Temporary camp areas will be established in consultation with WA DBCA, WA DoT and NT DEPWS and a Heritage Advisor if access is sought to culturally significant areas.

Given the controls in place and the short-term and localised incidental environmental effects from shoreline clean-up activities, there would only be minor residual impact consequences presented by personnel and equipment undertaking shoreline clean-up activities (Magnitude: −2, Sensitivity: M).

9.15.3.5 Shoreline Clean-up – Lighting

Threatened and Migratory Species

Marine Reptiles, Birds

Shoreline response activities may require use of lighting, which can cause disorientation and/or disruption to nesting and breeding behaviours in seabirds, shorebirds and turtles.

Shoreline clean-up and protect/deflect activities will be managed to minimise impacts on turtles (including hatchlings) and birds by minimising disturbance to nesting and feeding sites. The need to conduct night-time operations in sensitive areas will be assessed and operational restrictions established. It is considered unlikely that operations will be conducted at night because of the remote location of potentially impacted shorelines, using smaller teams to conduct response operations to reduce ecological impacts (see Section 12.3 of the OPEP) and the safety implications associated with dangerous marine fauna (e.g. saltwater crocodiles).

Given the controls in place and the short-term and localised incidental environmental effects from shoreline clean-up activities, there would only be minor residual impact consequences presented by personnel and equipment undertaking shoreline clean-up activities (Magnitude: −2, Sensitivity: M).

9.15.4 Impact Assessment Summary

Table 9-89 lists the highest residual impact consequence rankings of the relevant environmental receptor groups.

Table 9-89: Oil Spill Response Strategies Evaluation of Residual Impacts

Environmental Receptor	Magnitude	Sensitivity	Residual Impact Consequence
Physical Environment – water quality	−2	M	Minor
Biological Environment	−2	M	Minor
Socioeconomic and Cultural Environment[1]	0	L	No impact

1 *Potential impacts to socioeconomic and cultural environment receptors are not predicted to exceed those presented in Section 9.14 and therefore are not repeated in this section.*

9.15.5 ALARP Assessment and Environmental Performance Standards

Table 9-87 presents the ALARP assessment of oil spill response capability. A description of controls, EPSs and measurement criteria for each oil spill response strategy are presented in the OPEP.

9.15.6 Acceptability of Impacts

Table 9-90: Acceptability of Impacts – Oil Spill Response Strategies

Receptor			Acceptable Level of Impact	Acceptable?	Justification
Category	**Subcategory**				
Physical Environment	Water quality		No significant impacts to water quality.	Yes	No significant impacts are predicted from implementing spill responses strategies associated with a spill response as outlined in Section 9.15.3. Spills from decanting and the application of dispersant may result in a temporary reduction in water quality. The level of toxicity varies amongst the different dispersant types and can result in increased in-water concentrations of the toxic components of hydrocarbons. Dispersant combined with dispersed oil can be acutely toxic in the water column. Dispersant application has a limited window of opportunity, as the ability for the dispersants to break up the hydrocarbons typically decreases as the product weathers therefore surface application would only be considered as a secondary response option for an IFO spill in conjunction with the operational SIMA, Shell Surface Dispersant Application Guide and the necessary regulatory approvals. Residual impacts from the use of dispersants are expected to be low in nature and scale when assessed in isolation compared to the impact of the spill without dispersant application.
Biological Environment	Habitats and communities	Benthic communities	No significant impacts to benthic habitats and communities. Impacts to non-sensitive benthic communities limited to a maximum of 5% of the Project Area (as defined in the OPP).	Yes	Damage from protect and deflection equipment such as booms and anchors has a potential to damage intertidal habitats. The optimal suite of response strategies will be determined through the operational SIMA. No significant impacts are predicted from implementing spill response strategies associated with a spill response as outlined in Section 9.15.3.
		WA and NT mainland coastline	Limited environmental impacts to mainland coastline.	Yes	Damage from protection and deflection equipment (e.g. booms, anchors) has the potential to damage nearshore habitats along the WA and NT coastline. The optimal suite of response strategies will be determined through the operational SIMA and in consultation with the relevant agencies such as WA DBCA, WA DoT and NT DEPWS. As per Section 9.14.8, the risks of an emergency event have been reduced to ALARP and therefore are considered acceptable.

Receptor			Acceptable Level of Impact	Acceptable?	Justification
Category	**Subcategory**				
	Threatened and migratory species	Marine mammals Marine reptiles Birds Fish Sharks and rays	No mortality or injury of threatened MNES fauna. Management of aspects of the Activity must align with conservation advice, recovery plans and threat abatement plans (Table 7-14). No significant impacts to threatened or migratory fauna.	Yes	Moving personnel and equipment associated with shoreline clean-up activities has the potential to cause ground disturbance or lighting impacts, which may affect listed threatened or migratory MNES fauna populations and fauna such as nesting turtles and birds (including nests). The impacts associated with undertaking shoreline clean-up may be more than if the product was left in place and remediated through natural processes (natural recovery). Leaving the product in place is a very common response option if continual human and vessel/vehicle traffic has the potential to generate greater impacts than the product itself. The optimal suite of response strategies will be determined through the operational SIMA and in consultation with relevant agencies such as WA DBCA, WA DoT and NT DEPWAS. No significant impacts are predicted from implementing spill responses strategies associated with a spill response as outlined in Section 9.15.3.
Socioeconomic and Cultural Environment	Indigenous Cultural Features		No impacts to Indigenous cultural heritage features.	Yes	Shell will implement industry-standard controls to manage impacts from implementing oil spill response strategies required for unplanned hydrocarbon spills. An operational SIMA will be developed by the IMT(W) using real-time monitoring and evaluation data to select the optimal suite of response strategies. No significant impacts are predicted from implementing spill responses strategies associated with a spill response as outlined in Section 9.15.3.
	Indigenous Cultural Heritage Values		No significant impacts to Indigenous cultural heritage values.	Yes	
	Commercial fisheries		No negative impacts to targeted fish stocks resulting in demonstrated direct loss of income. Temporary displacement of commercial fishing activities within the Activity Area (excluding the PSZs) is acceptable.	Yes	
	Tourism and recreation		No negative impacts to nature-based tourism resources resulting in demonstrated loss of income. Temporary displacement of tourism activities within the Activity Area (excluding PSZs) is acceptable.	Yes	

New and/or unique environmental impacts associated with implementing the possible spill response strategies are considered to be acceptable if they present a net environmental benefit compared to the 'do nothing' option as determined and documented through the SIMA process (as described in the OPEP).

Assessing these impacts from the spill response strategies discussed above determined a residual ranking of Minor or lower (Table 9-89). The acceptability of these impacts has been considered in the following context.

Principles of ESD

The response option impacts described above are consistent with the principles of ESD because:

- The health, diversity and productivity of the marine environment will be optimised for future generations by minimising the impact of any large-scale spills by implementing the accepted OPEP and associated response strategies.
- The precautionary principle has been applied, and studies were undertaken where knowledge gaps were identified. This knowledge was applied when evaluating environmental impacts.
- With the prevention and mitigation controls in place, the conservation of biological diversity and ecological integrity will be optimised following a large-scale spill.

Relevant Requirements

Managing the impacts associated with implementing oil spill response strategies is consistent with relevant legislative requirements, including:

- The NOPSEMA–accepted Browse Regional OPEP (HSE_GEN_016765).

Matters of National Environmental Significance

Threatened and Migratory Species

Alignment with the relevant management plans, recovery plans and conservation advice for threatened and migratory fauna will be addressed on a case-by-case basis through the SIMA process when selecting appropriate spill response strategies (see Table 7-14 for the list of potentially applicable plans and advisory documents). These plans and advisory documents will help determine protection priorities once the nature, scale and trajectory of the spill is understood.

Commonwealth Marine Environment

The new and/or unique environmental impacts presented by dispersant application, decanting and/or shoreline clean-up on the Commonwealth marine environment when assessed in isolation from the spill event itself will not credibly exceed any of the significant impact criteri, as listed in Table 8-1.

External Context

To date, no objections or claims about oil spill response strategies have been raised by relevant persons. Shell's ongoing consultation program will consider statements and claims made by relevant persons when further assessing the risks (refer to Section 5.8).

Internal Context

Shell also considered the internal context, including Shell's environmental policy and ESHIA requirements. The EPOs and the controls that will be implemented for the Activity are consistent with the outcomes from consultation for the petroleum activity and Shell's internal requirements.

Acceptability Summary

As outlined above, the acceptability of the associated impacts have been considered in the context of:

- the established acceptability criteria
- ESD
- relevant requirements
- MNES
- external context (i.e. relevant persons claims)
- internal context (i.e. Shell requirements).

The potential residual impacts are deemed to be Minor, which Shell considers to be acceptable if they meet legislative and Shell requirements. The discussion above demonstrates that these requirements have been met in relation to the new and/or unique impacts associated with implementing the spill response strategies. Shell considers the potential residual impacts to be ALARP and acceptable.

9.15.7 Environment Performance Outcome

Environment Performance Outcome	Measurement Criteria
Select and implement spill response strategies to minimise the overall environmental impacts from a spill and the associated response strategies.	OPEP implementation records and SIMA records.

10 Implementation Strategy

Section 22 of the OPGGS(E) Regulations require an implementation strategy to be incorporated into the EP that includes:

- measures, systems and practices to ensure that environmental risks continue to be identified and reduced to a level that is ALARP, mitigating measures are effective, and environmental performance outcomes and standards are met
- chain of command
- measures to ensure workers are aware of their responsibilities
- monitoring and management
- records and reporting
- OPEP provided as a separate document with this EP submission
- ongoing consultation (See Section 5.8).

This section describes the implementation strategy (the management systems, standards and manuals) used to ensure emergency preparedness and environmental monitoring is applied to manage the risks and impacts of the project. These strategies will help achieve the EPOs and EPSs, as per the requirements under section 22(2) of the OPGGS(E) Regulations.

10.1 Management Systems

Shell's HSSE & SP-MS provides a structured and documented framework for effectively managing HSSE & SP risks and will govern the Activity. The HSSE & SP-MS demonstrates how the requirements of the Shell Group's SEAM Standards are effectively implemented and provides a clear guide for achieving the HSSE & SP objectives and requirements listed in Section 4.3.

The HSSE & SP-MS is subject to a continuous improvement cycle based on the 'plan, do, check, review' loop, with the elements as outlined in Table 10-1. There are numerous, specific ongoing (typically annual) assurance activities against each of the elements in this HSSE & SP-MS Manual. The audit and review function of the HSSE & SP-MS seeks to ensure that the system is being implemented, the requirements are effective in for implementation of the Environment Policy (Section 4.2) to achieve the EPOs and to identify areas for improvement. The detailed assurance activities that will be undertaken both prior to mobilisation and during execution of installation or cold commissioning activities, are further detailed in Section 10.4.

Shell's HSSE & SP-MS covers all its operations, including the Crux Project. Shell implements specific pre- and post-contract award processes and activities aimed at ensuring that contracts consistently and effectively manage HSSE & SP risks for contracted activities.

Contractor HSSE & SP management is governed by Shell Group SEAM Standards. As a minimum, Shell will assess all relevant field-active contractors' HSSE & SP-MSs to ensure they meet the materially equivalent outcomes of Shell's HSSE & SP-MS for mode 2 scopes. Mode 3 scopes will operate under contractors HSSE management system. Vessel contractors will use their own vessel/facility HSSE-MSs to manage work scopes on their vessel for offshore activities not covered by Shell's HSSE & SP-MS.

Table 10-1: HSSE & SP-MS Elements Implementation and Improvement

Management System Element	Implementation and Improvement
Leadership and Commitment *Creating and sustaining a culture that drives Shell's commitment of no harm to people or the environment*	Seek ongoing feedback on how others perceive HSSE & SP leadership (performance reviews, HSE Culture Survey [Shell People Survey], 360 feedback).
Policy and Objectives *Supporting the implementation of Shell HSSE & SP Commitment and policy*	Set annual HSSE & SP targets to drive continuous performance. Annually Review and approve HSSE & SP objectives
Organization, Responsibilities and Resources	When there are changes in the Business or organization, identify the positions that require Competence assurance. HSSE & SP Critical Position Register, Shell People Competency Profiles.

Management System Element	Implementation and Improvement
Establishing and maintaining an organization that enables the compliance with the Shell Group SEAM Standards	
Risk Management *Identifying the HSSE & SP hazards and establishing the controls to reduce the risks to ALARP*	Ongoing review of Hazards and Risks occurs where changes are identified during routine assurance activities (Section 10.4.3 and Section 10.4.4); as a result of incidents (Section 10.5); and/or through the Management of change process (Section 10.1.5). Regular review of Risk Registers occurs through the contractor management processes (Section 10.1.1).
Planning and Procedures *To integrate the requirements of the SEAM Standards into business plan and procedures: Emergency & Crisis Response, Spill Preparedness and Response, MOC, PTW*	Establish and maintain a programme of testing of Emergency Response plans and procedures at least once a year or more frequently based on the level of risk. Shell Australia Emergency Response Plan (ERP), Records of Emergency Response (ER) drills, exercises and After Action Reviews (AARs).
Implementation, Monitoring and Reporting *Implement the HSSE & SP requirements embedded in plans and procedures and take corrective action when necessary*	Report all Incidents, including Near Misses, to the Supervisor of the work activity. Learn from Significant Incidents and High Potential Incidents through communication and implementation of required actions.
Assurance *Providing assurance that the Shell Group SEAM Standard requirements are implemented and effective*	Establish, maintain and execute HSSE & SP Self-Assessments in support of the Business HSSE & SP Assurance Plan, self-assessment, CF Gap Analysis, HSSE & SP Management Review. Management Review (documents demonstrating how Shell Australia reviews the effectiveness, adequacy and fitness for purpose of the HSSE & SP Management System and take action to improve) Review the HSSE & SP Management System and its individual elements at least once a year and document the results.
Management Review *Reviewing the effectiveness, adequacy and fitness for purpose of the HSSE & SP MS and taking actions for improvement*	Assess the Effectiveness and Adequacy of the management system in delivering the policy and Objectives and in driving continual improvement.

10.1.1 Contractor Management

Contractors and their subcontractors carry out numerous activities on behalf of Shell. Effectively managing environment, integrity, health and safety risks in contracts involves Shell setting clear expectations and managing these risks throughout the contract lifecycle.

Shell implements specific processes and activities aimed at ensuring that contracts consistently and effectively manage HSSE & SP risks for the contracted activities. These processes are detailed in the HSSE & SP Contractor Management Strategy Manual. The contractor management processes implemented for the Crux Project are consistent with the requirements of Shell's SEAM Standards Contractor HSSE Management Requirements.

Key aspects of contractor HSSE management include:

- Pre-contract award activities:
  - Appoint a competent contract owner and contract holder for each contract.
  - Determine the Contract HSSE & SP risk by assessing the risk associated with the contracted activities.
  - Determine the contract mode.
  - For a high risk HSSE contractor, the contractor is to develop and provide a Contract HSSE Plan. All contractors operating offshore are considered high risk and therefore are required to implement this requirement.

  - Assess whether the contractor has the capability and resources to manage the risks associated with the contracted activities.
  - Before awarding the contract, confirm that the contractor meets the requirements. Focus on closing gaps in the draft contract HSSE & SP Plan submitted by the contractor.
  - Define the level of company monitoring based on the capability of the contractor, the contract HSSE & SP risk and the contract mode.
- Post-contract award activities:
  - Require the contractor to demonstrate that their personnel who are responsible for managing the HSSE risks of the contracted activity understand the HSSE requirements of the contract and any associated Contract HSSE Plan related to their role.
  - Require the contractor to demonstrate that all its personnel will receive an induction on the HSSE risks of the contracted activities including the controls to manage those risks specified in the contract and any associated Contract HSSE Plan.
  - Prior to mobilisation, require the contractor to undertake Hazard Identification (HAZID) workshops, to review and assess the HSSE hazards and risks associated with the contracted activities. This is also required to be revised where outcomes of MOCs require this to occur.
  - Verify that the HSSE requirements of the contract and any associated Contract HSSE Plan are being implemented and are effective at managing the HSSE risk of the contract. Where necessary, implement actions for improvement.
  - Regularly assess the HSSE performance of the contractor, including its management of subcontractors.

10.1.2 Contractor Competency Requirements and Assurance

The contractor is responsible for ensuring that all their personnel have the appropriate level of competence required to carry out the work safely and effectively. The contractor is also responsible for developing and implementing a competence assurance plan. The contract holder is responsible for ensuring that the contractor's competence assurance system is reviewed, is robust and meets Shell's requirements.

In addition to trade competencies and qualification requirements, the minimum competence requirements for key contractors working on Crux are based on the contractor's work scope and are developed in consultation between Shell and the contractor. The minimum requirements for a contractor going offshore on the Crux Project include:

- facility induction (e.g. life saving rules, emergency response and muster procedures, incident reporting, waste management, oil spill awareness)
- role-specific training (e.g. PTW, operating procedures of specific process units).

10.1.3 Manage Asset Care

The manage asset care is in accordance with the ECE Performance Standards and the Shell Group SEAM Standards. Implementation of these standards ensures that Crux is in a position for the facility to operate in a safe and environmentally responsible manner and realise the benefits of a proven maintenance execution process that is of a global standard. The standards cover excellence in maintenance execution which transcribes to 'the right job, by the right person at the right time'; i.e. jobs and processes that are approved, scoped, performed with the right competency and attitude, scheduled to be performed at a time that reflects the needs and risk of the business and that asset.

The manage asset care standards are designed to ensure the safe and reliable operation of assets, minimising risks and maximising performance. The key steps in this process are outlined below, in following these Shell aims to reduce the risk to the environment whilst improving overall operating safety:

- Asset register for all equipment in scope of the manage asset care scope work process.
- Inspection and assessment:
  - regular inspections are conducted to assess asset condition
  - non-destructive testing techniques are used to identify defects

  - risk-based inspection studies prioritise critical areas.
- Risk management:
  - based on inspection results, risks are evaluated
  - high-risk areas receive immediate attention
  - mitigation strategies are developed.
- Maintenance planning:
  - maintenance schedules are created based on asset criticality
  - preventive maintenance tasks are defined
  - corrective maintenance addresses identified issues.
- Materials and spare parts management:
  - inventory control ensures availability of critical spare parts
  - material specifications and quality control are crucial
  - efficient procurement processes are maintained.
- Work execution:
  - skilled technicians execute maintenance tasks in line with EPS standards
  - compliance with safety procedures is paramount
  - documentation of work performed is essential.
- Integrity assurance:
  - asset integrity management plans are implemented
  - corrosion control, cathodic protection, and coatings are monitored
  - fitness-for-service assessments guide decisions.
- Continuous improvement:
  - performance metrics are tracked
  - lessons learned drive process enhancements
  - collaboration with other disciplines ensures holistic integrity.

Effective manage asset care execution contributes to the longevity, reliability and environmental safety and performance of Shell's assets.

10.1.4 Crux Decommissioning

Decommissioning involves the timely, safe, and environmentally responsible removal of, or otherwise satisfactorily dealing with Crux Project infrastructure. This process aligned to the key principles for decommissioning, as outlined in the Offshore Petroleum Decommissioning Guideline (DISER 2022) and the Decommissioning Compliance Strategy 2024–2029 (NOPSEMA 2023a), which include:

- Decommissioning is the responsibility of titleholders.
- Early planning for decommissioning to occur as part of the design and concept selection.
- Removal of all property is the "base case" and is consistent with Australia's international obligations, primarily under the United Nations Convention on the Law of the Sea (UNCLOS) and the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972, (the London Protocol). Other decommissioning options may be considered but must comply with the OPGGS Act and its regulations, including the principles of ESD.
- Decommissioning must be completed before the end of title to ensure that all decommissioning activities are conducted under the OPGGS Act and regulations framework.

The Crux Project decommissioning planning commenced in the project development phase and will continue throughout the life of operations, including IMR activities, consideration of late-life asset management, cessation of production, removal of property, plug and abandonment of wells, and finally, title relinquishment. This assists with compliance with section 270, section 572(2) and section 572(3) of the OPGGS Act, which require titleholders to remove property when it is neither used, nor to be used, in connection with the operations or other arrangements that are satisfactory to NOPSEMA in relation to the property. Section 10.4.2 outlines the process to use pre-operations baseline and future environmental data to inform the impact assessment throughout the Crux Project operations and decommissioning phases to enable the eventual title relinquishment process as per section 270 of the OPGGS Act.

Table 10-2 outlines the decommissioning considerations for each of the proposed key property (infrastructure, structures and equipment) to be installed under this EP. These considerations include infrastructure specifications (composition, weight and dimensions), monitoring and maintenance requirements and decommissioning considerations. Following installation, this list will be updated for accuracy (including accurate locations) and uploaded into an asset register—using the manage asset care works process (refer to Section 10.1.3)—to manage future IMR activities and satisfy the decommissioning and removal obligations.

Subsection 572(2) provides that while property remains in the title area and are used in connection with the operations authorised by this EP, they must be maintained in good condition and repair. The Crux philosophy for IMR is to inspect and maintain the installed property portfolio such that its mechanical condition remains fit for the purposes specified in its original design requirements. These include but are not limited to integrity, availability, service life, and abandonment requirements. The IMR activities are described in Section 6.13. The manage asset care work process during the operate phase will be implemented under the future Crux Completions, Hot Commissioning, Start-up and Operations EP/s.

Shell's commitment to decommissioning planning and execution is described within Section 5.6.6 of the Crux OPP. Shell refers to this description as information previously given under section 56(1) of the OPGGS(E) Regulations. The decommissioning design provisions for all property installed above the mudline are intended to provide a number of technically feasible decommissioning and removal options (refer to Table 10-2). For all property installed above the mudline, this includes design provisions to allow full removal and onshore disposal of the equipment. Temporary structures, equipment and infrastructure that are no longer in use for this EP will be removed under this EP. Section 572(7) and section 270(3) of the OPGGS Act provide for alternative decommissioning options to full removal (such as leave in situ) where it can be demonstrated that the activity can comply with all other legislative requirements and that the potential risks and impacts are reduced to ALARP and acceptable level.

The future Crux decommissioning EP (to be developed) will meet the requirements of the OPGGS Act and OPGGS(E) Regulations, and any additional relevant legislation, policies (such as NOPSEMA's Policy: Section 572 Maintenance and removal of property [NOPSEMA 2022d]) and guidelines (such as the Offshore Petroleum Decommissioning Guideline [DISER 2022]) in force at the time. Decommissioning options will be assessed before the end of project life as per relevant legislative requirements. These decommissioning options will be evaluated to demonstrate that environmental impacts and risks are acceptable and ALARP during the Crux Decommissioning EP process. It is widely acknowledged that various factors that may affect titleholders' consideration of the most suitable decommissioning option, including site-specific environmental and safety risks, type of infrastructure, costs, and available technology/technical feasibility. An ALARP and acceptability assessment of the decommissioning options proposed for the project will provide transparency in decision making where environmental benefits and impacts are clearly presented in the context of a broader framework of decision criteria. The decommissioning and removal of any property from within the title area at the end-of-life will be undertaken pursuant to a future NOPSEMA–accepted Crux decommissioning EP, subject to ensuring that such activities do not cause unacceptable environmental impacts. Table 10-2 below outlines Shell's infrastructure being installed and confirmation that all equipment is designed to be able to be fully removed as the base case for anything at or above the mudline.

After the successful completion of decommissioning activities, Shell will apply to surrender the Crux production and infrastructure licences. Once satisfied that Shell has complied with all requirements for the surrender of these licences, the Designated Authority can consent to the surrender of the licences. It is anticipated that decommissioning and surrender of the licences, from approval of the Crux decommissioning EP through to the Designated Authority's consent to the surrender of the licences, will take about 12 months.

Table 10-2: Indicative Asset Specifications, Monitoring, Maintenance and Decommissioning Considerations

Asset	Description	Indicative Specifications			Temporary, Long–term or Permanent	Indicative Monitoring & Maintenance (Outside the Scope of this EP)	Decommissioning Considerations		Removed under this EP?
		Approximate Dimensions	Weight (~MT)	Typical Materials			Recoverable?	Possible Recovery Methods	
Export pipeline	Crux export pipeline located the Crux- and Prelude-end PLETs.	Length ~155 km 26" OD × 22.2/19.1 mm wall thickness (WT)	Steel: 48,000 Concrete: 53,000	Carbon steel pipe, 40-50 mm thick concrete weight coating and asphalt enamel coating. Sacrificial anodes spaced along the pipeline.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability. Check general condition, free spans, scour, marine growth, cathodic protection readings, coating damage, mechanical damage, field joint damage, leaks and other anomalies.	Yes	Inventory flushed to remove hydrocarbons and contaminants. Water jetting of sediment, if required. Disconnect and recover: • Via reversed installation method to pipelay vessel. Pipeline cut into shorter lengths on vessel before transported to shore for disposal. • Alternative option is to cut pipeline on seabed to manageable section before lifting via crane to vessel and transport to shore for disposal.	No
Fibre-optic jumper	Fibre-optic jumper Connection between Crux-end PLET and FOCT.	Length ~170 m	0.17	Various.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability.	Yes	Recover onto a vessel via crane after disconnection from CTA and PLET.	No
Static umbilical including UTH	Umbilical located within J-Tube of Crux topsides. Contains fibre-optic, hydraulic and electrical lines for SSIV control and fibre-optic connection from shore to Crux topsides. Subsea connection from the Crux-end PLET to the Crux-end UTH. Crux-end EFL/SFL connect the UTH to Crux PLET SSIV.	Length ~360 m Width 114.8 mm OD	15	Superduplex, various.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability of the umbilical length on seabed, cobra head and J-tube including J-tube cover. Check general condition, damage, marine growth and other anomalies.	Yes	Installation method reversed, disconnect and cap umbilical ends. Recover by lifting via vessel crane.	No
Crux-end PLET	Crux-end PLET comprising 26" SSIV.	Length ~12 m Width ~7.3 m Height ~6.2 m	80	Steel.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability. Check general condition, marine growth, CP reading, coating damage, leaks and other anomalies.	Yes	Structure internally flushed to remove hydrocarbons and other contaminants. Disconnect and recover: • Via reversed installation method to pipelay vessel. Pipeline cut into shorter lengths on vessel before transported to shore for disposal. • Alternative option is to cut pipeline on seabed to manageable section before lifting via crane to vessel and transport to shore for disposal.	No
Crux-end PLET foundation	Structure supports the Crux-end PLET and provides for export pipeline movement. Contains MQC panel for static umbilical interface.	Length ~20 m Width ~13.2 m Height ~2.85 m (top of MQC panel)	70	Steel.	Long–term (20 years design life).	Risk based visual inspections to monitor and maintain system integrity and operability. Check for general condition, settlement, inclination, scouring, CP reading and other anomalies.	Yes	Recover onto a vessel via crane.	No
Prelude-end PLET	Prelude-end PLET comprising 18" SSIV.	Length ~12 m Width ~7.3 m Height ~6.2 m	78	Steel.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care.	Yes	Structure internally flushed to remove hydrocarbons and other contaminants. Disconnect and recover:	No

Asset	Description	Indicative Specifications			Temporary, Long–term or Permanent	Indicative Monitoring & Maintenance (Outside the Scope of this EP)	Decommissioning Considerations		Removed under this EP?
		Approximate Dimensions	Weight (~MT)	Typical Materials			Recoverable?	Possible Recovery Methods	
						Risk based visual inspections to monitor and maintain system integrity and operability. Check general condition, marine growth, CP reading, coating damage, leaks and other anomalies.		• Via reversed installation method to pipelay vessel. Pipeline cut into shorter lengths on vessel before transported to shore for disposal. • Alternative option is to cut pipeline on seabed to manageable section before lifting via crane to vessel and transport to shore for disposal.	
Prelude-end PLET foundation	Structure to support Prelude-end PLET and provides for export pipeline movement.	Length ~20 m Width ~13.5 m Height ~2.85 m (top of MQC panel)	72	Steel.	Long–term (20 years design life).	Risk based visual inspections to monitor and maintain system integrity and operability. Check for general condition, settlement, inclination, scouring, CP reading and other anomalies.	Yes	Recover onto a vessel via crane.	No
Subsea tie-in spool	Subsea spool connecting the rigid riser to Crux-end PLET.	Length ~50 m 26" OD 2 × ~23 m	55	CRA clad carbon steel with a three-layer polypropylene coating.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability. Check for general condition, coating and field joint coating damage, settlement, scouring and other anomalies.	Yes	Inventory flushed removing hydrocarbons and other contaminants. Disconnect from the rigid riser and Crux-end PLET. Spool may need to be cut into shorter lengths to assist recovering. Recover onto a vessel via crane.	No
Rigid riser	Pre-installed riser located within Crux topsides.	Length ~200 m (linear) Width 26" OD, 25.4 mm CS +3 mm CRA clad WT.	120	CRA clad carbon steel with a three-layer polypropylene coating.	Long–term (20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain system integrity and operability including air, splash zone and submerged sections of the riser and the riser guides/clamps. Check for general condition, coating, field joint damage and other anomalies.	Yes	Inventory flushed to remove hydrocarbons and contaminants. Riser in the air section is to be cut and removed with topsides. Riser in the submerged sections to be recovered with the substructure.	No
EFLs	Subsea cables between static or dynamic umbilicals for power and signals to and from SSIV actuator instrumentations.	~20 m	0.1	Various.	Long–term	Maintenance undertaken in accordance with manage asset care. Periodic power and communication signal testing on the Prelude and Crux Topsides.	Yes	Recover with ROV intervention onto a vessel.	No
SFL	Subsea hydraulic tubes between static or dynamic umbilicals for hydraulic pressure supply to SSIV actuator to operate SSIV.	~25 m	0.067	Various.	Long–term	Maintenance undertaken in accordance with a planned maintenance schedule. Periodic testing of the hydraulic supply pressure on the Crux and Prelude Topsides.	Yes	Recover with ROV intervention onto a vessel.	No
Flexible riser	16" ID Flexible pipe connecting Prelude-end PLET to the Prelude FLNG. 19 Buoyancy units will be fitted to the flexible.	Length ~970 m, 528.84 mm OD	Flexible: 320 Buoyancy: 1.4 ea.	Flexible - Duplex, CS, various. Buoyancy - syntactic foam with a polyurethane shell.	Long–term	Maintenance undertaken in accordance with manage asset care. Periodic testing of the annulus vent flowrate via vent gas	Yes	Inventory flushed to remove hydrocarbons and contaminants.	No

Asset	Description	Indicative Specifications			Temporary, Long–term or Permanent	Indicative Monitoring & Maintenance (Outside the Scope of this EP)	Decommissioning Considerations		Removed under this EP?
		Approximate Dimensions	Weight (~MT)	Typical Materials			Recoverable?	Possible Recovery Methods	
		Buoyancy units: Width ~1.8 m Length ~1.6 m				monitoring system. Polymer coupon on the Prelude Topsides.		Disconnect from Prelude-end PLET/spool and Prelude FLNG. Recover onto a vessel. Buoyancy units on the flexible riser to be recovered onto a vessel.	
Dynamic umbilical, including UTH	Umbilical for SSIV controls with hydraulic tubes and electrical cables for between Prelude-end PLET foundation and Prelude FLNG. 21 Buoyancy units will be fitted to the umbilical, if required. 1 UTH.	Umbilical: Length ~1,100 m, Width 138.7 mm OD Buoyancy units: Width ~0.5 m Length ~0.5 m UTH: ~1.35 × 1.2 × 1.1 m	Umbilical: 65 Buoyancy: 0.1 ea.	Umbilical - Superduplex, various. Buoyancy - syntactic foam with a polyurethane shell.	Long–term	Maintenance undertaken in accordance with manage asset care. Periodic hydraulic supply pressure testing on Prelude Topsides.	Yes	Disconnect from Crux-end PLET, spool and Prelude FLNG. Buoyancy units on the flexible riser to be recovered onto a vessel.	No
Initiation anchor/structure	Suction pile with padeyes used for export pipeline initiation/installation start up.	Diameter ~10 m Height ~7 m	120	Carbon steel.	Temporary	Monitoring and maintenance not required. Anodes installed on initiation pile to mitigate corrosion.	Yes	Hatch on pile is opened to assist retrieval, then water or air is pumped into the suction pile cavity. Recover onto a vessel via crane.	Yes
Scour protection, span rectification, foundations	Mattresses, skirts, mudmats and grout bags may use scour protection, span rectification, foundations (e.g. spool) may use.	Typically ~6 m × ~3 m × ~0.3 m to ~1 m × ~1 m × ~1 m	3–5 ea.	Concrete mattresses are usually concrete blocks with polypropylene ropes. Grout bags are typically made of flexible material, such as woven polypropylene, and are filled with granular material like sand, which is stabilised with a binder (e.g. cement) or with rock without a binding material.	Long–term	Risk based visual inspections only.	Yes	Recover onto a vessel via crane, with ROV support. Use of ROV basket to assist if required.	No
Insert piles	12 (plus two contingency) insert piles.	Length ~64 m (per section) Width ~2.9 m OD with a 70 mm WT	313	Steel. Inert grout (refer to Section 9.10.1.3 for composition).	Permanent	N/A	No	Removing this equipment is considered not technically feasible due to its weight, size, depth below the mudline, and associated safety and risk considerations.	No
Primary piles	16 primary piles.	Length ~147 m Width ~3.5 m OD with a 60 mm WT	812	Steel. Inert grout (refer to Section 9.10.1.3 for composition)	Permanent	N/A	No	Removing this equipment is considered not technically feasible due to its weight, size, depth below the mudline, and associated safety and risk considerations.	No
Substructure	One fixed steel lattice-type jacket with pre-installed 26″ rigid riser.	Height ~190 m	28,000	Steel.	Long–term (>20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based visual inspections to monitor and maintain the integrity.	Yes	Substructure is decommissioned by cut-off at mudline to enable recovery. Alternatives that will be evaluated include complete or partial removal for onshore recycling or disposal.	No
Topsides	Refer to Section 6.7 for a high level description.	Length ~106 m (excluding helideck overhang) Width ~45 m Height ~32 m (Main deck)	11,700	Steel/Various.	Long–term (>20 years design life).	Maintenance undertaken in accordance with manage asset care. Risk based monitoring, inspections and testing to monitor and maintain system integrity and operability.	Yes	Inventory flushed to remove hydrocarbons and contaminants. Disconnect from structure. Removal of topsides processing and utilities equipment for onshore recycling or disposal. Alternatives will also be evaluated.	No

Asset	Description	Indicative Specifications			Temporary, Long–term or Permanent	Indicative Monitoring & Maintenance (Outside the Scope of this EP)	Decommissioning Considerations		Removed under this EP?
		Approximate Dimensions	Weight (~MT)	Typical Materials			Recoverable?	Possible Recovery Methods	
Well-tie-back and upper completions	5 × upper completions tubing, inner tie-back string with a lower sleeve latching into the production casing hanger wellhead profile and outer tie-back string/riser connected to the 18-3/4" high pressure wellhead housing.	5 × 7″ upper completions production tubing. 5 ×10-3/4″ inner tie-back string. 5 × 22″ outer tie-back string/riser.	0.1	Various.	Long–term (>22 years design life) / Permanent	Maintenance undertaken in accordance with manage asset care. Risk based inspections and testing to monitor and maintain system integrity and operability.	Yes	Inventory flushed to remove hydrocarbons and contaminants. Equipment is decommissioned by cut-off at mudline. All equipment below the mudline will be left in situ. Alternative subject to future regulatory approvals include may equipment above the mudline being evaluated for appropriateness to leave in in situ.	No
Ancillary permanent equipment and structures	Refer to Table 6-1.	Various.	Various	Various.	Long-term	Periodic visual inspection, if required.	Yes	These will be deployed and recovered to a project vessel for removal from the Activity Area. Where required, inventory will be flushed to remove hydrocarbons and contaminants and disconnected. Recovery could occur to a vessel (e.g buoyancy units), Prelude FLNG (e.g. EFL/SFL, spool) or Crux topsides (clamps).	No.
Temporary installation aids and equipment	Refer to Table 6-1.	Various.	Various	Various.	Temporary	Periodic visual inspection, if required.	Yes	These will be deployed and recovered to a project vessel for removal from the Activity Area. Temporary installation aids and equipment are all required to be retrievable (e.g. designed with anchor points or connected to lines).	Yes, unless required for future EPs.

10.1.5 Management of Change

The MOC process for the Crux Project is described in the Crux Management of Change Procedure (2200-010-FA-6180-00001). The overall objectives of the MOC Process are:

- Fully assess significant impacts of proposed project-level changes before decisions are made
- Prevent changes that would threaten the achievement of project objectives
- Ensure all potentially affected disciplines/parties are considered in the change assessment
- Permit changes that add value to the project with full consideration of impacts and risks
- Fully assess the risks associated with implementing, or not, the change.

Potential changes covered by this procedure includes:

- HSSE Change: changes that may impact HSSE requirements, including commitments within regulatory documents, such as Environmental Plans
- Scope Change: changes to the technical scope of the project, including mandatory requirements, specifications and procedures
- Organisational Change: changes to critical roles in the project, including Critical HSSE Leadership roles.

The MoC procedure is supported by specific procedures, templates and checklists.

- Identify – identify the need for change, initiate a MoC request with a proposed solution and gain endorsement by project management
- Screen – the screening identifies and considers the HSSE and project risks to confirm whether the MoC requires further development. This includes considered alternatives, HSSE considerations if any, required resources, cost and schedule consequences as far as is reasonable possible with the available data
- Develop – the change is detailed to a sufficient level to be risk-assessed by impacted parties. HSSE hazard screening may take place to confirm the need for a subsequent risk assessment. Where possible, actions to mitigate the risks will be identified and requirements to verify the effectiveness and inclusion of the mitigating actions will be detailed
- Approve – the proposed change(s) and the associated risks is reviewed by an MOC Panel to determine whether the change should be accepted or rejected
- Implement – following acceptance from the MOC panel, the change is implemented by impacted parties
- Close-out – verify once the change has been implemented that all outstanding issues have been addressed, that all work is closed out and all open action items are completed.

The "develop" step for changes includes an assessment of HSSE&SP aspects as per the Crux Management of Change Procedure.

The following will also trigger the review of the management of a particular environmental impact or risk to ensure that ongoing management of impacts and risks are at ALARP and Acceptable levels:

- Changes in regulatory requirements/standards
- Information which may suggest an increase in environmental risks or impacts to those outlined in the EP
- Prominent new scientific studies which may 'negatively' change the understanding of environmental risks and impacts
- Objections or claims raised which require changes in EP content following the process outlined in Section 5.

The screening process for all new changes require assessing the HSSE & SP aspects as per the Crux Management of Change Procedure require assessment of HSSE&SP aspects. This may result in a change

being flagged as possibly needing a change to the EP which require compliance with Sections 38 and 39 of the OPGGS(E) Regulations. If a change is considered significant determined by the MOC process, then a revised or new EP may be submitted to NOPSEMA for acceptance. Minor EP revisions will not be submitted to NOPSEMA for formal assessment.

10.1.6 Chemical Selection Process

Shell has adopted a chemical selection and approval process in accordance with Shell's chemical selection and approval guidelines as indicated in Shell Australia Chemical Change Process to assess chemicals than may pose environmental impact via planned discharges (Figure 10-1).

If chemicals may be discharged to the marine environment, Shell preference is to select those chemicals that are deemed environmentally acceptable (PLONOR, Gold, Silver, D and E) with no substitution warning under the Offshore Chemical Notification Scheme (OCNS) adopted in the United Kingdom and the Netherlands. Chemicals that fall within these bands require no further assessment and are deemed ALARP and accepted.

Chemicals that do not have an OCNS ranking or fall outside the preferred bands (i.e. PLONOR, Gold, Silver, D and E with no substitution warning) are required to be assessed further, including seeking a suitable alternative chemical of lower environmental impact. If no alternative is technically suitable, the chemical must be assessed via Shell Global Product Stewardship guidelines and demonstrate ALARP with risk reduction control measures (Figure 10-2). Approval will be provided by the Shell Production Chemist / Product Steward Focal Point. Chemicals that are not deemed ALARP will be not approved and an alternative product must be requested.

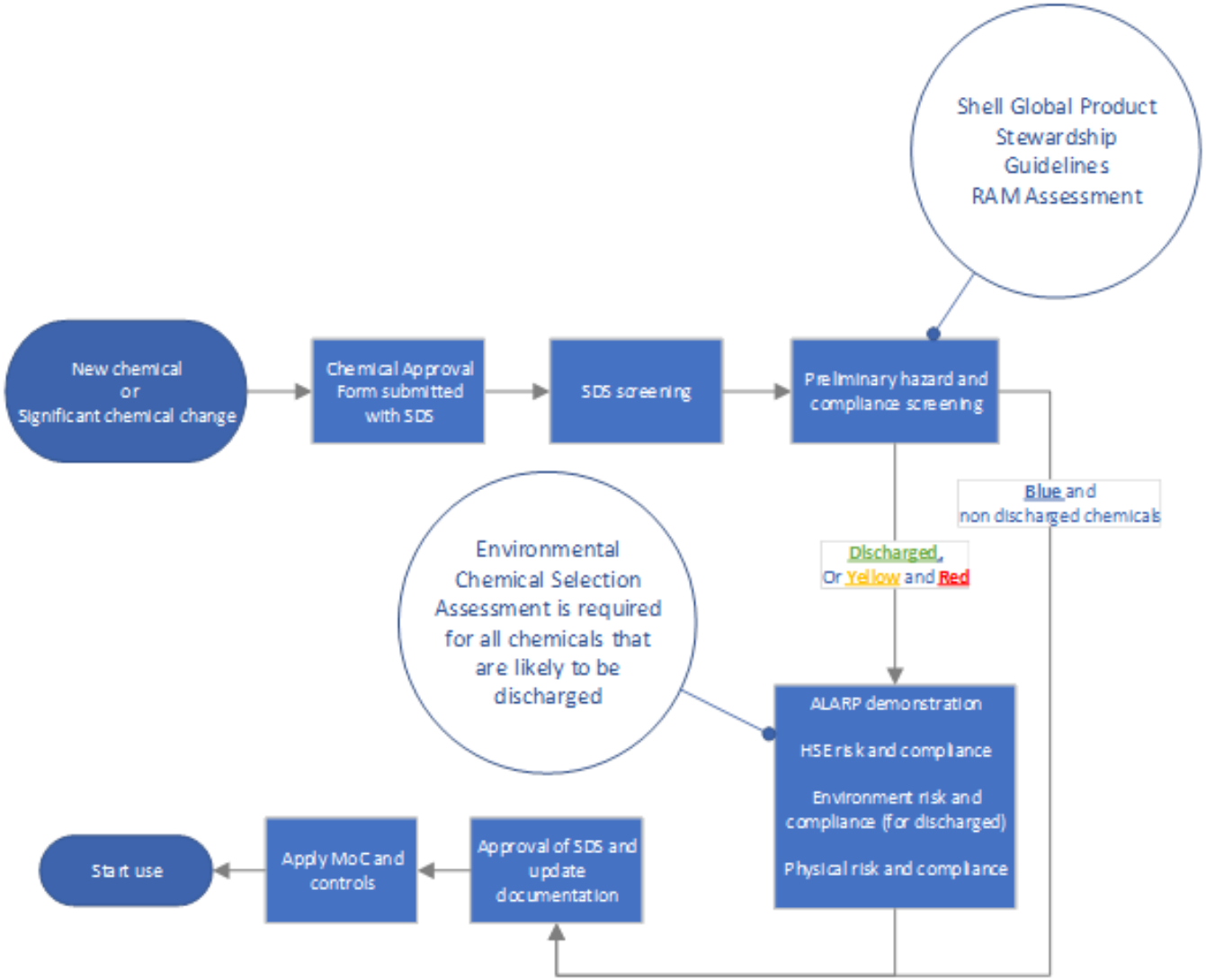


Figure 10-1: Chemical Approval Process

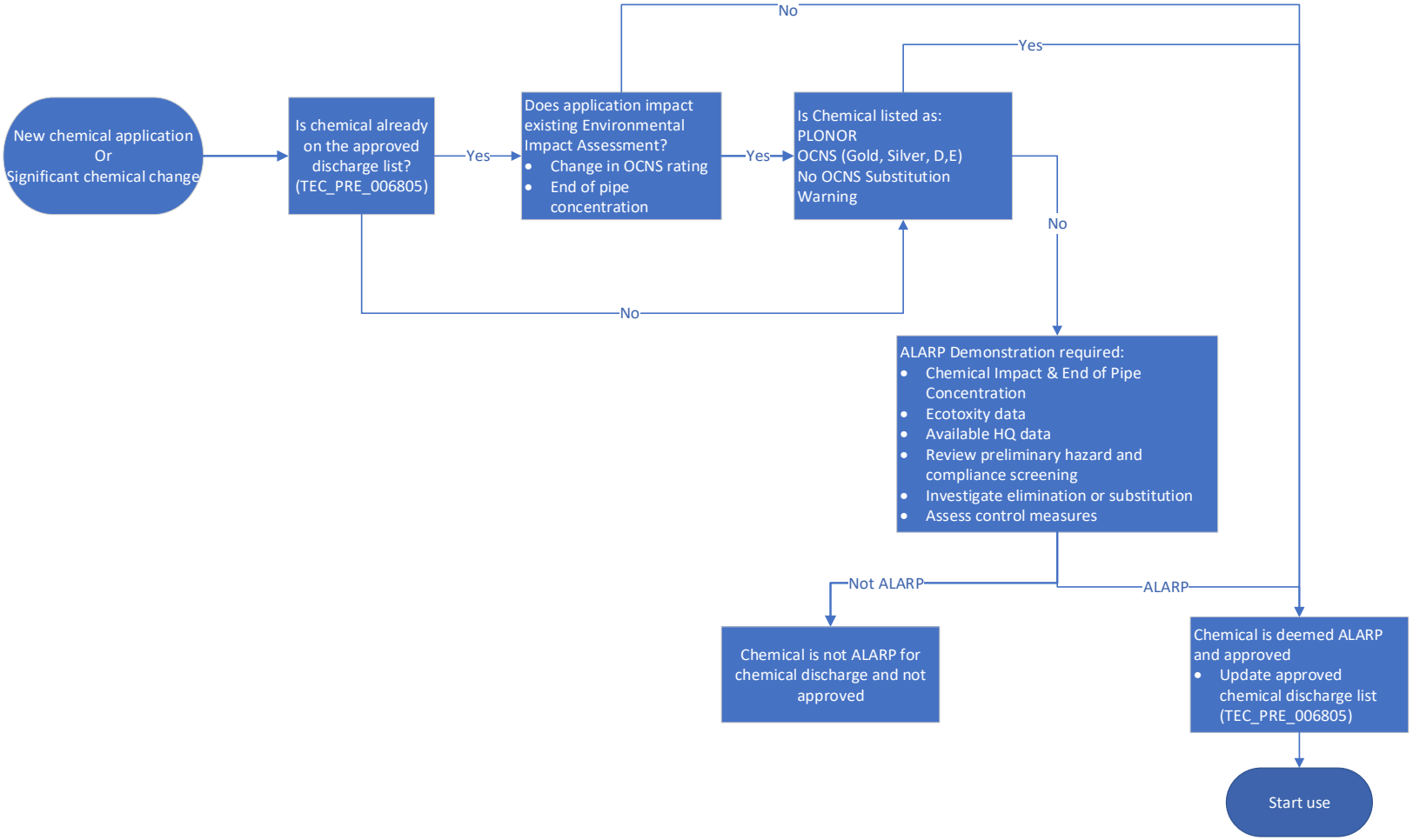


Figure 10-2: Environmental Chemical Impact Assessment

HQ = Hazard Quotient

10.2 Organisation, Roles and Responsibilities

Roles and responsibilities associated with this EP for key personnel are summarised in Table 10-3. Key roles and responsibilities related to the management and implementation of oil spill response arrangements in the event of an emergency event are outlined within the Browse Regional OPEP (HSE_GEN_016765) and Table 10-9.

Table 10-3: Key Responsibilities

Position	Responsibilities
Business Opportunity Manager	Accountable for approval of this EP.
Crux Project Director (EP Owner)	**Systems, Practices and Procedures** Accountable for the overall execution of the Crux Project. Accountable for ensuring all necessary regulatory approvals to operate are in place. Accountable for implementing this EP and ensuring its compliance. Accountable for executing activities in a safe, efficient and environmentally sound manner, in accordance with this EP, legislative requirements and Shell's policies and standards. Accountable and responsible for agreeing to and meeting key performance indicators (KPIs) and environment initiatives from annual plans and reviewing environmental performance to drive continuous improvement. Accountable for implementing relevant persons consultation as per the description in this EP and in compliance with regulations. Accountabilities align with the Crux Accountability Transfer Map, in particular as responsibilities change over project phases.
Shell Site Representative (which may be the Offshore Execution Manager, Company Site Representative or Person in Charge depending on the nature of the campaign)	**Systems, Practices and Procedures** Responsible for safe and efficient coordination of work between different contractors (SIMOPS) Responsible for implementation & monitoring performance against this EP Accountable for PTW governance, processes and permit requirements. Accountable for Incident Coordination, as required within the Crux 500 m zone. Responsible for reporting and investigating incidents in line with Section 10.5, with appropriate actions initiated and closed out. Responsible for aligning the Crux Accountability Transfer Map with roles and responsibilities, in particular as responsibilities change over project phases. Where responsibilities sit with the asset, responsibilities will be as per the SEAM Standards requirements.
Contractor HSSE Manager	**Systems, Practices and Procedures**

Position	Responsibilities
	Monitors and reviews progress against EP targets and KPIs with to ensure compliance with this EP. Escalates any potential environmental issues and non-compliances to the Crux Project Leadership Team to ensure ownership up the line. Responsible for communication of EP requirements, delegated through HSSE advisors or similar. Responsible for executing exercises and drills such that the facility's ability to respond effectively to an emergency is assured. Responsible for providing appropriate personnel with access to this EP and that they understand the outcomes, standards and measurement criteria and their environmental responsibilities for the activity. **Resourcing, Training and Competencies** Responsible for developing and maintaining environmental training and coaching materials. **Monitoring, Auditing, Non-conformance and Emergency Response** Responsible for environmental monitoring and reporting requirements from this EP including environmental performance and compliance reporting. Participates in environmental audits/inspections to ensure regular checking of compliance to this EP. Communicates findings to management and assists with close-out of actions. Helps with reviewing, investigating and reporting environmental incidents.
Crux Environment Lead	**Systems, Practices and Procedures** Responsible for providing appropriate personnel with access to this EP and that they understand the outcomes, standards and measurement criteria and their environmental responsibilities for the activity. Liaises with applicable regulatory authorities and stakeholders as required. Develops risk reduction strategies and defines performance standards. Facilitates ALARP and acceptability reviews. Responsible for updating this EP as required. Resourcing, Training and Competencies Responsible for developing and maintaining environmental training and coaching materials. **Monitoring, Auditing, Non-conformance and Emergency Response**

Position	Responsibilities
	Responsible for environmental monitoring and reporting requirements from this EP including environmental performance and compliance reporting. Monitors progress against environmental improvement plans. Participates in environmental audits/inspections to ensure regular checking of compliance to this EP. Communicates findings to management and assists with close-out of actions. Helps with reviewing, investigating and reporting environmental incidents.
Corporate Relations Advisor	Prepares and implements the Stakeholder Consultation Plan.
Vessel Master	Takes immediate action to rectify any environmental incident on the vessel. Responsible for communication and vessel operations implemented in accordance with regulatory and EP requirements. Accountable for providing effective vessel operation, taking into account relevant environmental aspects. Communicates vessel environmental management activities on board. Administers the vessel's environmental management system requirements. Responsible for all crew members complying with this EP. Manages any spills as per the SOPEP. Maintains good housekeeping and cleanliness around the vessel. Complies with DAFF and other marine regulations.
Pile driving MMOs and if relevant other trained crew members	Undertake visual observations for whales as per this EP. Provide advice to the Vessel Master/Shell Site Representative on the requirements of the pile driving procedure, including adequate whale monitoring, communication and operational response. Record all whale sightings and operational response.
Contract Holders	Responsible for implementation of this EP within the contractor's scope of work. Responsible for compliance with requirements for contractors to have adequate environmental capability to execute their scope of work. Reviews and provides assurance of contractor environmental performance.

Position	Responsibilities
	Provides appropriate offshore resource allocation to meet this EP's requirements, including performance outcomes, standards and measurement criteria. Accountable for the performance and development of offshore personnel and ensuring capability, training and competency.
All personnel	Complies with standards and procedures that apply to their area of work. Immediately reports any environmental hazards or incident to their supervisor. Understands the environmental risks and controls applicable to work. Follows instructions from their supervisor with respect to the environmental protection and measurement criteria outlined in this EP. Undergoes environmental training as required by their role and activity. Carries out assigned activities in accordance with approved procedures and this EP. Stops any operation or activity that is deemed to present an unacceptable risk to the environment.

10.3 Training, Competence and Inductions

10.3.1 Training and Competency

All personnel required to work on the Activity shall be employed on the basis they are competent to do their job and will complete relevant training and hold qualifications and certificates for their role. Shell and its contractors are individually responsible for ensuring that their personnel are qualified and trained. Personnel qualification and training records will be sampled before and/or during the Activity (e.g. during procurement process, inductions, crew change, inspections and audits).

In terms of the project vessel operators, only prequalified companies with a Shell service agreement are qualified to bid for the activity. A HSE pre-qualification questionnaire is included in the tender package, which is evaluated by the HSE department in parallel to the technical and commercial evaluations The Shell maritime assurance process is further detailed in Section 10.4.3.

10.3.2 EP Induction

Section 22(4) of the OPGGS(E) Regulations requires that the implementation strategy must include measures to ensure that each employee and contractor working on, or in connection with, the activity is aware of their roles and responsibilities in relation to the EP.

All personnel, including contractors and sub-contractors, under this EP will be given a HSSE induction prior to the commencement of work on the Activity so that they are aware of their obligations and commitments.

The HSSE inductions shall cover:

- Shell Australia HSSE & SP Policy and Commitment.
- legislative requirements – including key MARPOL requirements.
- key environmental aspects, impacts and risks associated with the activity.
- Shell's key EP commitments and environmental management requirements.

Additionally, on arrival most vessels or the facility, personnel (including short-term visitors) will attend an onsite orientation designed to familiarise them with the general operations and location of key areas. The orientation explains the site-specific safety, environmental and emergency response aspects.

10.3.3 MMO Competency and Training

A suitable number of competent MMOs will need to be present on the substructure or other suitable vessel before commencing pile driving activities, including at least two dedicated MMOs who may cover each shift or be appointed to daylight observations only (pending on the outcomes of EPS 3.4-3.6). The dedicated MMOs will be supplemented by crew trained MMOs to cover breaks and assist with the implementation of required EPSs (where required). The dedicated MMOs will be deemed competent by the Shell BES SME who has expertise in marine fauna observations (assessed against minimum competency described below). Crew trained MMOs may be trained onboard by qualified Shell or contracted dedicated MMOs who have expertise in marine fauna observations,. The training package will provide an overview of:

- pile driving activity
- whales species that may be present and how to identify different species
- behaviours including persistence in the area, dive time and swimming speed
- potential impacts and risks to whales from underwater noise
- the types of observation tools and equipment to be used
- optimal observation points on a vessel (such as high vantage points)
- observation requirements for pile driving operations (pre-start, during, stop work, night time and low visibility activities)
- communication and reporting requirements.

All training records will be maintained onboard.

MMOs will demonstrate competency to:

- implement the EPS 3.2-3.7 requirements
- British Joint Venture Conservation Committee (JNCC) MMO competency or other equivalent standard (for dedicated MMOs).
- use observation tools and equipment as required (such as binoculars, whale identification charts, night vision and thermal imaging equipment)
- communicate EPS 3.2-3.7 requirements (such as operational response, if applicable) with the Vessel Master, Shell Site Representative, other crew and MMOs
- record all whale sightings and operational response initiated, if applicable.

10.4 Monitoring, Assurance and Incident Investigation

This section of the EP outlines the measures Shell undertakes to regularly monitor the management of environmental risks and impacts of the petroleum activities against the performance outcomes, standards and measurement criteria, with a view to continuous improvement of environmental performance. The HSSE & SP-MS is also reviewed periodically as part of the monitoring and assurance process.

10.4.1 Environmental Performance Monitoring

Monitoring and review of environmental performance of the petroleum activities is done in a number of ways including monitoring of emissions and discharges, and through the use of various tools and systems. These monitoring systems meet the requirements of the following:

- Shell Australia Environmental Reporting Procedure (HSE_GEN_003179)
- Shell Australia Offshore Environmental Regulatory Approvals & Compliance Procedure (HSE_GEN_003180).

In accordance with section 22(6) of the OPGGS(E) Regulations, the implementation strategy must provide for sufficient monitoring of, and maintain quantitative records of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the EPOs and EPSs in the EP are being met.

Parameters that are monitored and recorded during the petroleum activity are detailed in relevant parts of Section 8.3 and are summarised in Table 10-4.

Table 10-4: Emissions and Discharges Monitoring for Petroleum Activity

Source	Parameter to be Monitored	Monitoring Frequency	Records	EP Reference
Emissions	Fuel sulfur content	As required (every delivery)	Bunker receipts (or equivalent).	Section 9.11 Section 9.12
	Fuel volume used	Monthly		
	Incineration volumes	As required	A copy of the completed garbage record book or official recording system that captures incinerate waste records.	Section 9.11
Bilge water	Oil content volume; as per IOPP certificate	Each discharge (infrequent)	Maintenance records of oily water separator. Oil record book or equivalent report.	Section 9.9
EGCS wash water	Volume and location discharged	Each discharge	EGCS record book (if relevant).	Section 9.9
Ballast water	Volume and location discharged	Each discharge	Ballast water records.	Section 9.8
Sewage	Volume and location, as per ISPP certificate	As per ISPP certificate	Maintenance records of sewage treatment system. Daily vessel reports.	Section 9.9
Waste generation	Hazardous waste volume Non-hazardous waste volume	As required (every delivery)	Garbage record book, as required for vessel class. Monthly waste reports.	Section 9.13
Noise emissions during piling of the substructure	Marine mega fauna observations by a MMO	During daylight hours, during the substructure piling activity	MMO records.	Section 9.5
GHG emissions from the activity	Volume GHG emissions emitted through fuel types combusted for stationary or mobile combustion	Quarterly	Records of fuel combusted and PMR reporting forms including relevant GHG conversion factors	Section 9.12
Planned activity discharges including commissioning fluids, drill cuttings and grout.	Volumes consumed	As required	Volumes used will be estimated based on known inventories.	Section 9.10
Accidental release of solid objects	Type/volume and location	As required	NOPSEMA recordable or reportable incidents as per Table 10-7.	Section 9.13
Accidental releases of hydrocarbons or chemicals	Type, volume and concentrations of release	As required	Incident reports. Monthly environmental incident reports.	Section 9.14

Source	Parameter to be Monitored	Monitoring Frequency	Records	EP Reference
	Incidents reported in accordance with Shell and regulatory requirements.		NOPSEMA recordable or reportable incidents as per Table 10-7.	

10.4.2 Baseline Environmental Studies

Reference is made to Appendix B (AECOM 2017) of the OPP as accepted by NOPSEMA in August 2020 as information previously given and assessed under section 56(1) of the OPGGS(E) Regulations. As stated in Section 5.2 of the AECOM (2017) report, the survey provided a 'snapshot' of the contemporary sediment and water quality at the time of the survey. These surveys provide valuable data against which post-impact data could be compared in general terms as required.

In relation to sediment and water quality, the AECOM (2016) and AECOM (2017) data provide valuable insights into the degree to which analyte concentrations vary across the undisturbed Activity Area which is utilised appropriately in the context of describing the existing environment and potential impacts and risks as they relate to the activities described in this EP.

Due to the short-duration, limited exposure and localised nature and scale of the impacts associated with the activities described in this EP (Section 8.3), it is not deemed practicable to undertake further baseline studies specific only to this phase (installation and cold commissioning) of the overall Crux Development Project.

It should also be noted that the area surrounding the proposed Crux platform location has been or is currently being disturbed via ongoing preceding development activities addressed in previously NOPSEMA–accepted EPs via drill template installation and development drilling activities. Therefore, Shell will be contracting a pre-operations baseline study of selected aspects of the marine environment (Table 10-5). This baseline will be set as close as practical to the commencement of operations, but within the life of this EP, to ensure that any pre-operations changes to the environment are not incorrectly ascribed to Crux operations activities or discharges. The intent of these further studies will be to complement existing characterisation datasets to build a pre-operations baseline dataset that enables a meaningful and robust assessment of changes to the marine environment that may occur through the operations and decommissioning phases of the project, and to inform the eventual title relinquishment process as per Section 270 of the OPGGS Act.

The key sources of potential changes to marine environmental quality during Crux operations are routine liquid discharges (i.e. PFW, etc.) and unplanned spills. Monitoring of impacts from the latter are addressed in Shell's Browse Regional Operational and Scientific Monitoring Bridging Implementation Plan (HSE_PRE_16370). The pre-operations water quality monitoring will serve to collect data that may be used to develop site-specific criteria for the allowable quality of planned discharges such as PFW. The data will also inform the establishment of mixing zone dimensions for routine discharges. Thereafter, ongoing operations monitoring of water quality will focus upon the physio-chemical properties of the routine liquid discharges.

Table 10-5: Baseline Monitoring Program

Study/Activity	Objectives	Timing	Study Design Parameters
Water Quality	To collect data which describes the existing physical and chemical sediment and water quality characteristics at locations within the Activity Area, with a view to: Establish a pre-operations sediment and water quality baseline dataset against which post-impact studies can be compared.	Executed during the duration described within this EP.	All relevant 'natural resources' will be considered in the context of Section 270 of the OPGGS Act (Title Surrender). Any further baseline studies will align with the most relevant and contemporary standards and best practices from a sampling and analysis perspective, i.e. the appropriate offshore standards and guidance material will be used (e.g. Przeslawski et al. [2024] and Przeslawski and Foster [2024]). Sampling sites will concentrate around potential areas of impact from the proposed activities and along the pipeline route based on nature and scale. There will be sufficient replication built into the pre-operations baseline and subsequent impact survey designs to ensure that intra- and inter- site variability
Sediment Quality			
Epibenthic Fauna	Establish the spatial extent, distribution, benthic cover and/or abundance and community composition within targeted benthic habitats (at a		

	suitable taxonomic resolution to differentiate communities). Set a pre-operations baseline for epibenthic fauna in which post-impact studies can be compared.		is sufficiently characterised and understood. This will allow for robustness in the corresponding statistical assessments when determining if a meaningful change has taken place over a specified time period. Decontamination and QA/QC processes relating to sampling equipment and processing will be clearly defined and documented.

In addition to monitoring the quality of the discharges, periodic sediment (including infauna) and water quality monitoring can provide an indication of whether additional management actions need to be implemented during operations to maintain sediment and water quality within acceptable levels. During the operations phase of the Crux facility, subject to future Environment Plan/s, Shell plans to carryout baseline impact monitoring of water quality once every 5 years and sediment (including infauna) quality once every 10 years. The details of these studies and the frequencies are subject to the future acceptance of the Crux operations phase Environment Plan/s, however they are deemed suitable for expected rates of change within the marine environment based on the planned operational discharges.

10.4.3 Marine Vessel Assurance

Project vessels within the Activity Area are required to achieve 'Positive Vetting' in accordance with the requirements specified in the SEAM Standards– Transport Standard. Sections 10.4.3.1 to 10.4.3.5 detail the compliance requirements for 'Positive Vetting'.

Numerous assurers are required to assure a positive vetting, including marine and aviation subject matter experts (SMEs), country security manager, Global Maritime Marine Warranty Surveyor, and the project workstreams responsible for the particular activity to be conducted. The Marine Vessel Assurance process ensures that the vessel's physical controls are robust, including:

- navigation equipment and aids
- communication equipment
- DP system
- lifting equipment
- maintenance systems
- emergency shut-down, alarm and lighting systems.

Oil Companies International Marine Forum's Offshore Vessel Inspection Database (OVID) is the basis for all vessel vetting. Project vessels will also be screened for class and port state control infractions.

10.4.3.1 Marine Warranty Survey

All vessels and activities will be assessed by the Marine Warranty Surveyor (MWS) on behalf of Shell's underwriter. Where required by the MWS, a marine vessel inspection/suitability survey is carried out in accordance with Construction All Risk insurance rules. The MWS issues a vessel suitability report with all significant actions and findings closed.

10.4.3.2 Pre-Mobilisation Inspection Report

The pre-mobilisation inspection is done to ensure compliance with HSSE, marine and technical requirements and readiness before the vessel commences work. The vessel (inclusive of equipment, processes and procedures) is thoroughly inspected; inspection report items must be closed before mobilisation.

10.4.3.3 Shell Aircraft International Approval

Shell Aircraft International (SAI) approval is required for all helidecks on any marine vessels used for personnel transport. Helicopters and their refuelling equipment must also be approved by SAI.

10.4.3.4 Group Maritime Assurance System Clearance

Group Maritime Assurance System (GMAS) clearance from the Shell Marine SME must be obtained before commencing marine operations on the Crux Project and before the contracted marine vessel enters the Activity Area. GMAS clearance ensures that marine vessel assurance has been completed satisfactorily.

10.4.3.5 Biofouling Risk Assessment for Vessel Movements

Shell will manage vessel compliance with biosecurity requirements as part of the Shell marine vessel assurance process and the vetting procedure. A biofouling risk assessment will be conducted for all project vessels before mobilising to the Activity Area. The IMS risk assessment process is commensurate to the risk and will depend on the location of the port of origin for each project vessel as follows:

- project vessels entering Australian territorial seas [12 nm limit] from international locations
- project vessels entering the Activity Area directly from international locations
- project vessels (as appropriate for size, type and class) entering the Activity Area from Australian domestic locations.

Biofouling management for project vessels entering Australian territorial seas [12 nm limit] from international locations, prior to entering the Activity Area, will apply the Australian Biofouling Management Requirements (DAFF 2023) which implements the requirements of the *Biosecurity Act 2015* (Cth) and the IMO 2011 Guidelines for the Control and Management of Ships' biofouling to Minimize the Transfer of Invasive Aquatic Species. All vessel operators that intend to enter Australian territorial waters (outside of the Activity Area) must provide biofouling management information (refer to EPS 6.2) through the mandatory pre-arrival report 12–96 hours prior to arrival via the DAFF reporting systems (Maritime and Aircraft Reporting System [MARS] and Vessel Compliance Scheme[66]). The MARS Biosecurity Document is required to demonstrate a low–risk status prior to entering the Activity Area.

Biofouling management for project vessels entering the Activity Area directly from international locations or locally sourced project vessels from Australian domestic locations (as appropriate for size, type and class) will implement the following requirements derived from the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee 2009):

- Conduct a biofouling risk assessment using an industry recognised IMS inspector or using the industry recognised risk assessment tool, such as Vessel–Check[67].
- Undertake IMS risk reduction measures as guided by an industry recognised IMS inspector if a vessel is not considered low–risk.
- Only vessels classified as low risk will be permitted entry into the Activity Area.

10.4.3.5.1 Project Vessel Risk Status

Project vessels must achieve a low–risk status to demonstrate to Shell that the IMS risk has been reduced to ALARP. The risk assessment categorises the vessel's risk status as:

- low–risk: low–risk of introducing IMS of concern; no additional management is required
- uncertain–risk: the risk of introducing IMS is not apparent; a precautionary approach is adopted, and additional management options is required to achieve a low–risk status
- high–risk: high–risk of introducing IMS; risk reduction measures are required prior to mobilisation.

10.4.3.5.2 Potential Risk Reduction Measures to Achieve Low–Risk Status

As described in Section 10.4.3.5.1, if the project vessel is classified as a low-risk status, no additional management is required. For project vessels classified as uncertain– or high–risk, the vessel operator is to undertake risk reduction measures either guided by an IMS inspector or identified via Vessel-Check to achieve a low–risk status and reduced to ALARP. Risk reduction measures may include but are not limited to:

[66] https://www.agriculture.gov.au/biosecurity-trade/aircraft-vessels-military/vessels/mars
[67] https://vessel-check.com/

- inspection (desktop, in-water or dry dock) by an industry recognised IMS inspector to understand and verify the actual biofouling risk.
- in-water cleaning.
- dry dock cleaning.
- internal seawater systems treatment.
- reject the vessel.

10.4.4 Environmental Assurance

Shell and its contractors' HSSE plans include provisions for monitoring, recording, auditing and regularly reviewing the environmental performance of the activities. These provisions ensure that:

- EPSs and control measures to achieve the EPOs are being implemented, reviewed and, where necessary, corrective actions taken
- potential non-compliances and opportunities for continuous improvement are identified
- all environmental monitoring requirements are being met.

A project assurance plan will be implemented for the Activity, which will include environmental assurance activities to be implemented.

Shell Group undertakes regular intermittent audits of all Shell businesses. This auditing process assures the HSSE & SP-MS as a whole. The frequency and scope of these audits will be determined by the risk profile of the location and activity.

Regular onsite HSSE assurance is conducted, which includes checking that environmental controls and/or EP performance standards are implemented. These assurance tasks will primarily take the form of prepopulated inspections checklists, audits or compliance reviews executed either in-field or desktop based. The assurance activities will be executed by Shell HSSE personnel (undertaking EP compliance audits, reviews and/or inspections) or contractors undertaking self-assurance via internal audits or inspections. Given the nature and scale of the Activity, its complexity and its range of work packages, Shell led assurance activities are planned periodically for the duration of this EP. Specific assurance tasks will be conducted both in preparation and/or during the installation activities using a risk-based approach as detailed below.

In accordance with Section 10.4.3.2, marine vessel assurance pre-mobilisation inspections will be carried out for project vessels to confirm that the vessel management systems are consistent with the marine requirements set out in this EP. To supplement the marine vessel assurance process, EP specific pre-mobilisation inspections will be conducted using a risk-based approach to select and target specific campaign vessels/contractors to assess compliance with EP performance standards and/or outcomes prior to mobilisation or commencement of activities. As a minimum, the following vessels/campaigns will be subject to these inspections:

- Export pipeline installation – Pipelay vessel
- Crux substructure Installation – transport barge and selected tow vessel
- Topsides installation – Heavy Transport Vessel
- Pipeline FCGT and dewatering – Contractor
- Substructure piling – piling vessel/s and topsides spread

During the Activity, assurance targeting compliance with the EP and/or OPEP will be performed at least annually and may be desktop based or include a field-based component. Assurance activities for the various offshore scopes will be targeted using a risk-based approach to select relevant EP performance standards and/or outcomes and will target activity campaigns which include complex environmental risk and/or impact profiles. As a minimum, the following activities will subject to Shell led assurance activities during execution of the scopes:

- Export pipeline installation – Pipelay vessel
- Pipeline FCGT and/or dewatering

- Substructure piling – piling vessel/s and spread
- Sample of support vessels/contractors
- Topsides cold commissioning

The outputs of the assurance tasks include documentation demonstrating compliance with both general HSSE requirements and EP specific controls and performance standards. This compliance documentation will be used to inform the compliance status included in the Annual Performance Report, as detailed in Section 10.6.1. Where required, corrective actions will be raised and tracked to completion. Close-out of these corrective actions are monitored and reviewed by action owners, as described in Section 10.5.

In addition, Shell will submit monthly recordable incident reports and an annual environmental performance report to NOPSEMA (see Table 10-6). These reports will assess the effectiveness of the implementation strategy, during the execution of the activities.

10.5 Management of Incidents and Potential Non-Conformances

All HSSE incidents and potential non-conformances are managed in accordance with the contractors HSSE incident reporting and investigation procedures, which describes the process of reporting, classification, investigation, follow-up and close-out. Environmental Non-Compliances (ENC) are instances where the requirements of this EP have not been met. Therefore, ENCs are considered and referred to as incidents for this EP.

Incident Investigation is about understanding the root causes of any incident, identifying corrective measures and implementing these to either reduce the likelihood of a repeat incident or reducing the consequences of an incident, or a combination of both. For incidents that occur on a Shell managed worksite and following the Shell HSSE MS (Mode 1), the Shell investigation process shall be followed.

For incidents that occur on a worksite classified as Mode 2 and Mode 3, the intent will be to use the Contractors incident investigation and reporting system, with the potential for Shell Crux team participation. The Contractors incident investigation system shall be detailed in the Contractor HSSEMP(s).

Actions arising from Shell Crux led investigations will be incorporated into the Crux HSSE Action Tracking system. Actions arising from Contractor led investigations will be incorporated into the Contractor Action Tracking system as detailed in their specific HSSEMP(s).

10.6 Reporting and Notifications

10.6.1 Routine Reporting and Notifications

Table 10-6 lists Shell's routine external reporting and notification requirements.

Table 10-6: Routine External Reporting and Notification Requirements

Reporting Requirement	Description	Recipient	Submission/ Notification Timing
Pre-activity			
54(1) OPGGS(E) Regulations: Notify NOPSEMA that the activity has started	Complete NOPSEMA's Start or end of activity form (N-04750-FM1405)[69].	NOPSEMA[70]	At least 10 days before the activity commences
55 OPGGS(E) Regulations: Notify the department of the responsible WA or NT Minister of the proposed commencement date	Notify activity commencement date	Minister's Department	At least 10 days before the activity commences

Reporting Requirement	Description	Recipient	Submission/ Notification Timing
DAFF's biosecurity requirements	Submit pre-arrival report and ballast water report using MARS online forms[68] for vessels entering Australian territorial waters (12 nm) arriving from international waters where applicable to meet DAFF's biosecurity reporting obligations pursuant to the *Commonwealth 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 DAFF before interacting with domestic vessels and aircraft	DAFF	Within 12–96 hours before vessel arrives into Australian waters
AMSA including Joint Rescue Coordination Centre (JRCC) Notification	Notify activity commencement date and duration	AMSA (JRCC)	Within 24–48 hours before vessel activities commence
AHO Notification	Notify activity commencement date and duration	AHO	At least 4 weeks before the activity commences
During activity			
50 OPGGS(E) Regulations: Reporting recordable incidents	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form (N-03000-FM0928)[69]	NOPSEMA[70]	Monthly, no later than 15 days after the end of the calendar month
51(1) and 22(7) OPGGS(E) Regulations: Environmental Performance Report	Report to include: summary of activities undertaken throughout the reporting period sufficient information to determine compliance with EPOs and standards.	NOPSEMA[70]	Annually (aligned to the financial year), submitted within 6 months following each financial year (1 July to 30 June).
AMSA including JRCC notification	Activity updates, particularly changes to previously communicated operations	AMSA (JRCC)	As soon as possible
AHO notification	Activity updates, particularly changes to previously communicated operations	AHO	As soon as possible
End of Activity			
54(2) OPGGS(E) Regulations: Notify NOPSEMA that the activity is completed	Complete NOPSEMA's Start or end of activity form (N-04750-FM1405)[69]	NOPSEMA[70]	Within 10 days after activity completion
AMSA including JRCC notification	Notify activity has been completed	AMSA (JRCC)	Within 10 days after completion
AHO notification	Notify activity has been completed	AHO	Within 10 days after completion
46 OPGGS(E) Regulations:	Complete NOPSEMA's Regulation 46 – End of operation of environment plan form (N-04750-FM1408)[69].	NOPSEMA[70]	After completing all obligations under this EP

[68] https://www.agriculture.gov.au/biosecurity-trade/aircraft-vessels-military/vessels/mars

[69] https://www.nopsema.gov.au/document-hub/forms-and-templates

[70] https://securefile.nopsema.gov.au/filedrop/submissions

Reporting Requirement	Description	Recipient	Submission/ Notification Timing
End of operations of an EP notification			
51(1) and 22(7) OPGGS(E) Regulations: Environmental Performance Report – End of Activity	Report to include: summary of activities undertaken throughout the final reporting period sufficient information to determine compliance with EPOs and standards.	NOPSEMA[70]	To be submitted following the 'end of activity' notification being submitted

10.6.2 Recordable and Reportable Incidents

Under section 5 of the OPGGS(E) Regulations:

- recordable incident, for an activity for which there is an environment plan in force, means a breach of an environmental performance outcome for the activity, or an environmental performance standard relating to the activity, that is not a reportable incident.
- 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.

Shell's Environmental Risk Matrix (see Section 9.1) uses magnitude criteria 0 to −5 to define environmental consequences (no impact [0], slight effect [−1], minor effect [−2], moderate effect [−3], major effect [−4] and massive effect [−5]) (see Table 9-2). All environmental effects with a severity ≥−3 (i.e. moderate to massive) are considered reportable incidents. Based on the risk assessment (Table 9-42 and Table 9-82), two events are considered to have a moderate or higher consequence:

- any confirmed introduced marine pest species in Australian waters attributable to the petroleum activities
- emergency event (hydrocarbon release resulting from a collision with another vessel).

With specific regard to the accidental death or injury of threatened, migratory or cetacean species as a result of project activities (as listed under the EPBC Act). These incidents may not result in moderate to significant environmental damage, however, they could result in the potential for moderate stakeholder/relevant person impacts (i.e. impact to totem species). Therefore, Shell elects to report these events to NOPSEMA as a reportable incident.

Table 10-6 outlines the monthly recordable incident reporting requirement to NOPSMEMA and Table 10-7 outlines the reporting requirements for reportable incidents. Table 10-8 lists the key externally notifiable incidents. Additional notification requirements relevant to oil spill incidents are included in the OPEP.

Table 10-7: Notifying and Reporting Reportable Incidents

Reporting Requirement	Recipient	Submission Timing
Section 47 of the OPGGS(E) Regulations: Notification of reportable incidents		
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	NOPSEMA[71]	Within 2 hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.

[71] To make an oral notification to NOPSEMA of a reportable environmental incident call: 1300 674 472

Reporting Requirement	Recipient	Submission Timing
the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident		
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.	NOPSEMA[70] NOPTA[72] Department of the responsible WA or NT Minister	As soon as practicable after the oral notification.
Section 48 of the OPGGS(E) Regulations: Written report of reportable incidents		
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.	NOPSEMA	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise.
	NOPTA[72] Department of the responsible WA or NT Minister	Must be submitted within 7 days after giving the written report to NOPSEMA.
NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form (N-03000-FM0831)[69].	NOPSEMA[70]	Within 3 days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise.

Table 10-8: Other Externally Notifiable Incidents

Reporting Requirement	Recipient	Submission Timing
Hydrocarbon spill within a marine park or likely to impact on a marine park.	Director of National Parks (Marine Park Compliance Duty Officer) 0419 293 465	As soon as possible.
Hydrocarbon spill predicted to enter NT waters.	NT Department of Environment, Parks and Water Security (Territory Emergency Management Council [TEMC]) 1800 064 567 pollution@nt.gov.au	Verbal notification as soon as practicable. POLREP (Harmful Substances Report - oil), within 24 hrs SITREP, as required.
Hydrocarbon spill predicted to enter WA waters.	WA DoT (Maritime Environmental Emergency Response) CEO of the DoT (HMA) 08 9480 9924 (24 hours)	Verbal notification as soon as practicable.

[72] reporting@nopta.gov.au

Reporting Requirement	Recipient	Submission Timing
	marine.pollution@transport.wa.gov.au	POLREP (Harmful Substances Report - oil), within 24 hrs SITREP, as required.
Hydrocarbon spill predicted to cause contamination of WA waters and/or shorelines.	WA Department of Biodiversity and Conservation and Attractions (DBCA) (Kimberley office) (08) 9195 5500 broome@dbca.wa.gov.au	As soon as practicable.
Hydrocarbon spill predicted to enter international waters.	DISR will notify DFAT who will notify the relevant foreign government 02 6213 6000 opicc@industry.gov.au	Verbal notification within 8 hours, if the spill is likely to extend into international waters.
	DFAT	Follow up with email outlining details of incident.
Vessel spill to marine environment (oil, oily mixtures or noxious liquid).	AMSA JRCC 1800 641 792 rccaus@amsa.gov.au	Within 2 hours of incident.
Marine pollution report (POLREP)[73] and situation report (SITREP)[74].	AMSA JRCC mailto:rccaus@amsa.gov.au and WA DoT marine.pollution@transport.wa.gov.au	As requested by WA DoT and AMSA following verbal notification.
Notification detailing any Level/Tier 2 or 3 hydrocarbon spill which has the potential to impact communities and environment. The notification to contain: all material facts and circumstances concerning the incident (including emergency response timeframes and expected environmental impacts) actions taken to avoid or mitigate any adverse impacts corrective actions taken.	NLC relevant persons contact details as held in Shell's relevant persons consultation database.	Immediately following establishment of potential impacts.
Notification detailing any Level/Tier 2 or 3 hydrocarbon spill which has the potential to impact each Tier 1 and Tier 2[75] Indigenous relevant persons functions, interests or activities. The notification to contain: all material facts and circumstances concerning the incident (including emergency response timeframes and expected environmental impacts)	Relevant persons contact details as held in Shell's relevant persons consultation database.	Immediately following establishment of potential impacts to relevant persons functions, interests or activities.

[73] www.transport.wa.gov.au/mediaFiles/marine/MAC-F-PollutionReport.pdf.
[74] www.transport.wa.gov.au/mediaFiles/marine/MAC-F-SituationReport.pdf.
[75] Tiers as defined in Table 5-10.

Reporting Requirement	Recipient	Submission Timing
actions taken to avoid or mitigate any adverse impacts corrective actions taken.		
Quarantine regulations breach.	DAFF (National Maritime Centre) 1300 004 605 maraitimenc@agriculture.gov.au	As soon as practicable.
Any confirmed introduced marine pest species in WA waters.	DPIRD (FishWatch) 1800 815 507 aquatic.biosecurity@dpird.wa.gov.au DPIRD (Aquatic Pest Biosecurity) 08 9203 0111 aquatic.biosecurity@dpird.wa.gov.au	Within 24 hours.
Death or injury of threatened migratory or cetacean species.	DCCEEW EPBC.permits@environment.gov.au	Within 7 days.
Any sighting and entanglements of a cetacean.	DCCEEW (Australian Antarctic Division, Australian Marine Mammal Centre)[76]	Within 2 months.
Any ship strike incident with cetaceans.	DCCEEW (Australian Antarctic Division, Australian Marine Mammal Centre) Report to the National Ship Strike database[77]:	Within 72 hours.

10.6.3 Internal Reporting

Shell also has internal reporting requirements against environment parameters identified in the Shell Group Performance Monitoring and Reporting standard. This data is used as the basis for an annual Shell Group Sustainability Report.

10.6.4 Details of Titleholder and Liaison Person

In accordance with section 23 of the OPGGS(E) Regulations, details of the titleholder, liaison person and arrangements for notifying changes are described below.

Titleholder:

Shell Australia Pty. Ltd. (ACN/ABN: 009663576/14009663876)

562 Wellington Street, Perth 6000 WA

Activity Contact:

Rama Gunturi

Crux Project Director

Email: SDA-Crux-Project@shell.com

Phone: 1800 059 152

If the titleholder, titleholder's nominated liaison person or the contact details for either change, Shell must NOPSEMA in writing of the change within two weeks or as soon as practicable.

[76] sightingsdata@aad.gov.au

[77] https://data.marinemammals.gov.au/report/shipstrike

10.7 Record Keeping

Compliance records will be maintained. Record keeping will be in accordance with section 52(7) of the OPGGS(E) Regulations, which addresses maintaining quantitative records of emissions and discharges that are accurate and can be monitored and audited against the environmental performance standards and measurement criteria.

10.8 Emergency Preparedness and Response

Under section 22(8) of the OPGGS(E) Regulations , the implementation strategy must contain an OPEP and provisions for updating it. Section 22(9) of the OPGGS(E) Regulations outlines the OPEP requirements, which must include adequate arrangements for responding to and monitoring oil pollution.

Shell's emergency and incident management framework and arrangements are described in the following sections.

10.8.1 Shell Group SEAM Standard Requirements

Shell Group's SEAM Standards are a comprehensive corporate management framework that applies to every Shell Group company, contractor and joint venture under Shell Group's operational control. Emergency response management and spill preparedness and response are two areas covered in the SEAM Standards.

10.8.2 Emergency Management Manual

Shell's Emergency Management Manual (HSE_GEN_010996) provides a tiered response framework that classifies incidents based on the level of resourcing and support required. It also outlines communication arrangements associated with each level of emergency, emergency response roster arrangements, emergency response training and competencies, and requirements for emergency management drills and exercises.

10.8.3 Incident Management Team (West) Emergency Response Plan

The Incident Management Team (West) (IMT[W]) Emergency Response Plan (ERP) (HSE_GEN_011209) is a supporting document to the SEAM Standards and Emergency Management Manual (HSE_GEN_010996) and is consistent with national and state emergency management arrangements. The IMT(W) ERP (HSE_GEN_011209) provides specific assistance and guidance to the IMT(W) in support of Shell-owned, -operated or -contracted facilities. This ERP contains these details:

- emergency management arrangements
- IMT(W) role checklists and duty cards
- incident management, action planning, Incident Command System (ICS) forms and briefing templates
- IMT(W) communications
- guidance for responding to emergencies
- lists of supporting SME units
- de-escalation and recovery.

10.8.4 Oil Pollution Emergency Plan

The Shell Browse Regional Oil Pollution Emergency Plan (HSE_GEN_016765) (BROPEP) outlines emergency management arrangements to respond to credible spill scenarios associated with all offshore activities, including Crux. The BROPEP provides the information required for an effective response in the unlikely event of an unplanned release of petroleum products. The BROPEP details the actions to be taken in response to the incident and provides contact details of emergency specialist response groups, statutory authorities and other external bodies requiring notification.

10.8.5 Operational and Scientific Monitoring Framework

Shell is required to have in place arrangements for monitoring oil pollution as part of its BROPEP. Shell has adopted use of the Joint Industry OSMP (APPEA 2020) and its associated OMPs and SMPs to guide environmental monitoring that may be implemented in the event of a Level/Tier 2–3 spill of hydrocarbons. Further information on how the Joint Industry OSMP Framework interfaces with Shell's activities, spill risks

and internal management systems is presented in Shell's Browse Regional Operational and Scientific Monitoring Bridging Implementation Plan (HSE_PRE_16370) (Browse Regional OSMP). Shell's baseline and characterisation datasets, including the results of future infield monitoring studies (refer to Section 10.4.2), have been or will be used in the design of OMPs and SMPs to establish the extent of impacts associated with oil spills.

10.8.6 WAFIC Loss Adjustment

In response to consultation with WAFIC, the adjustment protocols developed and included in the NERA Collaboration EP (taken to mean the NERA Collaborative Seismic Environment Plan) will be applied in the event of an unplanned spill or introduction of IMS. Shell refers to Appendix 3 of the NERA Collaborative Seismic Environment Plan (Revision 1) as information previously given under section 56(1) of the OPGGS(E) Regulations. The full text NERA Collaborative Seismic Environment Plan is available on the NOPSEMA EP website (https://info.nopsema.gov.au).

10.8.7 Emergency Management Structure

Shell applies the Incident Command System (ICS) methodology for emergency management. The ICS is designed to manage incidents by integrating facilities, equipment, personnel, procedures and communications operating under a single one. An ICS is commonly structured into functional areas that facilitate incident management activities, including operations, planning, logistics, finance and incident command.

Shell also applies a graduated response framework that increases resource involvement based on the significance and escalation potential of the incident. This graduated framework involves three key emergency management teams:

- Emergency Response Team (ERT), which is based on the facility and is responsible for the initial response to the incident. The Facility Incident Commander will liaise closely with the onshore IMT(W) leader and will identify when additional support is required to respond to an incident
- IMT(W), which is based onshore and supports the ERT by providing advice, logistical support and managing the operational and technical aspects of the response
- Crisis Management Team (CMT), which is also based onshore and is responsible for the overall management of the incident from a strategic, commercial, legal, reputational and high-level liaison perspective.

The ERT and IMT(W) are scalable to the nature and scale of the response (i.e. one person can take on multiple roles where circumstances permit). The mobilisation of the ERT is at the directive of the Facility Incident Commander or delegate. To mobilise the IMT(W), the Facility Incident Commander contacts the on-duty IMT(W) Leader who will then mobilise the IMT(W) as the situation warrants. Duty positions within the IMT(W) area are staffed by a roster system where each position has required personnel identified for the role. On-call positions within the IMT(W) provide specific functional expertise that helps the business respond to relevant incident scenarios. On-call positions are activated as part of the IMT(W) at the discretion of the IMT(W) Leader based on known or potential requirements. Several people are identified and trained for each on-call position, with a rotating on-call list used to contact these personnel.

Figure 10-3 outlines the emergency management escalation process adopted by the IMT(W); Figure 10-4 shows the IMT(W) structure.

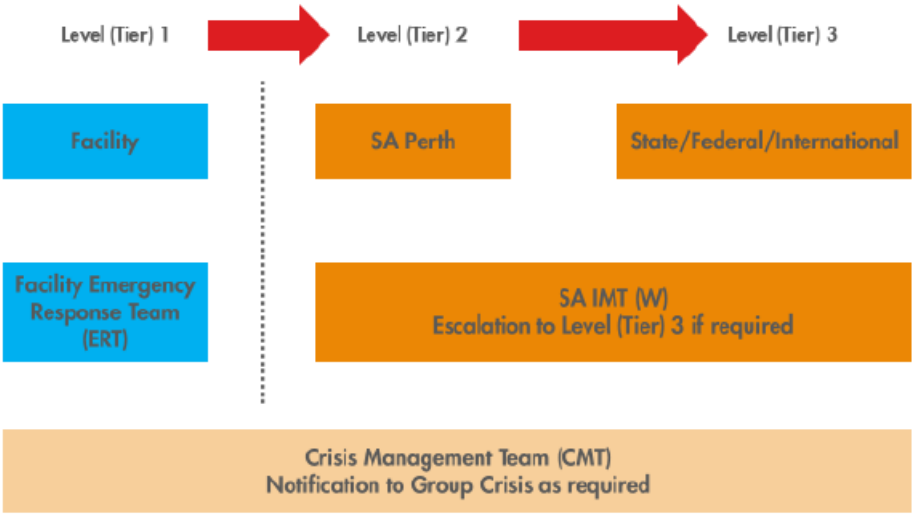


Figure 10-3: Emergency Management Escalation Process Adopted by IMT(W)

SA = Shell Australia

Interface between the IMT and Crisis Management Team (CMT) is outlined in the Shell Australia Weekly Contact List (HSE_GEN_011648). The affected facility business executive will be notified by the IMT (W) leader and IMT (W) will notify the Shell Australia CMT leader.

In addition to these resources, Shell Australia can activate additional support through the Shell Global Response Support Network (GRSN). The GRSN is a network of emergency response trained Shell Staff employed in a wide range of positions within Shell's global and local businesses who have received specific training related to oil spill response and who may be called upon to support any business or country globally which is responding to a large-scale incident. Shell Australia also has access to the Well Control Virtual Emergency Response Team (WCVERT) to provide virtual or physical mobilisation of a wide range of technical expertise to support an emergency event.

Shell Australia could also activate external additional resources for Level/Tier 2–3 spills to fill various ERT and IMT roles for the duration of the response if they were required. This includes Oil Spill Response Organisation (OSRO) personnel and trained mutual aid personnel (as per AMOSPlan), as outlined in the BROPEP.

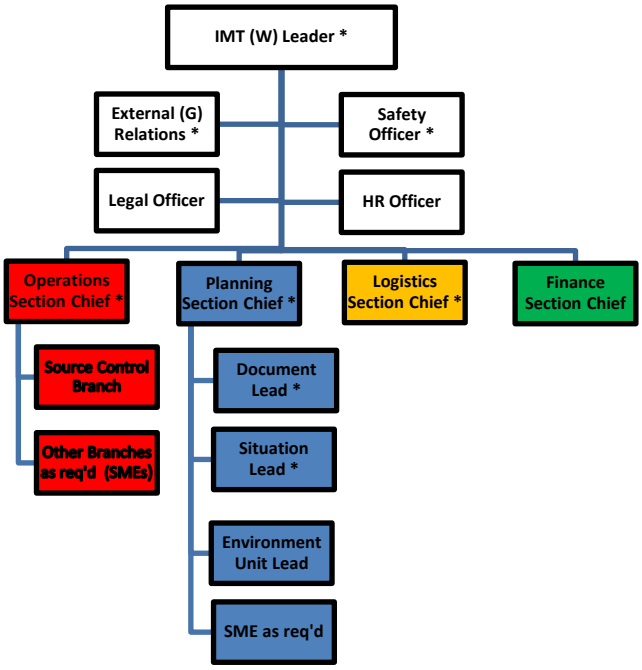


Figure 10-4: Incident Management Team (West) Structure

** indicates duty roles; all other positions are on-call*

HR = Human Resources

10.8.8 Emergency Management Roles and Responsibilities

Shell's IMT(W) ERP (HSE_GEN_011209) and facility ERP(s) (Contractor or Company) provide detailed guidance on the roles and responsibilities for all emergency management personnel.

Table 10-9 outlines the key incident response roles and responsibilities for Shell personnel. Table 10-10 outlines the roles and responsibilities of Shell personnel who are required to work within the WA DoT organisational structure, where WA DoT has responsibilities for spill response as a control agency, as per their Offshore Petroleum Industry Guidance Note – Marine Oil pollution: Response and Consultation Arrangements. WA DoT will provide two roles to Shell's IMT (W)/CMT in a coordinated response; their roles and responsibilities are listed in Table 10-11.

Table 10-9: Summary of Roles and Responsibilities of Key Emergency Management Personnel

Key Roles	Responsibilities
Facility Incident Commander (Offshore)	Maintain the safety of all Prelude and Crux personnel and initiate actions to protect the environment and assets Ensure all first-strike actions are carried out as per the BROPEP Control source of spill (if practicable) Classify the Level/Tier of spill Notify and maintain regular communications with IMT(W) Leader of incident Verbally notify NOPSEMA (within 2 hours of spill) if spill is within Commonwealth waters Initiate monitor and evaluate activities, as per the BROPEP
On-scene Commander (Offshore)	Responsible for coordinating the emergency scene and the safety of all personnel at the emergency scene Move ERT forward when authorised by the Facility Incident Commander

Key Roles	Responsibilities
	Provide regular situation updates to the Operations Section Chief on incident progress against response plan priorities
IMT(W) Leader (Onshore)	Ensure all first-strike actions are carried out as per the BROPEP Activate IMT, if required Conduct overall management of incident response operations Assess the situation and confirm or adjust the spill classification Level/Tier in consultation with the OIM and Operations Section Chief Notify CMT Leader of event and initial response level Determine incident priorities and objectives for IMT Confirm Incident Action Plan (IAP) is being developed; approve and authorise implementation of IAPs Confirm all external notifications and reporting have been made, as outlined in the BROPEP Mobilise external support, if required, as per the BROPEP
Operations Section Chief (OSC) (Onshore)	Oversee all operational resources and activities supporting an emergency Establish communications with ERT Provide overview of response operations at initial IMT briefing Communicate incident updates provided by the ERT to IMT through meetings and team briefings Provide incident details to the Planning Section Chief and Situation Unit Lead for developing the initial IAP and help develop incident objectives and strategies Determine Activity Areas (e.g. staging areas, forward command, incident area, oiled wildlife receiving, and demobilisation areas) Execute IAPs for each operational period Responsible for safety of all personnel involved in response
Planning Section Chief (PSC) (Onshore)	Facilitate all IMT meetings Help the IMT(W) Leader develop incident objectives Facilitate development of IAP for next operational period Mobilise Environment Unit Monitor situation reports and update status displays with additional information; adjust IAP as necessary
Logistic Section Chief (LSC) (Onshore)	Source all logistical requirements to complete response operations, including personnel, equipment and supplies for ongoing incidents Liaise with PSC on specialist resource requirements being considered in response strategies; verify availability of these resources as this may affect strategy selection If required incident resources are not immediately available through existing contracts, liaise with Contracts and Procurement to develop contractual arrangements as required

Key Roles	Responsibilities
Environment Unit Lead (EUL) (Onshore)	Conduct relevant external notifications, as outlined in the BROPEP Review OMP initiation criteria and activate OSMP contractor where required Confirm protection priorities Validate strategic SIMA and generate the initial operational SIMA Provide the OSC with guidance on environmental management measures to be followed during response operations.
Situation Unit Lead (Onshore)	Responsible for collecting, processing and organising incident information relating to the growth, mitigation or intelligence activities taking place on the incident Manage all situational awareness and intelligence information relating to the incident, including geospatial/meteorological information Ensure status boards are updated, retain clear records of out of date vs current information Prepare and disseminate resource and situation status information as required, including special requests.
Documentation Unit Lead (Onshore)	Responsible for maintaining accurate, up-to-date incident files (i.e. IAP, incident reports, communications logs) Compile and collate all unit logs, communications and other records so that a consolidated set of incident documentation is maintained Liaise with the Situation Unit Lead to collate and store all relevant documentation produced for Situation Updates.
External (Government) Relations/ Public Information Officer (Onshore)	Conduct relevant external notifications, as outlined in the BROPEP Manage all external communications until CMT assumes responsibility Evaluate the need for a joint information communication centre Ensure active and ongoing engagement with all relevant stakeholders and external response agencies; prepare stakeholder management plan for approval by IMT Develop material for use in media releases.
Safety Officer (Onshore)	Conduct hazard assessment and advise OIM of recommended safety actions and safe approach routes Assist the OSC and LSC by facilitating risk assessments during event response and recovery plan development, as required Review IAPs for safety implications.
Finance Section Chief (Onshore)	Responsible for all financial, administrative and cost analysis aspects of an emergency Provide financial and cost analysis information as requested.

Table 10-10: Shell Personnel Roles Positioned within the State Maritime Environmental Emergency Coordination Centre (MEECC)/ WA DoT IMT

Key Roles	Responsibilities
CST Liaison Officer	Provide a direct liaison between Shell and the State MEECC Facilitate effective communications and coordination between the Shell CMT Leader and the State Maritime Environmental Emergency Coordinator (SMEEC) Advise SMEEC on matters pertaining to Shell's crisis management policies and procedures
Deputy Incident Officer	Provide a direct liaison between the DoT IMT and the Shell IMT Facilitate effective communications and coordination between the Shell IMT(W) Leader and the DoT Incident Controller Advise the DoT Incident Controller on matters pertaining to Shell's incident response policies and procedures Advise the Safety Coordinator on matters pertaining to Shell's safety policies and procedures particularly as they relate to Shell employees or contractors operating under the control of the DoT IMT
Intelligence Support Officer	As part of the Intelligence Team, assist the Intelligence Officer in the performance of their duties in relation to situation and awareness Facilitate the provision of relevant modelling and predictions from the Shell IMT Help interpret modelling and predictions originating from the Shell IMT Facilitate the provision of relevant situation and awareness information originating from the DoT IMT to the Shell IMT Facilitate the provision of relevant mapping from the Shell IMT Help interpret mapping originating from the Shell IMT Facilitate the provision of relevant mapping originating from the Shell IMT
Deputy Planning Officer	As part of the Planning Team, help the Planning Officer perform their duties in relation to interpreting existing response plans and developing IAPs and related subplans Facilitate the provision of relevant IAPs and subplans from the Shell IMT Help interpret the Shell BROPEP Help interpret the Shell IAPs and subplans from the Shell IMT Facilitate the provision of relevant IAPs and subplans originating from the DoT IMT to the Shell IMT Help interpret Shell's existing resource plans Facilitate the provision of relevant components of the resource subplan originating from the DoT IMT to the Shell IMT (Note: The Deputy Planning Officer must have intimate knowledge of the relevant Shell BROPEP and planning processes)
Environmental Support Officer	As part of the Planning Team, help the Environmental Officer perform their duties in relation to providing environmental support into the planning process Help interpret the Shell BROPEP and relevant TRP plans

Key Roles	Responsibilities
	Facilitate in requesting, obtaining and interpreting environmental monitoring data originating from the Shell IMT Facilitate the provision of relevant environmental information and advice originating from the DoT IMT to the Shell IMT
Public Information Support and Media Liaison Officer	As part of the Public Information Team, provide direct liaison between the Shell media team and DoT IMT media team Facilitate effective communications and coordination between the Shell and DoT media teams Help release joint media statements and conduct joint media briefings Help release joint information and warnings through the DoT Information and Warnings team Advise the DoT Media Coordinator on matters pertaining to Shell media policies and procedures Facilitate effective communications and coordination between Shell and DoT Community Liaison teams Help conduct joint community briefings and events Advise the DoT Community Liaison Coordinator on matters pertaining to Shell's community liaison policies and procedures Facilitate the effective transfer of relevant information obtained from through the Contact Centre to the Shell IMT
Deputy Logistics Officer	As part of the Logistics Team, help the Logistics Officer perform their duties in relation to providing supplies to sustain the response effort Facilitate the acquisition of appropriate supplies through Shell's existing OSRL, AMOSC and private contract arrangements Collect Request Forms from DoT to action via the Shell IMT (Note: The Deputy Logistics Officer must have intimate knowledge of the relevant Shell logistics processes and contracts)
Deputy Operations Officer	As part of the Operations Team, help the Operations Officer perform their duties in relation to implementing and managing operational activities undertaken to resolve an incident Facilitate effective communications and coordination between the Shell Operations Section and the DoT Operations Section Advise the DoT Operations Officer on matters pertaining to Shell's incident response procedures and requirements Identify efficiencies and help resolve potential conflicts around resource allocation and simultaneous operations of Shell and DoT response efforts
Deputy Waste Management Coordinator	As part of the Operations Team, help the Waste Management Coordinator perform their duties in relation to managing and disposing waste collected in State waters Facilitate the disposal of waste through Shell's existing private contract arrangements related to waste management and in line with legislative and regulatory requirements Collect Waste Collection Request Forms from DoT to action via the Shell IMT

Key Roles	Responsibilities
Deputy Finance Officer	As part of the Finance Team, help the Finance Officer perform their duties in relation to setting up and paying accounts for those services acquired through Shell's existing OSRL, AMOSC and private contract arrangements Facilitate the communication of financial monitoring information to Shell to allow them to track the overall cost of the response Help the Finance Officer track financial commitments through the response, including the supply contracts commissioned directly by DoT and to be charged back to Shell
Deputy On Scene Commander (FOB)	As part of the Field Operations Team, help the On Scene Commander perform their duties in relation to overseeing and coordinating field operational activities undertaken in line with the IMT Operations Section's direction Provide a direct liaison between Shell's Forward Operations Base/s (FOB/s) and the DoT FOB Facilitate effective communications and coordination between the Shell and DoT On Scene Commanders Advise the DoT On Scene Commander on matters pertaining to Shell's incident response policies and procedures Help the Safety Coordinator deployed in the FOB perform their duties, particularly as they relate to Shell employees or contractors Advise the Safety Coordinator deployed in the FOB on matters pertaining to Shell's safety policies and procedures

Table 10-11: Roles and Responsibilities of DoT Personnel to be Positioned in Shell's IMT/CMT

Key Roles	Responsibilities
DoT Liaison Officer	Facilitate effective communications between DoT's SMEEC and Incident Controller and Shell's CMT Leader and Incident Controller Provide enhanced situational awareness to DoT of the incident and the potential impact on State waters Help provide DoT support to Shell Facilitate the provision technical advice from DoT to Shell's Incident Controller, as required
Media Liaison Officer	Provide a direct liaison between Shell's media team and DoT's IMT media team Facilitate effective communications and coordination between Shell and DoT media teams Help release joint media statements and conduct joint media briefings Help release joint information and warnings through the DoT Information and Warnings team Advise the Shell Media Coordinator on matters pertaining to DoT and wider government media policies and procedures

10.8.9 Emergency Management Exercises, Training and Competencies

Shell follows the approved ICS and IMO emergency management training requirement for ICS command and general staff. Specific competencies for IMT members are defined in the Shell Operational HSSE Competence

Framework and are tracked in the Shell Open University. Table 10-12 outlines the training requirements and core competencies for key ERT, IMT and CMT personnel. Table 10-13 outlines oil spill responder training requirements.

Only those who have completed all mandatory training requirements can be placed on the IMT roster. Training status of IMT personnel is reviewed monthly (or following significant personnel or policy change by the Emergency Response Coordinator) and notifications issued in advance to those requiring revalidation by training and/or emergency response exercise participation.

Table 10-12: Exercise and Training Requirements for Key ERT, IMT and CMT Personnel

Key Roles	Exercises	Training
ERT personnel	In accordance with vessel/asset emergency exercise schedule and SOPEP exercise schedule.	As specified via each respective contactor HSSE management system
IMT personnel IMT(W) Leader	80% of personnel must participate in an IMT exercise annually	All IMT personnel: ICS 100, 200 and IMT induction IMT(W) Leader: AMOSC – IMO3 Oil Spill Command and Control
OSC PSC LSC EUL	80% of personnel must participate in an IMT exercise annually Participation in exercises is tracked in the Exercises and Training Schedule and is reviewed monthly or following significant personnel or policy change by the Emergency Response Coordinator.	AMOSC – IMO2 Oil Spill Management
CMT personnel	Level/Tier 2–3 exercise every 2 years	Shell-specific – Group Crisis training

Table 10-13: Oil Spill Responder Training and Resources

Key Roles	Exercises/Training	Available Resources
Shell AMOSC Core Group members	AMOSC Core Group Workshop (refresher training every 2 years), Operations stream and management stream	As defined in AMOSC contractual core group requirements
AMOSC Core Group Responders	AMOSC Core Group Workshop (refresher training every 2 years)	As defined in AMOSC contractual core group requirements
OSRL Oil Spill Response Personnel	As per OSRL training and competency matrix	As defined in OSRL Service Level Agreement
AMOSC Oil Spill Response Specialists	As per AMOSC training and competency matrix	As defined in AMOSC Master Services Agreement
Operational and Scientific Monitoring Service Providers	As defined in the Shell Australia Operational and Scientific Monitoring Bridging Implementation Plan (HSE_PRE_16370)	As per Standby Capability and Competency Report
Oiled Wildlife Responders (Level 2–4) Shoreline clean-up personnel	As per DBCA OWR requirements (WA Oiled Wildlife Response Plan) As per WA DoT requirements	As per OWR state board (AMOSC and DBCA) As defined in AMOSC Master Services and OSRL Service Level Agreements. Team members available through labour hire contracts (training provided prior to deployment)

Shell maintains an Exercise and Training Schedule (as detailed in the Emergency Management Manual [HSE_GEN_010996]) to ensure its competency in responding to and managing major incidents, including oil spills. The Exercise and Training Schedule is reviewed and revised (if required) annually.

As part of this schedule, Shell conducts various exercises, as described in Table 10-14.

Table 10-14: Exercise Types, Objectives and Frequency

Exercise Type	Objective	Frequency
Notification exercise	To test all communication and notification processes to service providers and regulatory agencies defined within the BROPEP	At least annually When BROPEP is accepted or introduced When response arrangements have been significantly amended If a new location for the activity is added after the response arrangements have been tested
Equipment deployment exercises	To focus on Shell's deployment capability To inspect and maintain the condition of Shell's oil spill response equipment To maintain training of field response personnel	Level/Tier 1 – Annually Level/Tier 2 – Every 2 years
Tabletop exercise	To encourage interactive discussions of a simulated scenario amongst IMT members and refresh roles and responsibilities	As per Shell Australia's Exercise and Training Schedule
Incident management exercise	To activate IMT and establish command, control, and coordination of simulated Level/Tier 2 or 3 incident and test response arrangements as described in the BROPEP	Minimum of one oil spill exercise per year for Shell's activities. If the response arrangements are the same for several activity-specific BROPEPs, one exercise may be used to test the response arrangements for these BROPEPs at the same time
National Plan exercises or WA DoT exercises	Participate as required to ensure alignment between National/State Response Framework and Shell's Response Framework	As determined by AMSA and/or WA DoT, Shell may not be requested to participate every year
Shell Global Response Support Network (GRSN)	To test the functionality of Shell's Regional Core Group Level/Tier 3 oil spill response capabilities To achieve a target of 100% for participation of Shell Australia's Core Group personnel in GRSN regional exercises, as required	Annually Every 2 years
AMOSC audit	To test deployment readiness and capability of AMOSC as per its Master Services Agreement with Shell	Annually
OSRL audit	To test deployment readiness and capability of OSRL in Singapore as per OSRL's Service Level Agreement with Shell	Every 2 years

As part of the exercise process, several documents are prepared to ensure exercises are well planned, conducted and evaluated. These documents are used to support this document preparation:

- Exercise scope document: provides background context to the exercise, outlines the exercise need, aim, objectives, details of the scenario, participating groups and agencies, exercise deliverables and management structure. This document can be used to engage a third-party contractor to help conduct the exercise
- Exercise plan and instructions: provides instructions and 'play' (including any injects) for conducting the exercise

- Post exercise report: includes an after-action review of the exercise, evaluating how the exercise performed against meeting its aim and objectives.

10.8.10 Mechanism to Examine the Effectiveness of the Response Arrangements Against the Objectives of Testing

Shell routinely undertakes post-exercise debriefings following Level/Tier 2–3 BROPEP exercises to evaluate the effectiveness of response arrangements against the exercise objectives, identify opportunities for improvement and communicate lessons learned. Shell sets Specific, Measurable, Achievable, Realistic and Timely (SMART) objectives for oil spill exercises so that they can be clearly evaluated as being met or not.

An assessor (internal or external) examines the effectiveness of the response arrangements during a spill exercise. They then make written findings and recommendations to Shell, which Shell uses to help identify deficiencies in the response arrangements and to continually improve their overall response readiness.

Recommendations from the tests will have SMART actions added to them, where appropriate, and these actions will be tracked to closure in Sphera (Shell's action tracking system). The Sphera system assigns a responsible person and due date against each action to ensure they are tracked to closure.

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11.1 Shell References

Title	Document Number
Basis for Design Part 3 Execution Requirements	2200-010-AA-7704-00105
Chemical Change Process	HSE_GEN_007879
Chemical Programme Treatment Guide	TEC_PRE_006805
Crux Completions, Hot Commissioning, Start-up and Operations EP/s	N/A
Crux Development Drilling Environment Plan	2200-010-HX-5880-00001
Crux Development Drilling Template Installation EP	2200-010-HE-5880-00004
Crux Management of Change Procedure	2200-010-FA-6180-00001
Crux Seabed Survey EP	2200-010-HE-5880-00001
Emergency Management Manual	HSE_GEN_010996
Emergency Response Plan	HSE_GEN_011209
Environmental Reporting Procedure	HSE_GEN_003179
HSSE Incident Reporting, Investigation and Follow up Procedure	HSE_GEN_000027
Management of Change Manual	TEC_GEN_001465
Offshore Environmental Regulatory Approvals and Compliance Procedure	HSE_GEN_00318
Prelude Facility Emergency Response Plan	HSE_PRE_005612
Browse Regional Oil Pollution Emergency Plan	HSE_GEN_016765
Shell's Browse Regional Operational and Scientific Monitoring Bridging Implementation Plan	HSE_PRE_016370
Shell's Well Operation Management Plan – Crux Development, Well Construction Phase 1	2200-010-ZW-5880-00007
Weekly Contact List	HSE_GEN_011648

12 List of Acronyms and Definitions

Acronym	Definition
~	Approximately
″	Inch (measurement unit)
<	Less then / fewer than
>	Greater than / more than
≤	Less than or equal to
° C	Degrees Celsius
24/7	24 hours a day, 7 days a week
AAPA	Aboriginal Areas Protection Authority
ABC	Australian Broadcasting Corporation
ABF	Australian Border Force
ABN	Australian Business Number
ABT	Auxiliary-Buoyancy Tank
ACF	Australian Conservation Foundation
ACN	Australian Company Number
Activity Area	Petroleum titles AC/L10 and WA-3-IL; and pipeline licences WA-33-PL and AC/PL1. The pipeline route includes a 1 km buffer either side of the nominal pipeline route, and a slightly larger buffer (approximately 2 km), has been allowed at the Prelude end of the pipeline to allow for tie-in to the northern quadrant of the FLNG turret. All petroleum activities described within this EP will occur within the Activity Area".
ADB	Asian Development Bank
ADF	Australian Defence Force
ADIOS2	Automated Data Inquiry for Oil Spills
AEP	Australian Energy Producers (formerly Australian Petroleum Production and Exploration Association [APPEA])
AFMA	Australian Fisheries Management Authority
AHIS	Aboriginal Heritage Inquiry System
AHO	Australian Hydrographic Office
AHT	Anchor Handling Tug
AIS	Automatic Identification System
ALARP	As low as reasonably practicable
ALRA	*Aboriginal Land Rights (NT) Act 1976* (Cth)
AMCS	Australian Marine Conservation Society
AMOP	Arctic and Marine Oil Spill Program
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANSI	American National Standards Institute
ANZECC	Australian and New Zealand Environment Conservation Council
APASA	Asia Pacific Applied Science Associates

Acronym	Definition
API	American Petroleum Institute
APPEA	Formerly Australian Petroleum Production and Exploration Association Limited (now AEP)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARPA	Automatic Radar Plotting Aid
AS	Australian Standard
ASBTIA	Australian Southern Bluefin Tuna Industry Association
ASM	American Society for Microbiology
AUD INJ	Auditory Injury
BAC	Balanggarra Aboriginal Corporation
BBC	Big Bubble Curtain
BES SME	Shell Biodiversity Ecosystem Services Subject Matter Expert
BIA	Biologically Important Area
BOD	Biological Oxygen Demand
BOM	Bureau of Meteorology
BOP	Blowout Preventers
BP	Bollard Pull
BROPEP	Browse Regional Oil Pollution Emergency Plan (HSE_GEN_016765), Shell refers to this document as information previously given under section 56(1) of the OPGGS(E) Regulations.
Browse Island IMG	Browse Island Incident Management Guide
Browse Regional OSMP	Browse Regional Operational and Scientific Monitoring Bridging Implementation Plan (HSE_PRE_016370). Shell refers to this document as information previously given under section 56(1) of the OPGGS(E) Regulations.
BSDG	Black Start Diesel Generator
BTEX	Benzene, toluene, ethylbenzene, xylenes
CA	Conservation Advice
CAES	Catch and Effort System
CALM	Former Western Australian Department of Conservation and Land Management (now DBCA)
CAMBA	China-Australia Bilateral Agreement on the Protection of Migratory Birds
CCTV	Closed-Circuit Television
CER	Clean Energy Regulator
CFA	Commonwealth Fisheries Association
CHARM	Chemical Hazard Management Risk Management
cm	Centimetre
CMT	Crisis Management Team
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
COLREGS	International Regulations for Preventing Collisions at Sea 1972
Commonwealth waters	Waters stretching from 3 to 200 nautical miles (5.55 to 370.4 km) from the Australian coast.

Acronym	Definition
CP	Conservation Plan
cP	Centipoise
CPT	Cone Penetration Test
CR	Corporate Relations (Shell)
CSA	Cetacean Sightings Application as available on the National Marine Mammal Data Portal.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DAC	Djarindjin Aboriginal Corporation
DAFF	Commonwealth Department of Agriculture, Fisheries and Forestry
DAWE	Former Commonwealth Department of Agriculture, Water and the Environment (now split into DCCEEW and DAFF)
dB	Decibel
dB PK	The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).
dB re 1 μPa^2s	Unit for cumulative measure related to the sound energy in one or more pulses.
dB re 1 µPa	Unit for Sound Pressure Level and stands for decibels referenced to 1 micropascal
dB re 1 µPa RMS @ 1 m	decibels referenced to 1 micropascal Root Mean Square at a distance of 1 metre
dB re 1 μPa^2m^2	Unit for sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source
dB re 1 μPa^2m^2s	Unit for sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source
dB SEL_{24h}	Unit for that stands for decibels Sound Exposure Level over a 24-hour period
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DBSC	Diverless Bend Stiffener Connector
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DCS	Distributed Control System
DEMIRS	Western Australian Department of Energy, Mines, Industry Regulation and Safety
DEWHA	Former Commonwealth Department of Environment Water Heritage and Arts (now DCCEEW)
DFAT	Commonwealth Department of Foreign Affairs and Trade
DFES	Western Australian Department of Fire and Emergency Services
DGF	Dissolved Gas Flotation
DHA	Commonwealth Department of Home Affairs
DIFFS	Deck Integrated Fire Fighting System
DISR	Commonwealth Department of Industry, Science, and Resources
DITT	Northern Territory Department of Industry Tourism and Trade
DJTSI	Western Australian Department of Jobs, Tourism, Science and Innovation
DLV2000	Derrick Lay Vessel 2000
DNP	Director of National Parks (Cth)

Acronym	Definition
DoEE	Former Commonwealth Department of Environment and Energy (now DCCEEW)
DoT	Western Australian Department of Transport
DP	Dynamic Positioning
DPIRD	Western Australian Department of Primary Industries and Regional Development
DSEWPaC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities Energy (now DCCEEW)
DTH	Down the Hole
DWER	Western Australian Department of Water and Environmental Regulation
E	East (compass direction)
e.g.	For example
EAAF	East Asian–Australasian Flyway
EC50	A concentration or dose that yields biological effects in 50% of test animals/species
eDNA	Environmental DNA
EEZ	Exclusive Economic Zone
EFL	Electrical Flying Leads
EGCS	Exhaust Gas Clearing System
EHS	Environmental, Health, and Safety
EIAPP	Engine International Air Pollution Prevention (certificate)
EMBA	Environment that May be Affected
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
ER95%	95th percentile Exposure Range
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Ecological Sustainable Development
ESHIA	Environmental, Social and Health Impact Assessment
EU	European Union
EUL	Environment Unit Lead
FCA	Federal Court of Australia
FCGT	Flooding, Cleaning, and Gauging
FCGT	Flood, Clean, Gauge and Test
FGS	Fire and Gas System
FLNG	Floating Liquefied Natural Gas
FOB	Forward Operations Base
FOCT	Fibre-optic Cable Termination
FPSO	Floating Production Storage and Offloading (facility)

Acronym	Definition
ft	Foot (measurement unit)
g	Gram
GDA	Geocentric Datum of Australia
GHG	Greenhouse Gas
GHGEMP	Greenhouse Gas and Energy Management Plan
GIS	Geographic Information System
GMAS	Group Maritime Assurance System
GRSN	Global Response Support Network (Shell)
hr	Hour
HEMP	Hazards and Effects Management Process
HF	High Frequency
HFO	Heavy Fuel Oil
HGT	Horizontal Gene Transfer
HMI	Human Machine Interface
HP	High Pressure
HPLT	High Pressure Leak Testing
HSD	Hydro Sound Damper
HSE	Health, Safety and Environment
HSSE & SP	Health, Security, Safety, Environment and Social Performance
HTV	Heavy Transport Vessel
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
i.e.	That is
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention (certificate)
ICS	Incident Command System
ICSS	Integrated Control and Safeguarding System
ID	Identity / identification
IEE	International Energy Efficiency (certificate)
IFO	Intermediate Fuel Oil
ILUA	Indigenous Land Use Agreement
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMO	International Maritime Organization
IMR	Inspection, Maintenance and Repair
IMS	Invasive Marine Species
IMT(W)	Incident Management Team (West)
IOGP	International Association of Oil and Gas Producers
IOPP	International Oil Pollution Prevention

Acronym	Definition
IOT	Indian Ocean Territories
IPA	Indigenous Protected Area
IPCC	Intergovernmental Panel on Climate Change
IPIECA	International Petroleum Industry Environmental Conservation Association
IPS	Instrumented Protective System
ISO	International Organization for Standardisation
ISPP	International Sewage Pollution Prevention (certificate)
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Bilateral Agreement on the Protection of Migratory Birds
JASMINE	JASCO Animal Simulation Model Including Noise Exposure
JMP	Joint Management Plans
KEFs	Key Ecological Features
kg	Kilogram
kHz	Kilohertz
km	Kilometre
KO	Knockout
KP	Kilometre Point
KPI	Key Performance Indicator
kW	Kilowatt
L	Litre
L/min	Litres per minute
LBL	Long Baseline
LC50	Concentration or dose found to be lethal in 50% of a group of test species.
LF	Low Frequency
LMU	Leg Mating Unit
LNG	Liquefied Natural Gas
LOC	Loss of containment
LP	Low Pressure
LPG	Liquefied Petroleum Gas
LSC	Logistic Section Chief
m, m^2, m^3	Metre, square metre, cubic metre
m/m	Mass by mass
MARPOL	International Convention for the Prevention of Pollution from Ships, adopted by the International Conference on Marine Pollution, convened by IMO, 1973/78.
MARS	Maritime Arrivals Reporting System
MBC	Maritime Border Command
MBES	Multibeam Echo Sounder

Acronym	Definition
MC	Measurement criteria
MDO	Marine Diesel Oil
MEECC	Western Australian Maritime Environmental Emergency Coordination Centre
MESA	Marine Education Society of Australasia
Metocean	Meteorological and oceanographic
mg	Milligram
MGO	Marine Gas Oil
MHU	Menck Hydraulic Underwater (hammer)
mm	Millimetre
MMO	Marine Mammal Observer
MNES	Matters of National Environmental Significance
MOC	Management of Change
MOPO	Manual of Permitted Operations
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MQC	Multi-Quick Connect
MS	Management System
MT	Metric tonnes
MWS	Marine Warranty Surveyor
N	North (compass direction)
N/A	Not Applicable
NAXA	North Australian Exercise Area
NDC	Nationally Determined Contribution
NE	North-east
NEPM	National Environment Protection Measures
NGER	National Greenhouse and Energy Reporting
NGO	Non-government Organisation
NIAA	National Indigenous Affairs Agency
NLC	Northern Land Council
nm	Nautical mile
NMR	North Marine Region
NNTT	National Native Title Tribunal
NOAA	National Oceanic and Atmospheric Administration (US)
NOEC	No Observable Effect Concentration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NO_x	Nitrogen oxides, typically expressed as NO_2
NPI	National Pollutant Inventory

Acronym	Definition
NT	Northern Territory
NTRB	Native Title Representative Bodies
NTSP	Native Title Service Providers
NW	North-west
NWMR	North-west Marine Region
NZS	New Zealand Standard
OCNS	Offshore Chemicals Notification Scheme
OD	Outer Diameter
ODS	Ozone depleting substances
OIM	Offshore Installation Manager
OMP	Operational Monitoring Plan
OP	Operating Plan
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023
OPP	Offshore Project Proposal
OSC	Operations Section Chief
OSMP	Operational and Scientific Monitoring Plan
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North-east Atlantic
OSRL	Oil Spill Response Limited
OVID	Offshore Vessel Inspection Database (owned by Oil Companies International Marine Forum)
OWR	Oiled Wildlife Response
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
PBC	Prescribed Bodies Corporate
PFAS	Per- and polyfluoroalkyl substances
PFW	Produced Formation Water
pH	Measure of acidity or basicity of a solution
pig	Pipeline Inspection Gauge
PK	Peak (sound pressure level)
PLET	Pipeline End Termination
PLONOR	Poses Little or No Risk
PM	Particulate Matter
$PM_{2.5}$, PM_{10} etc.	Particulate matter with a diameter of 2.5 / 10 micrometres or less
PMST	Protected Matters Search Tool (EPBC Act)
PNEC	Predicted no effect concentration
POB	Persons on Board

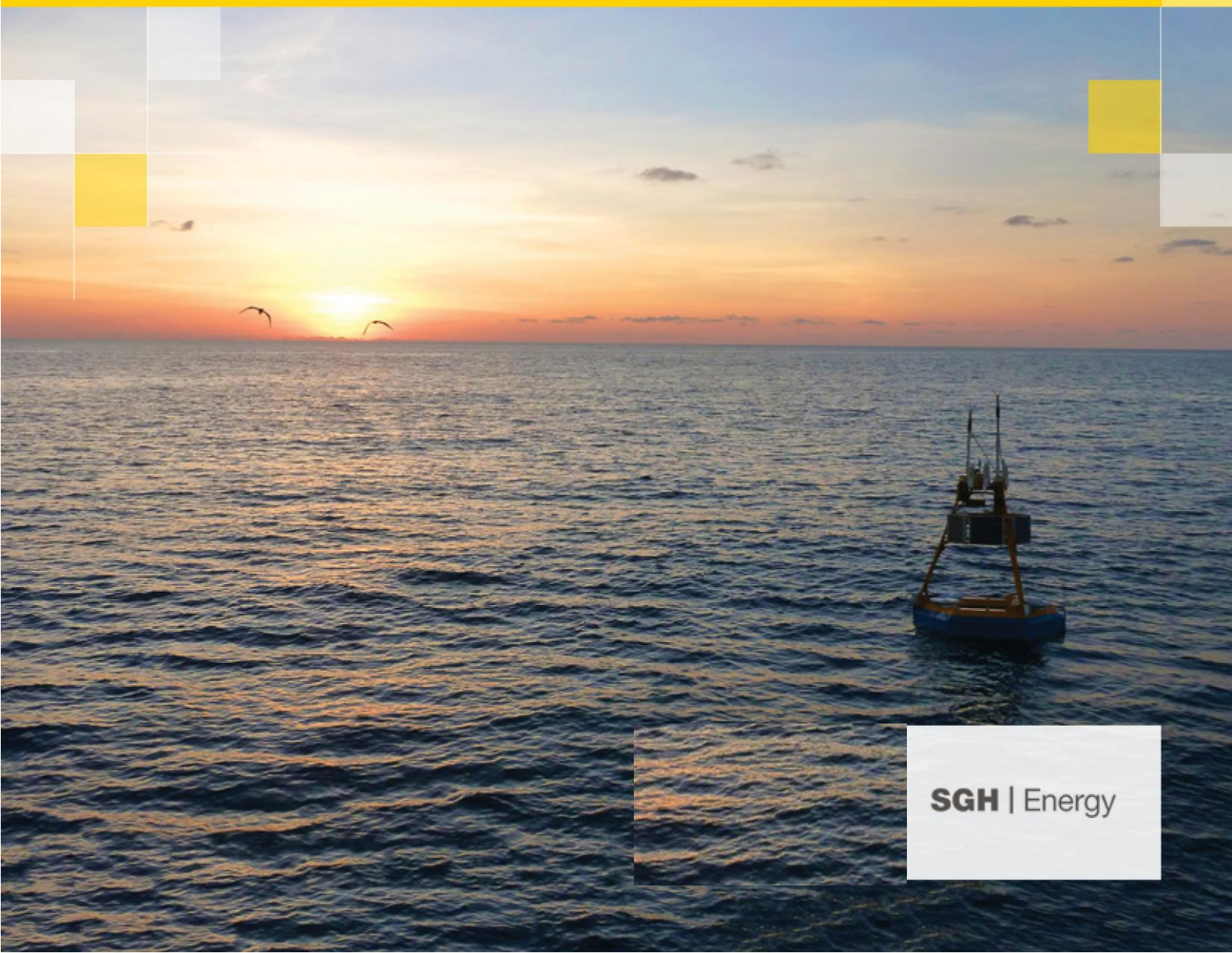
Acronym	Definition
POLREP	Pollution Report
POP	Persistent Organic Pollutant
ppb	Parts per billion
ppm	Parts per million
Project Area	Defined in the accepted OPP (NOPSEMA ID: A742335) as the in-field development area (30 km radius around the proposed Crux platform) and export pipeline corridor (1 km buffer either side of the route with a 2 km radius around the Prelude end) encompassing approximately 314,000 ha.
PSC	Planning Section Chief
PSV	Platform Supply Vessel
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
PTW	Permit to Work
RAAF	Royal Australian Air Force
RATSIB	Representative Aboriginal/Torres Strait Islander Body Areas
RCC	Rescue Coordination Centre
RESDV	Riser Emergency Shutdown Valve
R_{max}	Maximum Range
RMS	Root Mean Square
RNTBC	Registered Native Title Bodies Corporate
RO	Reverse Osmosis
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
ROV	Remotely Operated Vehicle
RP	Recovery Plan
S	South (compass direction)
s	Second (time)
S	Sulfur (chemical)
SAI	Shell Aircraft International
SBP	Sub-bottom Profiler
SDS	Safety Data Sheet
SE	South-east
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SFL	Steel Flying Lead
SGG	Synthetic Greenhouse Gases
Shell	Shell Australia Pty Ltd
SIMA	Spill Impact Mitigation Assessment
SITREP	Situation Report
SMART	Specific, Measurable, Achievable, Realistic and Timely

Acronym	Definition
SME	Subject Matter Expert
SMEEC	State Maritime Environmental Emergency Coordinator (WA)
SMPEP	Shipboard Marine Pollution Emergency Plan
SO_2	Sulfur dioxide
SOLAS	International Convention for the Safety of Life at Sea 1974
SOPEP	Shipboard Oil Pollution Emergency Plan
SO_x	Sulfur oxides
SP	Social Performance
SPL	Sound Pressure Level
SSS	Side-scan Sonar
State waters	The marine environment within 3 nautical miles (5.55 km) of the mainland of Western Australia or its islands
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978
STS	Ship-to-ship
SW	South-west
t	Tonne
TEG	Triethylene glycol
TLC	Tiwi Land Council
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
TSSC	Threatened Species Scientific Committee
TTS	Temporary Threshold Shift
UCH	Underwater Cultural Heritage
UCH Act	Commonwealth *Underwater Cultural Heritage Act 2018*
UCON	Universal Connector
UK	United Kingdom
UN	United Nations
UPS	Uninterruptable Power Supply
US / USA	United States / United Sates of America
USBL	Ultra-short Baseline
UTH	Umbilical Termination Head
UV	Ultraviolet
UWA	University of Western Australia
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
VSAT	Very Small Aperture Terminal Satellite Communications
W	West (compass direction)
w/w	Weight by weight

Acronym	Definition
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WCVERT	Well Control Virtual Emergency Response Team
WGAC	Wunambal Gaambera Aboriginal Corporation
WT	Wall Thickness
WWF	World Wildlife Fund

Appendix A Crux Environment in Design Process Overview and Outcomes

Crux Environment in Design Process Overview and Outcomes



SGH | Energy

Crux Environment in Design Process Overview and Outcomes

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1 Introduction

This Appendix describes the current status of the implementation of the environment in design process and outcomes to date for the Crux project infrastructure to be installed under the Crux Installation and Cold Commissioning EP to November 2023.

The purpose of this document is to describe the design process which has been implemented for the Crux project to ensure all relevant regulatory requirements are met, including the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth) (OPGGS Act), during the operating phase of the facility. The elements of the infrastructure and operating conditions described within this Appendix do not inform the description of the activity provided for in this EP. The activities and associated impacts and risks associated with operating phase of the Crux facility will be assessed in a future permissioning document, the Completions, Hot Commissioning, Start-up and Operations EP.

2 Purpose of the Environment in Design Process

The purpose of the environment in design process for the Crux project is to ensure the design of the facility meets the principles of acceptability, ALARP and Ecologically Sustainable Development (ESD). Additionally, the process ensures that Major Environment Event (MEE) risk and potential Environmental Non Compliance (ENC) risk are managed in line with local regulatory requirements. This includes the Crux facility meeting the requirement of Section 572 of the OPGGS Act. The focus of this document is the Platform and topsides.

The Crux approach to MEEs and ENCs represents the first time this approach is being adopted during the identify, select, design and detailed design phases of a project within Shell.

It is noted that the introduction of MEEs on Prelude FLNG was not undertaken until the Operations phase. Part of the lessons learnt from this experience was to implement this process earlier in the project, i.e. in the early design phases, such that the design can be improved where needed, and to maximise the potential for success (and hence the minimisation of the potential for MEEs to occur).

It should also be noted that the management of ENC risk is a new and novel approach, which expands the traditional environmental risk management process of focusing on MEEs. The introduction of ENCs ensures that environmental aspects which may pose an issue for compliance (for example with regulations, or for commitments of the EP itself) are given heightened attention and managed to the same degree as MEEs.

This results in a more detailed and thorough assessment of environmental aspects of regulatory concern regardless of whether or not they are considered to result in a major environmental impact. It is nonetheless noted that all design aspects with potential environmental impact or risk have been reviewed and reduced to as low as reasonably practicable, according to their nature and scale.

3 Environment in Design Process

3.1 Process Overview

Figure 1 illustrates the key activities involved in the Crux environment in design process.

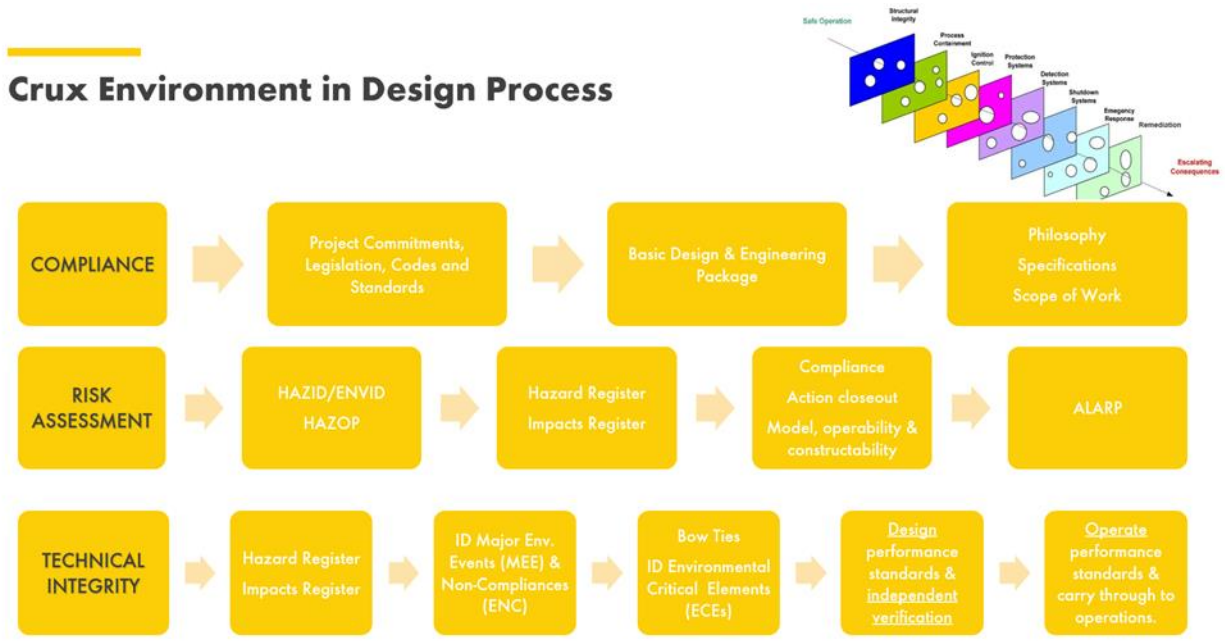


Figure 1: Crux Environment in Design Process

This environment in design process is managed by the Shell HSSE & SP Control Framework, a corporate directive that includes a Hazards and Effects Management Process (HEMP). The HEMP is a structured risk analysis methodology that involves hazard identification, risk assessment, selection of controls and recovery measures, and comparison with tolerability and ALARP criteria. Crux Project achieved this by managing multi-disciplinary workshops to identify hazards and assess risk using the Shell Risk Assessment Matrix (RAM) and the Environmental Legal Risk Ranking Matrix. This work is documented, managed, and tracked in the Hazards and Effects Register (for unplanned activities, such as loss of containment) and Impacts Register (for planned activities, such as emissions from power generation) and enables subject matter experts to confirm compliance with relevant legislation, codes, and standards; plus utilise the hierarchy of controls to reduce risks to ALARP.

For those environmental hazards which, by their nature and scale, require a heightened level of management, the HEMP process requires the development of Bowtie diagrams for all identified MEEs and ENCs that are ranked as Red or Yellow 5A/5B on Shell's RAM or as Severe (with Impact ranked at 4 or 5) or Critical with regards to Shell's Environmental Legal Risk Ranking Matrix. The Bowtie process enables a multi-disciplinary team to define the environmental critical elements (ECE barriers) that prevent or mitigate the consequence of a MEE or ENC. Each ECE is subsequently further evaluated to record the required performance of the associated equipment for both design and operational modes, therefore ensuring a framework for assurance and verification of environment-critical equipment on the Crux facility. This is described in more detail in the following section.

However, it should be noted that, whilst Bowties are only developed for MEEs and ENCs, all environmental aspects are assessment and managed under the HEMP process and local regulatory requirements to ALARP and acceptable levels in accordance with their nature and scale; noting those environmental aspects that are considered to be MEEs have the potential for a major environmental impact, whilst those considered to be ENCs are considered to have the potential for environmental non-compliances, and have therefore been assessed more thoroughly.

3.1.1 MEE, ENC and ECE Process Overview

The Crux environment design process, primarily from the delivery and documentation of HAZID and ENVID risk assessments, enables the Project to identify and categorise MEEs and ENCs, whose nature and scale of risks and/or impacts requires a more thorough management approach, utilising the following definitions:

- MEEs are environmental hazards that are risk ranked as Red or Yellow 5A/5B with regards to Shell's RAM.

- ENCs are environmental legal non-compliance that are categorised / risk ranked as Severe (with Impact ranked at 4 or 5) or Critical with regards to Shell's Environmental Legal Risk Ranking Matrix.

The purpose of the MEE and ENC categorization is to enable the identification and management of Environmental Critical Elements (ECEs) which are defined as an item of equipment, system, or structure where the failure of which could lead to a MEE or ENC; or has the purpose preventing or limiting an MEE or ENC.

The ECEs therefore represent critical barriers in the hierarchy of controls for facility environmental hazards, and as such, the design team develops a Design Performance Standard for each ECE with the input of a multi-disciplinary team including Shell technical safety, engineering, commissioning, operations and decommissioning representatives alongside a series of dedicated technical authorities.

The Design Performance Standards contain a sequence of assurance tasks relating to the required performance of the critical element, therefore enabling the execute phase to verify that the environment-critical barriers are designed, procured, fabricated, and commissioned in accordance with the required statement of performance of that equipment.

Further, the Design Performance Standards are then transformed into draft Operations Performance Standards during the execute phase, in readiness for the roll-out of operational assurance processes for the ECEs, as part of Shell's overall technical integrity management framework. This process will enable Shell to carry forward ongoing management and maintenance of environment-critical barriers into the Crux Operations phase.

3.1.2 Environment in Design Outcomes from Concept Stage to FID

The Crux project has undergone extensive evaluation and concept definition in the years leading up to the completion of Front-End Engineering Design (FEED) and decision to proceed with the project (Financial Investment Decision, FID), most of this is documented in the Crux Offshore Project Proposal (OPP). This has continued into detailed design, noting the scale of available alternatives naturally reduces as the project moves through the project definition phases. The summary of design alternatives considered as part of the design progression and the associated ALARP analysis are shown in Section 4.2 at a high level, noting these will be presented in detail in the Operations EP.

3.2 Legislation, Codes and Standards

3.2.1 External

The Crux Platform has been designed to meet all applicable legislative requirements as well as applicable international conventions and guidelines.

Key Commonwealth legislation (primary Act only, Regulations or subsidiary legislation not listed) that applies to the Crux platform design includes:

- OPGGS Act – legislation and guidance notes inform design philosophy and basis for demonstrating that environmental risks are as low as reasonably practicable.
- *National Environment Protection Council Act 1994* (Cth) – design consideration and assessment relating to Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ) (2000) enacted in state legislation and National Environmental Protection Measures (NEPMS) relating to managing emission and discharge streams such as produced water and GTG exhaust.
- *National Greenhouse and Energy Reporting Act 2007* (Cth) – design of devices and protocols for the monitoring and measurement of fuel gas systems, purge and pilot gas systems, and flare systems.
- *Navigation Act 2012* (Cth) – in conjunction with safety discipline, design guidance relating to navigation safety requirements (such as International Regulations for Preventing Collisions at Sea 1972) designed prevent physical collisions at sea and preventing loss of containment events.
- *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (Cth) – design guidance relating to specification and procurement of heating, ventilation, and cooling systems to reduce emissions of ozone depleting substances.
- *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth) – design considerations for marine orders and instruments relevant to design of a facility or establishment of good practice.

A range of international conventions are also considered as applicable to the design or operation of facilities, which include International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL); OSPAR Commission; International Convention for the Safety of Life at Sea 1974 (SOLAS); International Regulations for Preventing Collisions at Sea 1972 (COLREGS); Paris Agreement on Climate Change (2015).

For technical integrity management of environment-critical barriers and equipment, the Crux project environment design considers external standards such as the following standards (typically incorporated in equipment specifications):

- OSPAR Agreement 2005-15; OSPAR Reference Method of Analysis for the Determination of the Dispersed Oil Content in Produced Water for produced water sampling.
- National Greenhouse National Greenhouse and Energy Reporting (Measurement) Determination 2008 relating to measurement of greenhouse gases.
- API STD 537 Flare Details for Petroleum, Petrochemical, and Natural Gas Industries relating to the flare tip design, ignition design and flame monitoring.

3.2.2 Shell

For general environment in design for the Crux facility, the Shell HSSE & SP Control Framework is implemented by adherence to the Shell Carbon, Environment, Social Performance, Product Stewardship & Quality Standard; the Process Safety & Asset Management Standard; and HSSE & SP and Asset Management Foundations Standard.

For technical integrity management of environment-critical barriers and equipment, the Crux project has adopted the relevant process, standards, and requirements of Prelude FLNG (as relevant to the Crux facility) to enable continuity and uniformity between the facilities given Crux is remotely operated. This includes the HEMP methodology for managing environmental risks and impacts for the project, as well as identifying MEEs, ENCs and assignment of ECEs and subsequent performance standards for each of the environment-critical barriers. Within each performance standard, external codes, standards, and legislation may also apply and these are addressed separately.

For general environment in design of the Crux facility, it was designed according to a Basic Design and Engineering Package (BDEP) which provides a design basis for the facility as determined during FEED and FID. The BDEP includes environmental design criteria, design process specifications and a detailed listing of applicable legislation, codes, Australian and international standards across all disciplines. The BDEP subsequently forms part of the design contractor scopes in detailed design and is subsequently enforced by Shell through assurance activities such as design review, document review, workshop review, audit, inspection, and verification. Given environment in design is most often influenced by engineering standards (i.e., piping, materials, mechanical, structural, etc.), the BDEP is a key document for the overall multi-disciplinary execution of Crux environment in design. Some examples of external design standard groupings that apply to environment in design includes World Bank/IFC, ISO, ASME, DNV, CAP, ISO/IEC, API, ANSI, AS/NZS, NFPA, ASTM, ASHRAE, BS, BS EN ISO, SOLA, IMO, NACE.

3.3 Design ALARP Analysis

The Shell HEMP process utilises a structured risk analysis methodology that involves hazard identification, risk assessment, selection of controls and recovery measures, and comparison with tolerability and ALARP criteria. The HEMP is applied to the project Hazards and Effects Register and Impacts Register and documented alongside the hazards/impacts in these registers, as well as in the end of phase detailed design ALARP summary that collates the holistic and integrated ALARP justification for the environmental design.

Examples of environmental aspects that are assessed through this process include power generation (configuration, turbine selection, efficiency, cooling, heating, emissions control, measurement); flare system (commissioning, start-up, operational flaring, ignition, flame monitoring, measurement); produced water (treatment, analysis, discharge); open drains; lighting; noise; and waste management.

The HEMP process is also used to support key project decisions, multi-disciplinary assessments that may carry significant trade-offs, and environmentally relevant design decisions or developments which impacts upon, or has the potential to impact upon, the environment. For these assessments, dedicated ALARP assessment worksheets may be undertaken to underpin Project decision records. This HEMP process ensures

that environmental aspects are detailed and evaluated in line with the nature and scale of the aspect, and demonstrates that risks and impacts are reduced to ALARP. For those decisions where an ALARP worksheet is completed, the ALARP worksheets typically comprise an identification or assessment of the problem or context, evaluation of HSE issues and risks, and an assessment of relevant standards and tolerability criteria. This will be supplemented by an assessment of options and alternatives considered to manage the risk (that utilises hierarchy of controls) with a multi-disciplinary (HSE, operations, maintenance, economics) review of advantages, disadvantages and tradeoffs associated with the alternatives, followed by an assessment of good practice and decision context using the adapted UKOOA framework and conclusions, recommendations, and forward actions for the Project.

3.4 ECE Design Performance Standards

Design performance standards for safety and environment are put in place to ensure key hardware barriers are given appropriate focus in the detailed design process to meet set minimum performance criteria. For environment, the preparation of design performance standards originated from a lesson learnt from Prelude FLNG, noting the difficulties encountered in trying to implement operate performance standards on an operating project which had not been designed with those in mind. By designing the platform to meet the design performance standard intent, the operations performance standards will naturally follow.

3.4.1 Verification of ECE Design

Shell Quality Engineering undertakes an in-depth ECE verification process with the independent contractor Bureau Veritas (BV) as an additional assurance step during the detailed design and execute phase. BV are tasked to independently verify ECEs for compliance with the performance requirements of the project performance standards throughout detailed design, procurement, construction, commissioning, and installation offshore. BV is required to input all verification activity results in Shell's verification management database.

In addition to this, Shell's Crux design contractors (also under the oversight of Shell Quality Engineering and environmental engineers) also undertake a Technical Integrity Verification (TIV) Plan during detailed design, procurement, fabrication, manufacture, construction, installation, and commissioning of the Crux platform. The TIV is a suite of defined and tangible (SMART) activities to be conducted which enable assurance and independent verification of the integrity with a primary focus on environmental critical elements.

3.5 ECE Operate Performance Standards

Shell also initiated the transformation of design performance standards into 'operate' performance standards during the detailed phase with the inputs of engineering teams, subject matter experts and technical authority signatories from Shell (including Prelude FLNG) and engineering contractors. The purpose of this is to ensure continuity of the HEMP technical integrity process from detailed design through to offshore commissioning, start-up, and operations. This ensures that there is a managed transition of ECE design performance to operational performance, and in doing so, enabling Shell Operations to prepare and plan critical maintenance tasks well in advance for these environment critical barriers. The Operate Environmental Performance Standards are aligned with the Prelude FLNG system and are built-up with references to assurance and maintenance tasks using the applicable Shell maintenance software.

4 Outcomes of Environment in Design Process

This section summarises the environment in design process for the Crux project to date, as of June 2024.

A key design requirement of the Crux project is to reduce risks and impacts to ALARP. All identified risks and impacts have been reviewed as part of the design process, as identified during the ENVID workshops, and assessed relative to the nature and scale of their potential impact. For those significant aspects, which have been determined to be MEEs or ENCs, additional management (though design and operate performance standards) has been implemented to ensure the facility meets the design intent which is subsequently translated into successful operations.

The HEMP process results in the generation of ALARP worksheets for the key identified environmental aspects, which will be provided in the Operations EP.

4.1 Environmental Risk and Impact Identification

One of the key processes in identifying the environmental risks and impacts is the Environmental Hazard Identification (ENVID) process. This is carried out through a multi-disciplinary workshop approach which

includes a systematic and methodological approach to identifying potential environmental impacts and risks. Additionally, any environmental risks or impacts identified in other workshops (e.g. HAZID, HAZOP, model review, etc.) or environmental studies are included in the overall project risks and impacts registers.

As an example, for the Topsides ENVID, 27 environmental impacts were identified, 7 of which were deemed to be slight impacts, 14 of which were deemed to be minor impacts and 6 were deemed to be moderate impacts. No major environmental impacts were foreseen. However, in addition to the impacts, environmental risks were identified, two of which were considered major environmental events, as discussed in the following section.

Once the risks and impacts are identified, mitigation is considered, in line with the hierarchy of controls, and with the aim to ensuring risks and impacts are both acceptable and reduced to ALARP. Shell's engineering contractors produce a series of reports scopes to deliver on Shells' HEMP process, including as an example ALARP Demonstration Reports.

Additionally, a subset of the environmental risks and impacts, i.e. those considered to be MEEs or ENCs, are subjected to additional review along with the preparation of performance standards for heightened management of these environmental critical elements (ECEs).

4.1.1 Identification of MEEs, ENCs and ECEs

After completion of HAZIDs, ENVIDs, and the preparation of the Hazards and Effects and Impacts Registers, a multi-disciplinary team developed a report that detailed MEEs and ENCs relevant to Crux (in addition to major accident events and major health hazards), based on the definitions shown in Section 3.1, alongside the Bowtie diagrams produced for each top event identified. The identified MEEs and ENCs relevant to environment include:

- CRX-MEE-01: Hydrocarbon Gas / Condensate under Pressure (Risers & Pipelines) - Loss of Containment
- CRX-MEE-02: Hydrocarbon in Formation (Well Production) - Loss of Containment
- CRX-ENC-01: Offspec Produced Water (PW) – Unable to Demonstrate Onspec PW Discharge
- CRX-ENC-02: Greenhouse Gas (GHG) and Energy Monitoring and Reporting - Loss of Primary GHG Monitoring and Reporting
- CRX-ENC-03: Unlit Flare
- CRX-ENC-04: Oil Spill Response and Source Control Capability - Inability to Demonstrate Readiness to Major Liquid Hydrocarbon Loss of Containment

This report is then further evaluated by the environmental engineers to identify each of the ECEs for each of these MEEs/ENCs, and subsequently delivered as a standalone report with recommendations on the development of the associated performance standards for these ECEs.

The two MEEs identified for loss of containment events (risers/pipelines and well) were determined by the Project to be equivalent to safety Major Accident Events (MAEs). Therefore, the critical barriers/elements for these two events were therefore equivalent and therefore combined into the same MAE performance standards. For the risers and pipelines and wells loss of containment MEEs (CRX-MEE-01 and CRX-MEE-02) the critical barriers (ECEs) included equipment such as the following examples (which are all individually coded): subsea structures, topsides structures, pipelines, ventilation, electrical equipment, earth bonding, ignition control, fire and gas detection, gas dew point measurement, fire and explosion protection, passive fire protection, navigation aids, collision avoidance systems, emergency shutdown systems, isolation valves, emergency shutdown valves, communication systems and uninterruptible power supply.

For the four ENCs identified, the critical barriers (ECEs) included equipment such as the following examples (which are all individually coded): Oil in Water Emission Discharge Detection and Monitoring – Produced Water; Emissions Monitoring - Flare and Vent; Emissions Monitoring - Product Throughput; Flare Tip Ignition System; Emissions Monitoring - Gas Turbine Generator (Fuel Gas Flowmeter).

The final step of the process is the production of individual design performance standards for each ECE, which are reviewed by a multi-disciplinary team including Shell Technical Authorities in a workshop environment. The design performance standards are again issued in a standalone report, where each statement of performance is assigned a unique code that can then be taken into the verification databases by BV and the engineering

contractors TIV systems. Section 4.2 provides an overview of the specific goals for the ENC ECEs (these exclude the loss of containment ECEs detailed above, as these are covered under the MAE process).

4.2 ALARP Analysis

As part of the Crux design process, all identified environmental risks and impacts have been evaluated with the intent of reducing risks and impacts to ALARP. The risks and impacts identified during the ENVID workshops and associated studies and design reviews have been assessed relative to the nature and scale of their potential impact. For the key environmental aspects considered, ALARP worksheets have been developed. The details of these worksheets will be provided in full in the Operations EP, however a summary of the ALARP evaluations has been included in the sections below. Additional content to show how the considerations of ALARP were applied for mercury emissions across all sources is provided separately within Annex A.1.

4.2.1 Platform Concept

As detailed in the OPP, an assessment of development concepts was undertaken, including subsea tieback to Prelude FLNG facility, tieback to a greenfield FLNG facility, assessment of fixed and floating host options such as a jacket platform fixed to seabed, a tension leg platform, SPAR platform, and floating options such as a Floating, Production, Storage and Offloading (FPSO) ship-shape host and a semi-submersible floating platform. The screening process selected the fixed jacket platform (as this was predicted to achieve the lowest physical and GHG footprint relative to all options) exporting multiphase hydrocarbons in a single export pipeline and this has carried through into detailed design for execution. This concept was determined to be the ALARP option for the project design, for the reasons detailed in the OPP, which have not been replicated or revisited in this document, as they are still appropriate for the project.

4.2.2 Not Normally Manned (NNM) Concept

One of the key evaluations which took place early in the design process is the decision on manning of the platform, as discussed in the OPP.

Manning a facility allows more day-to-day control over a facility, and increased on-site monitoring of operations and, for environment, emissions and discharges. However, the presence of operators also introduces a significant risk to the health and safety of personnel. Many offshore facilities are manned, simply because it is not feasible to operate larger facilities without staff due to the high volume of operational and maintenance aspects and other activities. However, for smaller, simpler operations, with a lower volume of overall operator tasks, a NNM strategy can be considered, such as done on the Angel platform.

For Crux, the NNM platform would, once commissioned and in steady-state operations, be generally unmanned (i.e. zero personnel on the platform), with campaign maintenance visits envisaged from between 14 down to about 7 per year.

By adopting such a strategy, the personnel are removed from areas of safety risk, as well as potential health impacts, which is a significant benefit to the overall project. While the facility is still designed to operate in a safe manner at all times, such separation removes personnel from the facility when not required, such that the overall impact of an unintended event (such as a Major Accident Event, MAE) could be significantly lower or potentially avoided due to the absence of personnel.

There are additional benefits to not having a manned facility from an environmental perspective, given that the overall energy demand is lower (heating, cooling, hot water systems, catering), the emissions are reduced (lower fuel combustion due to lower energy demand), the discharges are reduced (potable water, sewage) and wastes generated at the facility to be managed are lower (food wastes, containers). However, there are also constraints from an environmental perspective, given the limitations of such a strategy (for example on complexity of produced water treatment systems, discussed separately below).

The overall benefits of adopting a NNM strategy for the project are considered to substantially outweigh the cons, and this has been adopted for the Crux project.

It is recognised that there is a slight reduction in environmental performance associated with the move to a NNM facility, however the overall project benefits are seen to justify the approach and overall risks and impacts have been reduced to ALARP and acceptable levels.

4.2.3 Power Generation

4.2.3.1 Power Generation Technology

The power generation configuration was assessed as part of the engineering process, with 3 main options considered:

- 2 x 100% turbines with a cold (offline) standby;
- 3 x 50% turbines with a cold (offline) standby; and
- 3 x 50% turbines with a hot (online) standby.

From an availability perspective, which is a key consideration for power generation systems, especially for the NNM platform, the third option of 3 x 50% with a hot standby provides the highest reliability and availability. This in turn provides the lowest risk of power failure and shutdown, with associated flaring (emitting greenhouse gas (GHG) emissions). However, this option also has the highest continuous GHG emissions due to the continuous burning of fuel by the spare GTG, which is not considered as good practice from an efficiency perspective.

The lowest routine emissions option is the 2 x 100% option with a cold standby; however the availability and reliability is considerably lower, which was deemed a key reason why this was not considered ALARP during FEED. For the 2 x 100% option, should the running GTG fail, the facility will shut down, and blowdown to flare. There is no alternate option, whilst for the 3 x 50% configuration, load shedding can be used to enable the facility to continue to operate if one of the GTGs trips, by turning off non-essential power users and keep the facility online.

The 3 x 50% with a cold standby option was considered the ALARP option, which balances availability against emissions and energy efficiency. The 3 x 50% power generation arrangement with a cold standby and fast load shedding minimises the potential for facility trip, which reduces shutdown and re-start flaring emissions over the 2 x 100% arrangement. And, while the option of 3 x 50% with a hot standby further reduces the potential for facility trip and associated flaring, it also significantly increases the GHG emissions in normal operations as a result of the running spare turbine, and as a result has been rejected.

Based on the 3 x 50% option, Solar Centaur 40 gas turbine generators (GTGs), of approximately 2.8 MW duty each, were selected. These are aeroderivative turbines, which are relatively efficient for their size, and are well proven in the field (which is of critical importance to a NNM philosophy), and can react quickly to changes in load. This results in high availability and reliability of the power generators, which is important for any platform, and reduces the potential for power failure and resultant shutdown with blowdown to flare (which otherwise increases GHG emissions). The GTGs will only run on fuel gas during routine operations (and not diesel, which generates significantly more GHGs than operation on fuel gas).

The power generation arrangement with a cold standby and fast load shedding minimises the potential for facility trip, which reduces shutdown and re-start flaring emissions. balances availability against emissions and energy efficiency, and is considered ALARP for the Crux platform.

4.2.3.2 Process Heating

Electric heaters provide high reliability and availability for heating duty and can be precisely controlled according to operating parameters. However, electric heating is not an energy efficient option, given gas is burnt generating heat to drive turbines to generate electricity, to be converted back to heat. A more energy efficient option is to use standalone gas fired boilers to provide heat. Even further, the capture and use of waste heat generated by the GTGs is the most efficient option.

This was studied in FEED, however the additional space and additional equipment (and hence maintenance) required for the boiler / waste heat recovery units was not considered warranted for the facility. The only significant process heat requirements are for the TEG reboiler, and this system was decided to have electric heaters due to the increased reliability and availability as part of the NNM concept. Additionally, these options would reduce the facility availability, which is a key driver, and move away from the NNM philosophy. As such, the FEED concluded the use of electric heaters was ALARP and this was not amended in detailed design.

4.2.3.3 Cooling System

Many offshore platforms utilise seawater cooling systems given the availability of seawater; however, these systems require seawater intake pumps, treatment, marine growth inhibition, and discharge to the environment (with corresponding significant impact on manning and maintenance requirement). The Crux platform has

instead designed an air-cooling system which has significantly lower maintenance requirements and align with the NNM philosophy. From an environmental perspective, air cooling generally results in incrementally higher GHG emissions than seawater cooling (with the lower efficiency of air cooling outweighing the energy consumption of the large seawater intake pumps), however air cooling avoids the use of marine growth systems (e.g., the resultant discharge of residual chlorine). The overall environmental differentiation is not significant for the size of the system, and the key driver for this system is simplification and safe operations in the NNM environment.

4.2.3.4 GTG Burner Technology Selection

Conventional burners (instead of Low NOx burners) for the aeroderivative GTGs was specified in detailed design as a means of improving energy efficiency and reducing GHGs by more efficient fuel gas consumption rates. Given the remote location of the Crux platform and distance from sensitive receptors, low NO_X emissions was not considered necessary. Additional advantages of the conventional burners include lowest complexity option and hence lowest operations / maintenance requirements to support the NNM philosophy; and the GTGs can also tolerate a broader fuel gas specification which can improve power generation reliability during fuel gas composition changes.

4.2.3.5 Battery Energy Storage System

A Battery Energy Storage Systems (BESS) in combination with various GTG systems and standby modes was assessed for the Crux platform in FEED and revalidated in detailed design to provide backup power in the case of a GTG failure. After screening out various other power supply alternatives in concept select phase (discussed in OPP), the assessments in FEED and revalidated in detailed engineering focused on:

1. 3 x 50% Solar Centaur 40 GTGs (~2.8 MW rating) with one turbine in hot standby configuration
2. 3 x 50% Solar Centaur 40 GTGs (~2.8 MW rating) with one turbine in cold standby configuration.
3. 2 x 100% Solar Taurus 60 GTGs (~4.6 MW rating) with ~3.2 MW BESS standby.

Despite Alternative 1 carrying the highest reliability rating (~99.98%), it was screened out as the increased fuel gas demand to maintain the additional online spare power capacity was estimated to increase GHG emissions by ~130,000 tCO_2-e over field life. The considerations by the design and operations team for assessing Alternatives 2 and 3 are summarised below:

- 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) was predicted to have a higher reliability (99.95% or ~5 hours downtime per year) than 2 x 100% Taurus 60 GTGs plus BESS (~99.53% or ~41 hours downtime per year) (Alternative 3). This difference in reliability is significant as it equates to an additional emergency shutdown and production restart each year for Alternative 3.
- Each Centaur 40 GTGs in Alternative 2 was predicted to require less frequent major overhauls at ~40,000 hours compared to ~30,000 hours for the Taurus 60 GTGs in Alternative 3. However, given the reduced GTG count, Alternative 3 is predicted to require less planned routine maintenance hours per year by ~125 hours.
- 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) has lower total CAPEX than 2 x 100% Taurus 60 GTGs plus BESS (Alternative 3) by approximately ~USD $8.5 million.
- 2 x 100% Taurus 60 GTGs plus BESS (Alternative 3) total weight is ~35% greater (~156 tonne) than 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) (~120 tonne).
- The total footprint of the 2 x 100% Taurus 60 plus BESS configuration (Alternative 3) is ~43% greater than the 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2).
- 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) provides optimal spare capacity for future potential electrical loads relative the x 100% Taurus 60 GTGs plus BESS (Alternative 3).
- 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) was predicted to increase the carbon dioxide emissions specific to the power generation system by ~28% (~100,000 tCO_2-e) over field life compared to the 2 x 100% Taurus 60 GTGs plus BESS (Alternative 3). However, this excludes consequential flaring because of unplanned shutdowns and restarts which may be approximately ~9,000 tCO_2-e per event (Crux only, without considering additional potential flaring at the Prelude FLNG facility which may result).

- As Crux is a NNM platform, if the spare GTG in the 2 x 100% Taurus 60 GTGs plus BESS (Alternative 3) does not start after a second start attempt, production may soon shutdown (within ~1 hour) when the BESS battery is fully expired, and this may eventually also shutdown Prelude production. If this occurs, the GHG emissions from an emergency shutdown and production restarts will far outweigh the GHG reduction from the BESS system (i.e. approximately ~9,000 tCO2-e per event on Crux only). This demonstrates why higher reliability and simplification is critical for the Crux NNM platform. In addition, platform visits that may be required after power system failure introduce additional logistics disadvantages and increases health and safety risks associated with platform visitations.

After robust studies and ALARP assessments undertaken, Shell decided that integration of a BESS with the power system (alternative 3) was likely to cause degraded platform reliability issues, reduced spare electrical load capacity and increase platform cost/weight requirements given restricted weight allowances enabled by the platform and substructure design, for limited incremental potential GHG benefit and disadvantaged by risk of higher GHG emissions as a consequence of a predicted increase in platform shutdowns and restarts.

The adoption of 3 x 50% Centaur 40 GTGs with cold standby configuration (Alternative 2) is therefore considered to be optimal and ALARP for the Crux NNM platform, with the load shedding on a GTG failure allowing time for the cold standby GTG to be brought online, without losing total power and resulting in a shutdown and restart.

The decision to not design and install a BESS was therefore thoroughly assessed for environmental, safety, operability, maintainability, and reliability considerations alongside the key project driver of not normally manned operations. The ultimate decision was integrated entirely with the overall power generation selection strategy which investigated all relevant power and battery combinations that could be applied to Crux, and in doing so it was determined that the selected configuration demonstrates risks are ALARP and acceptable.

It is noted however that the project does utilise Uninterrupted Power Supply (UPS) (battery) systems for critical infrastructure (which includes e.g. fuel and flare gas monitors for reporting), enabling them to continue to operate for short periods of power generation interruption.

4.2.3.6 Solar Power System

Solar power as a source of main power generation was also studied but found to be too capital / space intensive for the required power load and that the reliable supply of electrical power would require a quantity of solar panels exceeding the footprint of the Crux platform. It was also concluded that whilst a floating solar technology is available for benign conditions (i.e., not yet proven in equivalent open water environments), significant technology risk and uncertainty was associated with open ocean cyclonic conditions.

4.2.3.7 NNM Platform Energy Use

The selection of a NNM facility reduces the need for accommodation on the platform, which subsequently reduces the HVAC requirements, which is an energy consumer, as well as the water requirements which also have energy demands (intake pumps, desalination, sterilisation, and water heating).

4.2.4 Flare System

4.2.4.1 HP Flare

The Crux platform includes a high pressure (HP) flare system designed to enable depressurization of the facilities in a sufficient time that reduces the risk of vessel failure and facility integrity (i.e., in the case of emergency).

The HP Flare Tip is a vertically oriented proprietary (variable slot) sonic tip specified to burn with optimum combustion efficiency over the anticipated flow ranges.

Apart from the pilot and purge gas, the HP flare will not normally flow, as it will only be used on start-up, shutdown and in upset conditions / emergency conditions.

The HP flare system requires a continuous purge of fuel gas to prevent air ingress into the system and continuous lit pilot also supplied by fuel gas. The purge and pilot systems result in continuous emissions through the flare but are considered critical to the safety and protection of the platform and process stability and are a very small incremental source of GHG emissions for the platforms normal operations. A continuous purge gas is also required to ensure oxygen ingress to the flare stack does not occur, which could result in a potential Major Accident Event on the topsides – for this reason, a backup flare purge of nitrogen (via portable N_2 quads) is included on the topsides (the risk of oxygen ingress and flame migration outweighs the risk of

flare flame out, when the normal flare fuel gas purge is unavailable). Backup propane pilot gas bottles are also included in the design to ensure the pilots stay lit.

The HP flare tip is continually lit. Emerging best practice in flares is to utilise pilotless flares which have a fast starting pilot ignition system – however these require a continual nitrogen purge, which has constraints, and given the relatively new application of these systems and operator requirements for testing and maintenance, it is not suited to a NNM platform. The pilot and purge flaring and subsequent emissions associated with the HP flare are a minor contribution to the overall GHG emissions from the facility, and given the criticality of ensuring the HP flare is lit, the current design is considered ALARP.

4.2.4.2 LP Flare

The low pressure (LP) flare system safely disposes of waste gas streams from the Triethylene Glycol (TEG) system (regeneration and flash drum offgas) and produced water system (degasser and dissolved gas flotation offgas). It is noted that these waste streams will have a high moisture content (i.e. will generally contain more moisture than hydrocarbons).

In order to combust these waste gases, in addition to a continuous fuel gas pilot, a continuous fuel gas purge is required, to ensure the flare flame stays lit (doesn't extinguish with the high moisture load and inert contents) and within the combustibility zone. A nitrogen gas purge cannot be used with the LP flare system, as it introduces complexity and increases the risk of flare flame out, and subsequent venting, which would result in increased GHG emissions.

Off-gas recovery was investigated during FEED, however given the relatively low hydrocarbon content of the waste gas and the high moisture and inert content, it was not deemed to be efficient to recovery this waste gas stream back into the process or suitable for NNM operation.

The LP flare tip is specified to burn with optimum combustion efficiency of 98% over the anticipated flow ranges for continuous flaring, for the remainder of flaring combustion efficiency is assumed to be ~98%..

4.2.4.3 Flare Monitoring

The detailed design of Crux has specified the installation of CCTV monitoring system for the flare flame with a software analytics package that raises an operator alarm, and thermocouple monitoring for the flare pilot (3 duplex thermocouples per pilot). The pilot also has other design measures such as flame retention devices and wind shields specified to help reduce the likelihood of flameouts. A remotely triggered flare ignition package is also designed with two forms of ignition, including an electrical primary High Energy Ignition and propane back-up Flame Front Generator. The Crux flare system flame monitoring design has incorporated learnings from the Prelude FLNG facility which include:

- Fuel gas primary continuous purge gas supply to increase reliability (with nitrogen backup for start-ups).
- Pilot gas sourced from dehydrated gas.
- Pilot detection system with additional thermocouple (3 of) per pilot, additional length 20 metre duplex element (rather than 15 metre simplex). Duplex type means each thermocouple for Crux has two sensors, and one signal reporting back to DCS (therefore, the thermocouple can still detect and report if one of the sensors has failed).
- Crux has installed a fixed thermal CCTV camera (with automatic flame detection software) pointed at the flare flame to provide backup confirmation that the flare tip is lit (visual and thermal).
- Automatic ignition logic has been improved for Crux by also including a reignition failure alarm. However, the failure to reignite status of a single pilot will not inhibit automatic reignition of remaining pilots on the same flare tip if future failure is to occur. In addition, the Crux logic is to be configured on DCS and sequence improvement can be optimised if required in the future.
- Design of alarms for a cold venting incident (if all pilots are reporting in alarm, then an alarm is generated to alert the operator to act to manually relight pilot).
- Design of a variable slot HP flare tip (instead of fixed slot), LP flare tip is fixed slot. The benefits of variable slot design include the reduced required purge rate (reducing GHG emissions), prevention of lazy flame and any subsequent burn back, and minimisation of air ingress.

For flare emissions measurement, flow instruments are installed on the line to the flare tip from the HP and LP flare knock out drums to measure the total gas flow to each flare. These flow meters are integrated with

temperature and pressure instruments and fitted with volume and mass flow totaliser with density correction using learnings from the Prelude FLNG facility.

4.2.4.4 Flaring Minimisation

Flaring during start-up has been minimised by the implementation of a 2-stage well clean up strategy. The initial plan for well clean-up was to undertake this activity in a single event, at a high clean-up rate. This resulted in a high rate of flaring, until clean-up was complete, which is a significant source of GHG emissions during this phase. However, further studies in detailed design have enabled a two-phase well clean-up strategy to be planned, enabling well clean-up in two stages at lower clean-up flow rates (second stage producing to pipeline hence further reducing emissions). This strategy significantly reduces the flaring rates during well clean-up, which directly results in reduced flaring, and as such results in significant GHG reductions and is considered the ALARP option.

Another GHG reduction measure developed during detailed design is enabling the platform to import clean fuel gas from the Prelude FLNG facility via the export pipeline. This enables use of fuel gas earlier than would normally be available, which helps reduces both diesel consumption and flaring to ALARP given the shorter durations required to condition fuel gas for use by the GTGs during commissioning and some restart scenarios.

For the operations phase, flare minimisation studies were conducted where the opportunity to recover various TEG and PW system off-gas / hydrocarbon vapour streams from the low-pressure flare system was evaluated. The study assessed the use of a compressor to recover these gases and instead route them for use as fuel gas or reinjection into the process, instead of disposing via flare. These studies concluded that the technology was not proven for a NNM facility (no equivalent benchmark or analogue) and the systems introduced reliability and operability risks for the platform that outweighed the benefits. However, the TEG system did undergo energy efficiency evaluation in FEED and detailed design by optimising the power demand from the system (which is the largest consumer of electricity on the platform). This included addition of a lean/rich TEG heat exchanger to minimise heating duties; reduction of the lean TEG cooler duty; reduction of the overhead heating bundle duty; and optimisation of the TEG reboiler duty.

4.2.5 Light Emissions

The Crux facility is not located in a sensitive environment from a light emissions perspective. The environment that may be affected by the facility light emissions does not contain any significant receptors sensitive to light emissions. There are no important habitats or BIAs for listed species affected by light pollution within 20 km of the Crux site, which is the threshold for further evaluation in the new National Light Pollution Guidelines, indicating a low risk site.

Light emitting diode (LED) lights are the preferred light source for the facility, given they have high light levels for a low energy consumption, with a long bulb lifetime, and without hazardous elements (such as mercury, which is found in certain fluorescent light types).

Whilst LED lights can be filtered, if required, by filtering the light the overall light emitted per bulb is reduced, which results in an increased number of light fittings throughout the facility, increasing energy consumption and waste generation for spent bulbs, as well as the increased cost for purchase and maintenance, which is not in line with the NNM philosophy. Given there are no environmental drivers to provide a select wavelength, due to the remote, offshore location away from sensitive areas, filtered lights were not considered further.

Additionally, external lighting on offshore facilities/infrastructure has been minimised to that required for navigation, safety of deck operations and security considerations, except in the case of an emergency.

However, the continuous flaring through the tall flare stack of the facility will result in light emissions from the platform, as will the requirement to keep the facility lit at all times for safety reasons (even when unmanned). This results in light emissions in the platform surrounds; however, given the low sensitivity of the area, there is not expected to be any significant impact as a result of the light emission. Refer to Section 6.7.10 for a detailed overview of the platform flare design and components that will be installed to minimise light and air emissions from the flare.

Normal lighting, lighting required for safe operation of the facility during maintenance campaign visits, can be switched off remotely for periods where the facility is unmanned.

The facility lighting design has minimised light spill from the facility where reasonably practicable; this coupled with the NNM philosophy and the lack of sensitive species / drivers for light emission reduction in the area, and very low impact of lighting at the nearest sensitive areas, is considered ALARP for the facility in consideration of the nature and scale of the aspect.

4.2.6 Reservoir Carbon Dioxide Management

Carbon dioxide (CO_2) management alternatives were evaluated as part of concept selection and revalidated through FEED. These included analysis of venting reservoir CO_2, implementing carbon capture and storage (CCS) at Prelude or Crux, and making allowances in design for future implementation of CCS at Crux.

Based on economic, operational and safety grounds, the decision was taken during identification and concept selection studies to not deploy CCS as a part of the Crux greenfield development, and this has since been revalidated in FEED phase after additional assessment of a Crux bridge-linked platform with CO_2 removal functionality and disposal by pipeline at the Montara field, and a Prelude CO_2 compression retrofit. Neither option was proven to be economically feasible and was not studied further in detailed design. Crux reservoir will be vented through the Prelude FLNG acid gas removal system and Crux's reservoir CO_2 will be offset as required under relevant legislation.

4.2.7 Produced Water

Produced water is made up of condensed water (condensed from the process), which is expected to occur from commencement of production, and formation water which may be generated later in field life. Produced water may contain residual oil and other constituents which occur naturally in the formation, plus any residual process chemicals.

As noted in the OPP, there are no identified suitable (non-producing) geological formations in the vicinity of the project area with the capacity to receive the predicted PFW volumes for Crux and as a result produced water reinjection was not considered feasible. As such, the decision was made to treat the produced water on the Crux platform for overboard discharge.

4.2.7.1 Treatment

The produced water treatment system design included in the OPP and carried through concept select and FEED consisted of a bulk liquid/liquid separator followed by a degasser for produced water treatment to meet the stated project limit of ≤ 30 mg/L residual dispersed/free oil in water over a 24 hour average period, with space and weight allocated for the future installation of hydrocyclones (if determined to be required). The bulk liquid/liquid separator vessel separates hydrocarbon liquids and water (also refer Section 6). The hydrocarbon condensate is routed to the export system, and water routed to the produced water treatment system.

In FEED tertiary produced water treatment (including MPPE systems) was further evaluated, however tertiary systems were found to require significant operator involvement and are not suited to NNM operations. In this assessment, it was concluded that produced water treatment by a degasser (and hydrocyclones, if required in the future) met both the project oil-in-water limit at the point of discharge as well as the ANZG (2018) ambient marine water quality guidelines limits (for the hydrocarbon components and other components including heavy metals) within the allowed mixing zone (noting there are no sensitive ecological features within this zone). As a result, tertiary treatment was not considered required based on the produced water composition and was not able to be implemented at the facility under a NNM concept. As such, tertiary treatment was ruled out as not being ALARP for the overall project.

During detailed design, the produced water system was again reviewed in detail, and concern was raised over whether the degasser would function as intended over all the design conditions specifically for oil-in-water treatment based on the potential oil droplet sizes that may be realised, particularly due to droplet shearing in the process.

An aspirational target treatment quality of 15 – 20 mg/L dispersed/free oil in water was included in the BDEP which required Shell and its Contractors to design the Produced water system to attempt to meet the target, without it being a required minimum limit which must be achieved. Subsequently, an ALARP assessment was undertaken during detailed design which concluded that the degasser should be upgraded to a dissolved gas floatation (DGF) system, which dissolves and injects fuel gas into the degasser vessel, utilising the gas to strip out fine oil droplets, which the degasser alone cannot remove, thereby maximising the probability that the aspirational target treatment quality of 15 – 20 mg/L dispersed/free oil in water could be achieved. Noting however, the basis of design specification for all design cases and vendor guarantee is a concentration of ≤ 30 mg/l dispersed oil-in-water, refer above and Section 6.7.8. The use of the DGF with the degasser was determined to reduce risks to ALARP in improving dispersed/free oil in water separation efficiency, and was adopted for the project during detailed design (despite the trade-offs which include additional fuel gas consumption plus additional NNM complexity). The design retains space and weight allocation for the future installation of hydrocyclones (if determined to be required).

Other contaminants (such as mercury and other trace metals) may occur naturally in the Crux reservoir and therefore carry through in the produced formation water. Available data does not indicate high levels of these other contaminants (Table 1), however some metals, including mercury, are known to have the potential for bioaccumulation and/or biomagnification in the marine environment. Biomagnification of mercury in marine fauna, particularly fish, can result in impacts to higher trophic levels. Accordingly, Shell assessed and revalidated engineering alternatives for the control of any mercury that may partition into the produced water discharge during the design process. The outcomes of this assessment are provided in within Annex A.1.

Note that consideration of a buffer tank and recirculation system was considered during select engineering phase and FEED as outlined in section 5.8.2.1 of the Crux OPP. However, it was deemed not to be practicable given space and weight constraints associated with the platform size, and the buffer tank could not have been installed large enough to hold water for a meaningful amount of time to delay reprocessing. However, through further studies in detailed design, this was demonstrated to be further mitigated by the inherently sustainable design of the Crux produced water system in removing OIW to required specifications before discharge further outlined below. Temporary diversion of produced water to the low-pressure flare knockout drum (by remote control) is available to operators for maintenance or other purposes, however, this is not considered a procedural mitigation for upset conditions as the vessel design volume is ~32.7 m^3 which cannot accommodate large produced water flows.

In addition to these design provisions, the platform has been designed with various contingency measures to address changing water profiles in the future. These include space and weight provision on the cellar deck for the installation of another or additional produced water treatment package (such as hydrocyclones) should this be required in the future; and tie-ins and space for the injection of water clarifiers or demulsifiers if required to aid oil in water separation in the future.

In the OPP, a low-shear level control valve was nominated as selected treatment technology to maximise the size of oil droplets in the produced water streams. It was decided during detailed engineering design of the facility that the low shear valves will be purchased, but not installed and kept as back-up. The reason for this is because engineering assessments concluded that due to produced water service and high pressure drop, these low shear valves will potentially experience cavitation resulting in risk of rapid valve degradation, potential for failure and loss of containment. Additionally, whilst low-shear valves may reduce shearing, the resultant oil droplet size is not significantly improved as the valve is required to operate in a high pressure drop (high shear) service.

For start-up, two anti-cavitation valves were instead selected and installed to mitigate against cavitation risks. Cavitation will be assessed through physical observation and sound monitoring when operations commence and continued with surveillance and PTM during the unmanned mode. This design change is considered ALARP and acceptable as additional produced water treatment (dissolved gas flotation) has been included, providing additional direct treatment capability to separate small oil droplets from the produced water and therefore comply with the basis of design. This engineering solution was not previously considered in the OPP. In addition, Shell have purchased and will keep the low shear valves as spares which can be installed during commissioning and startup, if required to address separation performance.

The included and adopted treatment and storage technologies are therefore bulk liquid/liquid separation (refer above and section 6.7.7 and 6.7.8); produced water degasser vessel with dissolved gas flotation; space for additional treatment technologies; and disposal to the ocean via piping; with spare low-shear valves as detailed above.

The produced water handling system is designed for the full range of flows and conditions expected during field life from zero flow to ~19,020 b/d (~3,029 m^3). The predicted flow is from ~400 to 1,500 b/d (~69 to 235 m^3/d) expected in early to mid-field life (comprised mainly of condensed water), up to ~19,020 b/d (~3,029 m^3/d) (comprising condensed and formation water) that may be experienced later in field life (in the event there is breakthrough of formation water). Together with the sizing and capacity of the system components for these changing flows and conditions, remote monitoring, and systems available to detect and prevent the discharge of off specification produced water / formation water are designed to ALARP and acceptable levels.

4.2.7.2 Monitoring

For the measurement and analysis of the produced water treatment system, the Crux detailed design needed to develop a suitable option for the NNM philosophy. Typically, manned facilities would utilise an online UV fluorescence oil in water analyser for total oil, with manual samples typically taken periodically as required. However, the differentiators for the Crux detailed design are that it will not be manned for most of its operations, which limits the ability to carry out manual testing; and the project oil in water design is targeting dispersed/free

oil. Therefore, the ALARP review process in detailed design evaluated alternatives for analyser specifications to enable measurement of free/dispersed oil in water.

The conclusion of this assessment recommended the project continue with a microscopy analyser to measure to measure dispersed/free oil content. In addition to selecting analyser technology with microscopy functionality, the detailed design also selected two (2) analysers for installation providing maximum operator flexibility, redundancy and sparing, supplemented by a manual sampling port for ongoing analysis and calibration purposes when the facility is manned. Shell undertook a robust procurement process to select the OIW analyser for Crux. This involved the issuance of a requisition for tenderers that included specifications and datasheets alongside other relevant project documentation. A key part of this documentation is specification of not normally manned requirements which includes a 12-week 'no touch time' design requirement, design data including composition and design cases the produced water system, and requirement for vendor performance guarantees. All tenderers for the OIW analyser requisition submitted bids to supply the equipment which were then evaluated by Shell for a range of assessment criteria across all disciplines. Shell ensured the most appropriate vendor and technology were selected through this process. Once awarded, Shell required the vendor to produce various deliverables and a Factory Acceptance Test (using a condensate sample from Prelude FLNG which is very similar to Crux in characteristics) to assure the various design and operability requirements, which are then future assured by checks during the onshore and offshore commissioning stages. Vendor has produced confirmation that the maintenance schedule conforms to the 12 week no touch time requirement, with calibration only needed at start-up (when manned), self-cleaning with remote intervention, and validation in accordance with maintenance schedule (recommended minimum frequency is once per 24 months). At the time of writing, maintenance procedures have not yet been finalised for this vendor package. Shell production chemists work with the vendor data to produce operating procedures that enable calibration, validation, and management of the analysers throughout the lifecycle. This process provided assurance that the selected analysers are appropriate for the not normally manned facility and procedures will reflect the manufacturer's recommended maintenance schedules. The procurement and acceptance testing process enables Shell to conclude that the Advanced Sensors EX-1000M is suited to the physio-chemical properties of the hydrocarbon expected within the produced water.

The system is equipped with a set of alarms and controls that enable the remote operators to detect unstable conditions that require rectification (as discussed in the following section) and enable operators to visualise trends in oil-in-water concentrations, as well as remotely switch between the analysers should an issue occur with one of the analysers.

The Crux detailed design team are also working with Prelude FLNG to manage lessons learned and develop strategies of ongoing management of the analysers and sampling regimes.

4.2.7.3 Discharge

Treated produced water (i.e., outlet of the bulk separation, degasser and dissolved gas flotation system) will be discharged via a dedicated discharge pipe, which will terminate above the sea surface, to maximise nearfield dispersion and minimise marine growth and fouling (and eliminating hypochlorite dosing) and maintenance (a concept that has been carried since the OPP and during FEED).

Additionally, in line with analogous facilities in Australia, adaptive monitoring of the produced water effluent stream can be carried out and will be part of the Crux adaptive management process which will be described within the Operations phase environment plan.

The produced water will include additional components, which have been detailed in Table 1 for the formation water, in conjunction with the threshold concentration in accordance with the OPP / ANZECC, and the required dilution factor to achieve a no observed effect concentration.

Table 1 Produced Formation Water Design Composition

Constituent	Predicted Concentration (mg/L)	Threshold Concentration (mg/L)	Level of Species Protection (%)	Required Dilution Factor to Reach No Observed Effect Concentration (NOEC)
Benzene	240	0.5	99	480

Constituent	Predicted Concentration (mg/L)	Threshold Concentration (mg/L)	Level of Species Protection (%)	Required Dilution Factor to Reach No Observed Effect Concentration (NOEC)
PAHs (as Naphthalene)	10.7	0.05	99	214
Phenol	0.76	0.27	99	2.8
Cadmium (Cd)	4.6×10^{-3}	7.0×10^{-4}	99	6.6
Chromium (as Cr VI)	2.5×10^{-2}	1.4×10^{-4}	99	177
Copper (Cu)	9.2×10^{-3}	3.0×10^{-4}	99	31
Lead (Pb)	4.6×10^{-3}	2.2×10^{-3}	99	2.1
Nickel (Ni)	1.9×10^{-2}	7.0×10^{-3}	99	2.7
Zinc (Zn)	2.9×10^{-2}	3.3×10^{-3}	99	8.8

Produced water modelling was carried out as part of the OPP. The far-field stochastic modelling results indicated that high dilutions are expected to be achieved during the early operations phase (i.e., prior to formation water breakthrough), with 1:500, 1:2,000 and 1:4,000 dilutions expected to occur within 67 m, 356 m and 873 m, respectively, from the discharge location for all seasons. Stochastic modelling results for late phase operations (i.e., following formation water breakthrough) indicated these dilutions would be achieved at increased distances from the discharge location due to the increased discharge rate. Maximum distances at which 1:500, 1:2,000 and 1:4,000 dilutions are expected are 999 m, 4,696 m and 7,814 m respectively. No named shoals or key ecological features were predicted to be exposed to dilutions lower than 1:5,000, which indicates the concentrations of all produced water components as shown in the table above are expected to be below the threshold prior to encountering any sensitive areas.

Mercury is also considered to be present in the produced water stream – refer to Annex A.1 for details .

Based on the above, the produced water discharge will not result in a significant impact to the marine environment. The produced water treatment specified is considered ALARP, and the discharge is expected to rapidly dilute and ANZG (2018) guidelines values for relevant pollutants are predicted to be met within the allowed mixing zone (which has no sensitive ecological features), therefore ensuring risks of this discharge are as low as reasonably practicable.

4.2.8 Sewage Treatment

The Crux Platform has been designed as a NNM facility, with no permanent accommodation building currently planned. There is a temporary refuge, with two toilets, which was initially intended to be only for use in e.g., emergency conditions (and not for routine use). During platform visits for campaign maintenance, operators will utilise the toilet facilities on the support vessel and, based on the FEED design, were to use an ablutions container which would be lifted on to the facility for each maintenance campaign, then subsequently be lifted off and sent to shore. This ablutions container would store all sewage for onshore treatment and disposal.

This was reviewed in detailed design due to the potential health impacts associated with managing this sewage waste, as well as the overall inefficiency and fuel consumed in transporting this waste stream onshore. It is normal and acceptable practice for offshore facilities to macerate sewage and discharge overboard, which is a significantly simpler operation and minimises the potential for health impacts as well as the overall energy and GHGs associated with the sewage handling, transport and treatment. The environmental impact of this sewage discharge is not considered to be significant. As such, the design has changed to allow for maceration of sewage (to 25 mm or less) followed by discharge to the marine environment. This revised design is considered to minimise HSE risks and impacts to ALARP.

4.2.9 Hazardous Materials Storage and Bunding

The main hazardous materials storage on the Crux Platform, aside from with the process units themselves (which are designed to avoid loss of containment as part of the MAE design criteria), is the chemical supply tanks located on the upper deck.

Chemicals will be supplied by tote tanks, which will fill the Crux tanks on the upper main deck by hoses with unique, dry break couplings. To provide secondary containment in the event of a spill or leak, the upper main deck is plated and the chemicals tanks bunded, with capacity sufficient to capture the greater of 110% of the largest single tank, and 25% of the total volume. The bunded area surrounding the chemicals tanks is normally closed and isolated from the open drains system. On investigation, should the bunds contain leaked chemicals, these will be manually diverted through the chemical drains system to the oil side of the open drains separator, and subsequently to the waste oil tank for onshore disposal – as such, no chemicals are discharged overboard. As the above represents good practice offshore, it is considered ALARP for the nature and scale of the environmental risk.

4.3 Design Performance Standards

4.3.1 Oil in Water Discharge Detection (Produced Water)

The goal is to monitor and record produced water oil in water concentration to ensure levels can be demonstrated, and to monitor the flowrate of discharged produced water to enable reporting in line with regulatory requirements. The performance standard subsequently details performance criteria for the functionality, availability, reliability, survivability and interdependencies for analysers, flow meters, sampling points and associated equipment for these systems.

4.3.2 Emissions Monitoring Flare and Vent

The goal is to monitor and record gas streams sent to the HP and LP flares to enable greenhouse gas emissions reporting in line with environmental regulatory requirements. The performance standard subsequently details performance criteria for the functionality, availability, reliability, survivability and interdependencies for flowmeters, transmitters, and associated equipment for the flare systems (no venting applies).

4.3.3 Flare Tip Ignition System

The goal is to maintain, monitor and record the flare flame to avoid venting scenarios in line with regulatory requirements. The performance standard subsequently details performance criteria for the functionality, availability, reliability, survivability and interdependencies for the high energy ignition systems, secondary ignition systems, pilot assembly, flare monitoring system, CCTV with flame detection software and thermocouples and associated equipment.

4.3.4 Emissions Monitoring (Production and Throughput)

The goal is to monitor and record gas and condensate product exported to Prelude FLNG to enable energy reporting in line with regulatory requirements. The performance standard subsequently details performance criteria for the functionality, availability, reliability, survivability and interdependencies for flowmeters, transmitters, and associated equipment for the export systems.

4.3.5 Emissions Monitoring (Gas Turbine Generator - Fuel Gas)

The goal is to monitor and record fuel gas supply to each gas turbine generator to enable greenhouse gas emissions reporting in line with regulatory requirements. The performance standard subsequently details performance criteria for the functionality, availability, reliability, survivability and interdependencies for flowmeters, transmitters, and associated equipment for the GTG fuel gas systems.

4.4 Operate Performance Standards

The Operate phase performance standards, which are initiated in the detailed design phase, are converted in the replicate format used by Prelude FLNG and transformed into a format that applies an assurance task(s) and measurement criteria to each functional criterion. Preventative Maintenance task codes are also applied to enable uploading into the applicable Shell maintenance software, along with reference to relevant procedures, strategies, or control narratives. The Operate performance standards utilise the same naming convention as Prelude FLNG (to maximise uniformity in the operational team) and each signed off by a Technical Authority allocated by an internal technical integrity database. These Operate performance

standards are further developed and optimized during the start-up, ramp up and steady state operational periods.

These have been developed in the detailed design phase to ensure they are integrated into the Crux operation and maintenance systems from day one, which is a lesson learnt from the Prelude FLNG project which incorporated these into an operating asset.

5 Future Design, Quality Assurance and Operability Readiness and Verification Scopes

The Crux detailed design phase transitions from engineering design to onshore fabrication, construction, and cold commissioning both onshore and offshore prior to preparing for introduction of hydrocarbons. To achieve this, Shell and its contractors develop project execution plans which include detailed plans for commissioning execution, work execution flow schemes, completions management, testing philosophy and assurance, pre-commissioning plans, commissioning plans, hook-up and commissioning plans, and start-up and ramp-up plans. In preparation for Operations, Shell develops operating manuals, procedures, and maintenance schedules for operation of the facility (of which a key subset involves ongoing inspection and maintenance of environmental critical elements to assure environmental performance standards).

Throughout the entire process, Shell and its contractors operate quality management systems which integrate different levels of inspection, testing and acceptance regimes to provide verification that environment critical equipment is designed, fabricated, constructed, commissioned, and operated to the design intent. Prior to operating any system, it is a requirement that a Pre-Start up Safety Review is conducted to confirm that the system is at a level of completion with all necessary controls, procedures, and competency requirements in place to ensure safe operation. In addition, a Pre-Start-Up Audit is undertaken by the Shell assurance team prior to Crux start-up to confirm that the facility is in a safe state to operate, supporting systems are complete and operator competences in place.

Additionally, as part of the continual improvement process, lessons learnt from operating facilities have been identified and incorporated into Crux during the design phase to address aspects which may be applicable to the project. In particular, lessons learnt from Prelude FLNG have been reviewed for potential impact to the Crux Platform in all phases, and mitigations incorporated into the design.

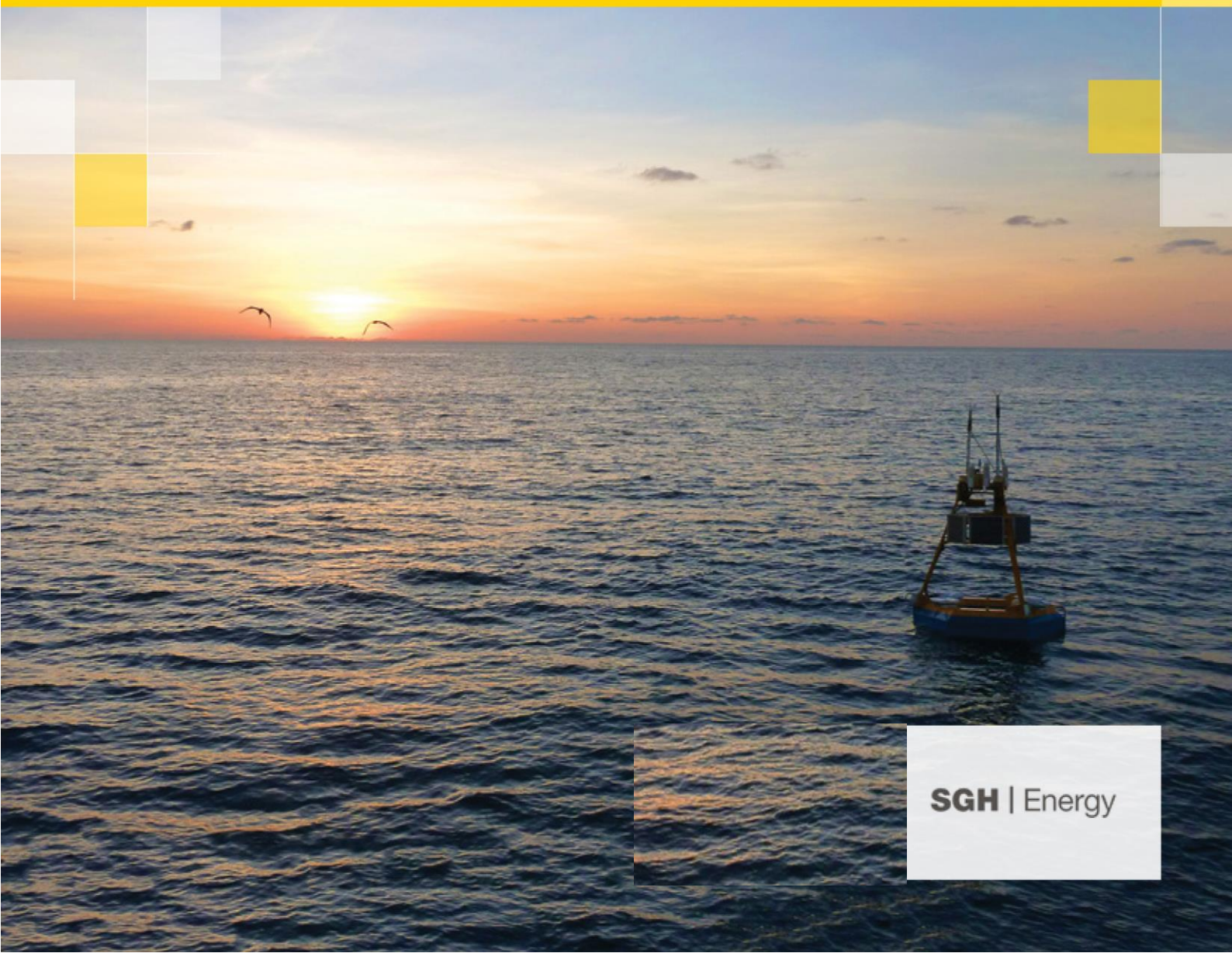
6 List of Acronyms

Acronym	Definition
ALARP	As Low as Reasonably Practicable
BDEP	Basic Design and Engineering Package
BESS	Battery Energy Storage Systems
BV	Bureau Veritas
CCS	Carbon Capture and Storage
CH_4	Methane
CO_2	Carbon Dioxide
CO_2-e	Carbon Dioxide Equivalents
Cth	Commonwealth
DGF	Dissolved Gas Floatation
ECE	Environmental Critical Elements
ENC	Environmental Non-Compliance
ENVID	Environmental Impact Identification
ESD	Ecologically Sustainable Development
FEED	Front-End Engineering Design
FID	Final Investment Decision

Acronym	Definition
FLNG	Floating Liquefied Natural Gas
FPSO	Floating, Production, Storage And Offloading
GHG	Greenhouse Gas
GTG	Gas Turbine Generator
HAZID	Hazard Identification
HEMP	Hazards And Effects Management Process
HP	High Pressure
HSE	Health, Safety and Environment
HSSE & SP	Health, Security, Safety, Environment and Social Performance
IMR	Inspection, Maintenance and Repair
LP	Low Pressure
MAE	Major Accident Events
MEE	Major Environment Event
NEPM	National Environment Protection Measures
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides, Typically Expressed as NO_2
OPGGS Act	Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPP	Offshore Project Proposal
PFW	Produced Formation Water
PLET	Pipeline End Termination
PW	Produced Water
RAM	Risk Assessment Matrix
Safety of Life at Sea	SOLAS
SEAM	Safety, Environment, and Asset Management
SMART	Specific, Measurable, Achievable, Realistic and Timely
TEG	Triethylene Glycol
TIV	Technical Integrity Verification

Annex A.1 Additional Information: Detailed Mercury ALARP Assessment

Crux Environment in Design Outcomes for Mercury Treatment



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Crux Environment in Design Process Outcomes for Mercury Treatment

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1 Executive Summary and ALARP Outcome

This document provides a summary of the mercury assessments conducted for the Crux facility, including best available techniques and practices evaluated to minimise environmental impacts and risks to as low as reasonably practicable (ALARP).

The document also provides further information on how the Minamata Convention on Mercury was considered in the design of the Crux facility and the controls that prevent or reduce mercury release to the environment.

1.1 Minamata Convention and Guidance

Oil and gas production facilities are potentially affected by Article 9 ('Releases') of the Minamata Convention, which focuses on controlling land and water releases of mercury. Under Article 9, a party to the Convention is required to take measures to control mercury releases from "significant anthropogenic point sources". In 2023, the Minamata Convention parties adopted guidance providing information on common release control techniques applicable to industry sectors (including oil and gas) to assist parties in fulfilling their obligations under Article 9. The Minamata Guidance includes considerations for the selection and implementation of Best Available Techniques (BAT) and Best Environmental Practices (BEP) to control releases from relevant sources. These considerations have been reviewed and the implementation of BAT and BEP are considered equivalent to an ALARP assessment under the OPGGS(E) Regulations.

1.2 Crux Project Mercury Basis, Emissions and Releases

Whilst only trace amounts of mercury were observed in Crux reservoir fluids during the exploration campaign (0.2 to 0.8 ug/Sm^3), mercury assessments have utilised a conservative basis of 150 to 240 ug/Sm^3, based on regional mercury data.

The Crux project began concept design in 2016 with the selected Not Normally Manned (NNM) platform concept described and approved in the Offshore Project Proposal (OPP) in 2020. Front End Engineering Design (FEED) for the project was completed in 2020 and reached Final Investment Decision (FID) in 2022, with supporting concept engineering and OPP phase ALARP assessment decisions confirming the techniques that will be utilised to minimise the impact of mercury to the environment. Throughout the design phases, information on best available techniques and practices (including the Minamata Guidance available at the time) was used to inform ALARP assessments.

As presented in the OPP, Shell evaluated a range of alternative facility options to inform the selected NNM platform concept. The design decisions incorporated into the platform concept provide inherent mercury control advantages compared to alternative upstream facility designs being developed in Australia (i.e. FPSO), which are based on low temperature gas dew pointing designs. Crux incorporates three critical process engineering design decisions, eliminating (i) low temperature gas dew pointing; (ii) condensate stabilisation; and (iii) subsea hydrate inhibitor injection. These measures implemented at Crux inherently prevent or reduce mercury releases at the Crux platform.

Critically, the NNM platform concept includes temperature control measures that ensure ~99% of produced mercury (~95% in late life) remains in the gas and condensate export streams to the Prelude Floating Liquefied Natural Gas (LNG) facility ("Prelude"). These gas and condensate streams are exported to Prelude which maximises the utilisation of the existing Mercury Removal Unit (MRU), that has been in operation on Prelude since 2018. By utilising BAT in the design, the worst-case mercury emissions and discharges are significantly lower than available industry mercury standards as summarised below:

- Produced Water Liquid Discharge (2.3 ug/L point source concentration, 0.1 to 2.6 kg/yr quantity depending on water flowrate) – the discharged mercury concentration is below treatment specifications for available produced water mercury removal technology as currently available in the market (e.g. MPPE / adsorbent beds remove mercury down to 10 ug/L). For all design cases, ANZG 99% species protection guideline value for mercury is achieved within the defined mixing zone surrounding the platform. The facility design achieves low mercury in water concentrations for all design cases. The predicted worst-case quantity of mercury discharge (2.6 kg/yr) in late life is not due to facilities performance but related to the potential for higher formation water production rates.
- Combustion Emissions from Power Generation (29 ug/Sm^3 worst-case point source mercury concentration, 2.9 kg/yr total mercury quantity) – concentration below the most stringent available

point source concentration limits for exhaust flue gases such as 200ug/Sm^3 Group 6 targets under the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW).

- Atmospheric Emissions from Flare (566 ug/Sm^3 pre-combustion point source concentration, 9.7kg/yr total quantity) – dispersion within the combustion zone of the flare tips will result in rapid reduction in concentration. Mercury concentrations are expected to be below detectable limits at sea-level and accessible areas on the platform. Shell will manage occupational exposure to mercury on the Crux platform through a Mercury Adaptive Management Framework.

1.3 Best Available Techniques, Best Environmental Practices and ALARP

Whilst the mercury control techniques included in the design of the Crux project result in mercury emissions and discharge being lower than regional analogues, an ALARP reassessment was conducted in December 2024/January 2025 to validate and reassess the facility design.

Consistent with good practice considerations, including the Minamata Guidance, this reassessment concluded that installing additional mercury treatment such as MRUs on Crux during execute or operate phase is not a reasonably practicable measure to further reduce mercury in any emission or discharge stream, given the costs of installation would be grossly disproportionate to the incremental reduction in mercury discharged.

All reasonably practicable design measures to reduce environmental risks and impacts have been implemented. The Crux design results in routing of ~99% of produced mercury during early operations phase (~8-9 years) and ~95% in late life, to Prelude which maximises the utilisation of the existing Prelude MRU.

Therefore, the risks and impacts are considered to have been reduced to ALARP. Further details of the ALARP assessment can be found in Section 4.

During the operational phase of Crux, the performance of the design techniques will be monitored using BEP. A range of controls have been adopted and incorporated within a Mercury Adaptive Management Framework to continually manage potential impacts of the produced water discharge and atmospheric emissions to ALARP and acceptable levels.

The Mercury Adaptive Management Framework ("Framework") ensures the nature, extent, and potential effect of mercury releases are adequately assessed as operational data becomes available. This Framework also helps to determine and assess the nature and scale of changes to water quality and atmospheric emissions in relation to applied triggers and thresholds.

The overall summary of control measures that will be adopted are detailed in Section 5. The measures will be included and further expanded upon (where required) in the Crux Completions, Hot Commissioning, Start-up and Operations Environmental Plan.

2 Applicable Legislation, Design Standards and Guidelines

This section describes the key requirements considered when assessing the facility design and operational processes required to control releases of mercury from the Crux facility.

2.1 Minamata Convention

The Minamata Convention on Mercury is an international treaty that seeks to protect human health and the environment from human-caused emissions and releases of mercury and mercury compounds. The Australian Government ratified the Convention on 7 December 2021, and it entered into force for Australia on 7 March 2022.

Oil and gas production facilities are potentially affected by Article 9 ('Releases') of the Minamata Convention, which focuses on controlling land and water releases of mercury. Under Article 9, a party to the Convention is required to take measures to control mercury releases from significant anthropogenic point sources (defined as "relevant sources").

The 2024 National Implementation Plan: Minamata Convention on Mercury (NIP) outlines how Australia is implementing its obligations under the Minamata Convention. The NIP stipulates that relevant sources are those reporting mercury emissions through the National Pollutant Inventory (NPI). The Crux project is expected to report through the NPI and consequently will be a relevant source under the Minamata Convention.

It is noted that Article 8 of the Minamata Convention defines controls for mercury emissions to air. However, Article 8 is limited to relevant sources for the following industry categories (and is not applicable for oil and gas production):

- Coal-fired power plants;
- Coal-fired industrial boilers;
- Smelting and roasting processes used in the production of non-ferrous metals;
- Waste incineration facilities;
- Cement clinker production facilities.

Notwithstanding that Article 8 is not applicable to the Crux facility, the below assessment includes both produced water and air emission sources to demonstrate ALARP for all sources of potential mercury discharge.

2.2 Minamata Guidance on BAT / BEP

At the Conference of the Parties (COP) to the Minamata Convention in 2023, guidance was adopted on Best Available Techniques (BAT) and Best Environmental Practices (BEP) for controlling mercury releases to land and water ("the Minamata Guidance"). The Minamata Guidance provides information on common release control techniques applicable to industry sectors (including oil and gas) to assist parties in fulfilling their obligations under Article 9 of the Minamata Convention[1].

The NIP provides that Australian facilities are expected to comply with the Minamata Guidance unless existing controls are demonstrated to be more protective of human health and the environment.

The Minamata Guidance defines BAT as those techniques that are the most effective to prevent and, where that is not practicable, to reduce emissions and releases of mercury to air, water and land and the impact of such emissions and releases on the environment as a whole, taking into account economic and technical considerations for a given party or a given facility within the territory of that party. In this context:

- "Best" means most effective in achieving a high general level of protection of the environment as a whole;
- "Available" techniques means, in respect of a given party and a given facility within the territory of that party, those techniques developed on a scale that allows implementation in a relevant industrial sector under economically and technically viable conditions, taking into consideration the costs and

[1] Although the guidance was adopted in 2023, the Minamata Guidance was formally distributed on 14 October 2024. MC_Guidance_Mercury_Releases_EN.pdf

benefits, whether or not those techniques are used or developed within the territory of that party, provided that they are accessible to the operator of the facility as determined by that party; and

- "Techniques" means technologies used, operational practices and the ways in which installations are designed, built, maintained, operated, and decommissioned.

The Minamata Guidance defines BEP as the application of the most appropriate combination of environmental control measures and strategies.

The process suggested in the Minamata Guidance for selecting and implementing BAT is as follows:

- "Step 1: establish information about the source, or source category. This may include, but not be limited to, information on the processes, input materials, feedstocks, or fuels, and on the actual or expected activity levels, including throughput. Other relevant information could include the expected life of the facility, which is likely to be of particular relevance when an existing facility is being considered, and any requirements or plans for controlling other pollutants.
- Step 2: identify the full range of options of emission control techniques and combinations thereof which are relevant for the source under consideration, including the techniques described in the chapters of this guidance on common techniques and on specific source categories.
- Step 3: among these, identify technically viable control options, giving consideration to techniques applicable to the type of facility within the sector, and to any physical limitations which may influence the choice of certain techniques.
- Step 4: from these, select the control technique options which are the most effective for the control and, where feasible, reduction of emissions of mercury, taking into account the performance levels mentioned in this guidance, and for the achievement of a high general level of protection of human health and the environment as a whole.
- Step 5: determine which of these options can be implemented under economically and technically viable conditions, taking into consideration costs and benefits and whether they are accessible to the operator of the facility as determined by the party concerned. Note that the options selected may differ for new and existing facilities. The need should also be taken into account for sound maintenance and operational control of the techniques, so as to maintain the achieved performance over time."

As construction of the Crux facility commenced in November 2022, Crux is considered to be an 'existing source' under the Minamata Convention, in contrast with new facilities which have greater opportunities to integrate BAT early in their project development stages.

2.3 OPGGS(E) Regulations

The OPGGS(E) Regulations require that Crux's activities be undertaken in a manner that continually reduces environmental risks and impacts to as low as reasonably practicable (ALARP) and an acceptable level. ALARP is achieved when all practicable measures to reduce environmental impacts or risks are implemented and any further measures not implemented are demonstrated to be grossly disproportionate in cost when compared to the reduction in environmental impact or risk reduction gained.

The definitions and suggested determination of BAT and BEP under the Minamata Guidance consider whether implementation can be undertaken under economically and technically viable conditions, allowing for the costs and benefits. Accordingly, the adoption of BAT and BEP is considered equivalent to an ALARP assessment under the OPGGS(E) Regulations.

2.4 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) (ANZG) provide a platform for consistent water quality management advice, technical support and tools for governments and the community to utilise. The ANZG are a joint initiative of the Australian and New Zealand governments to help manage water resources in both countries so that the use of water is sustainable, and the ecology of waterways is maintained.

The focus of the ANZG is water quality in the context of ecosystem health and management. Default guideline values (DGVs) and guidance documents ensure that specific physical and chemical stressors in waterways do not reach harmful levels for biota.

Shell has accounted for national water quality default guideline values (DGVs) defined in the ANZG, through modelling of the discharge stream and subsequent framing of future adaptive management monitoring programs once Crux is operational.

The ANZG guideline value for mercury is 0.1 µg/L for the 99% species protection level in marine waters and 1.4 µg/L for the 80% protection level.

2.5 Atmospheric Emissions Limits

Safe Work Australia sets Workplace Exposure Standards (WES) for airborne contaminants for occupational exposure, including mercury. These standards aim to minimise the impact of mercury emissions from industrial activities and ensure safe levels of mercury in the environment. These have been developed to protect against acute and chronic exposure.

Mercury and mercury compounds have been assigned WES by Safe Work Australia, also known as Occupational Exposure Limits (OEL).

Table 1 shows the current exposure standard for mercury (elemental and inorganic) is 0.025 mg/m³ Time-Weighted Average over an 8-hour workday[2]. Short-term exposure limits and other exposure guidelines apply in other international jurisdictions (not Australia). Shell will manage occupational exposure to mercury through a Mercury Management Procedure.

Table 1 Mercury Exposure Limits

Mercury Compound	Occupational Exposure Limit (OEL)		
	Time Weighted Average (TWA, 8 hours)	**Short Term Exposure Limit (STEL, 15 mins)**	**Immediately Dangerous to Life or Health (IDLH)**
Elemental mercury Inorganic divalent mercury compounds	0.025 mg/m^3	--	10 mg/m^3
Inorganic monovalent mercury compounds	0.1 mg/m^3	--	10 mg/m^3
Organic mercury – alkyl	0.01 mg/m^3	0.03 mg/m^3	2 mg/m^3
Organic mercury – aryl (aromatic chain)	0.1 mg/m^3	--	10 mg/m^3
Note: the 8-hour TWA OELs shall be adjusted for extended work shifts as per occupational health hazard management methodology to manage mercury exposure risk.			

Not all Australian jurisdictions have standards for emissions from point sources such as those from the flare and power generation exhaust. However, the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW) is generally the most comprehensive state-based legislation and often applied to projects throughout all Australian jurisdictions.

For the most stringent Group 6 criteria, this legislation includes a maximum point source concentration target of 0.2 mg/m³.

Mercury is not a regulated substance under the National Environment Protection (Ambient Air Quality) Measure or National Environment Protection (Air Toxics) Measure. These guidelines aim to minimise the impact of air emissions from industrial activities on the environment.

[2] Safe Work Australia - Workplace Exposure Standards for Airborne Contaminants. Note that the standard utilizes mg/m³ units (0.025 mg/m³ is equivalent to 25 ug/Sm³). Exposure standards - airborne contaminants | Safe Work Australia

3 Crux Mercury Basis and Partitioning Study

3.1 Mercury in Crux Reservoir Fluids

During the 2007-2008 Crux exploration campaign, onsite mercury measurements showed mercury concentrations between 0.2 to 0.8 ug/Sm^3 based on Drill Stem Test (DST) samples.

Whilst this provides a useful datapoint, it is difficult to accurately ascertain the concentration and speciation of mercury until the Crux wells commence production. Sampling of the Crux production fluids allows larger fluid volumes to be analysed based on more representative fluids (rather than fluids local to the well bore).

Noting this uncertainty, Shell's Geochemist in consultation with the Shell Thermodynamics Principal Technical Expert were consulted to establish an uncertainty range for the mercury concentration of the Crux fluids during the Crux Select Phase (Ref: 2000-0103323-00086 Technical Note - Investigation into Regional Mercury Content for Crux).

The mercury concentration uncertainty range for the Crux field was established as 150ug/Sm^3 (Base Case) to 240ug/Sm^3 (High Case). This was based primarily on the maximum mercury concentration from regional analogues including Shell exploration data. The principal species of mercury present at the inlet is expected to be elemental mercury, as measured in exploration well samples and consistent with regional analogues.

3.2 Mercury Partitioning in Crux Platform Facility

During the concept engineering phase, Shell evaluated a range of alternative options to inform the selected concept. The NNM Fixed Platform concept was identified as the optimal host type for Crux. The Crux design has significant advantages for mercury reduction compared to other upstream facility designs being developed in Australia (i.e. FPSO), which are based on low temperature gas dehydration design. It incorporates three critical process engineering design decisions, which eliminates (i) low temperature gas dew pointing; (ii) condensate stabilisation; and (iii) subsea hydrate inhibitor injection, that inherently prevent or reduce mercury releases at the Crux platform. This is a key point and differentiates the Crux facility from other facility designs in relation to mercury management.

Hydrocarbons from Crux are exported to Prelude which maximises the utilisation of the existing Mercury Removal Unit (MRU), that has been in operation on Prelude since 2018.

Throughout the design process, several techniques have been utilised to reduce GHG emissions from power generation and flare sources to ALARP as described in Appendix A – section 4.2. As mercury is a constituent component of the fuel gas and flare streams, the implemented GHG ALARP techniques have the added benefit of providing multi-pollutant control of mercury emissions.

A simplified process flow diagram of the Crux platform facility design is shown in Figure 1 below.

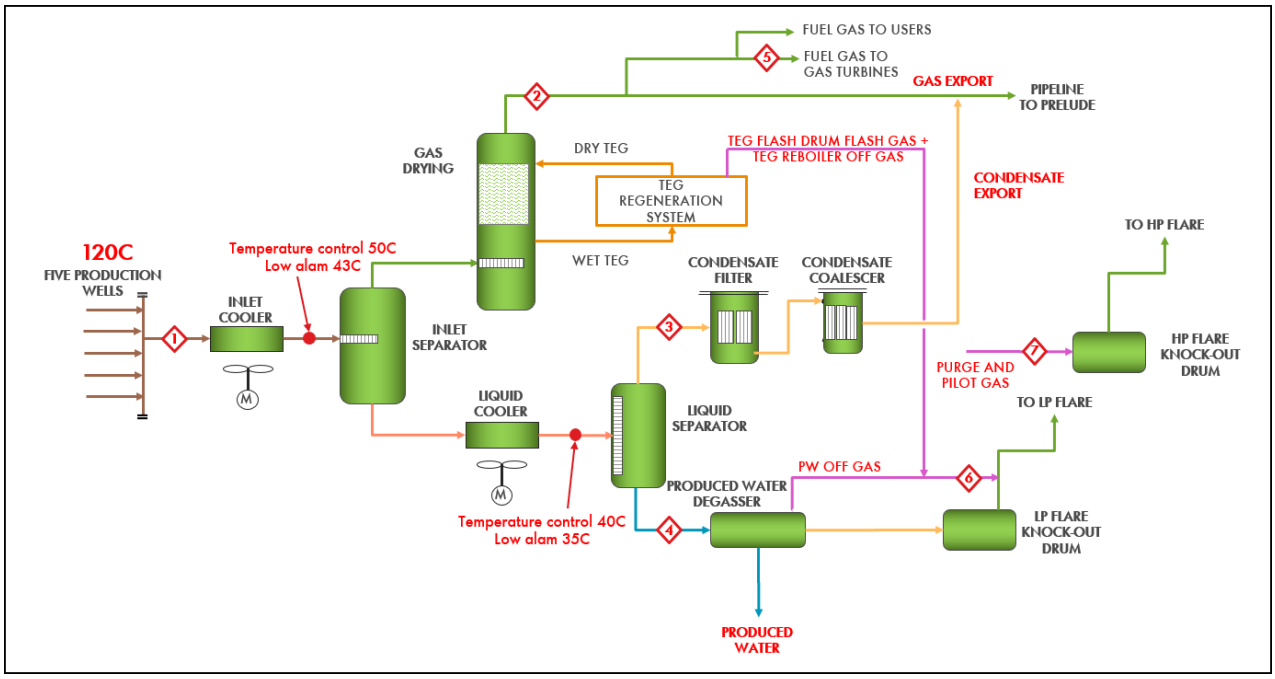


Figure 1 Crux Simplified Process Flow Diagram

With these design controls in place, the mercury content of streams within the Crux platform facility was estimated by performing a mercury partitioning study. The partitioning model used for Crux is based on internal thermodynamic models. This fluid package has been validated with both experimental data and operational measures of mercury solubility in hydrocarbon and water phases.

Partitioning studies have been performed for the design cases covering the different operating phases of the Crux project. These partitioning studies have been updated with the latest design cases and the results are presented below.

Table 2 shows the mercury partitioning study results utilising the High Case reservoir mercury concentration for three design cases representing potential operating conditions through the Crux lifecycle:

- Reference Case - maximum platform hydrocarbon production at initial reservoir pressure;
- End of Plateau - maximum hydrocarbon production at end of production plateau during mid-life. Platform operation will be in low pressure mode. This design case assumes formation water production from wells, resulting in elevated produced water discharge flowrates of ~11,000 bpd;
- Late Life – late life production case with formation water production at the design limit of the produced water system. Note that the ~19,020 bpd water production assumed for the Late life design case is very conservative.

Table 2 Predicted Mercury Concentrations for Crux Process

Process Area	Design Case	Mass flow (kg/h)	Hg Concentration Gas (µg/Sm^3) Condensate (ppbw) Produced water (µg/L or ppbw)	Hg Partitioning (% of Inlet Hg)	Hg Mass Rates (kg/yr)
Overall full well stream 1	Ref Case	665,855	240	100%	1,403.4
	End of Plateau	731,723	240	100%	1,450.8
	Late Life	242,115	240	100%	275.3
Gas export 2	Ref Case	569,828	183	71.37%	1,001.5
	End of Plateau	568,978	202	76.68%	1,112.2
	Late Life	104,796	226	85.69%	235.9
Condensate export 3	Ref Case	82,424	346	28.15%	395.0
	End of Plateau	71,682	491	22.35%	324.2
	Late Life	8,500	348	9.94%	27.4
Produced water 4	Ref Case	9,791	1.3	0.01%	0.1
	End of Plateau	86,711	1.8	0.10%	1.4
	Late Life	126,384	2.3	0.93%	2.6
Fuel Gas to Gas Turbines 5	Ref Case	1,480	183	0.18%	2.6
	End of Plateau	1,478	202	0.20%	2.9
	Late Life	758	226	0.60%	1.7
Low Pressure (LP) Flare Gas Note 1 6	Ref Case	2,231	187	0.27%	3.8
	End of Plateau	2,772	374	0.66%	9.5
	Late Life	1,576	566	2.76%	7.6
High Pressure (HP) Flare Gas Note 2 7	Ref Case	101	183	0.01%	0.2
	End of Plateau	102	202	0.01%	0.2
	Late Life	101	226	0.08%	0.2

Note 1: The LP Flare Gas is contributed from tanks blanketing gas, purge, pilot and flash and off-gases from the triethylene glycol (TEG) regeneration system during normal operations.

Note 2: The HP Flare Gas is contributed from purge and pilot gas during normal operations. For intermittent HP Flare Gas contributed by emergency platform blowdown, see Section 3.4.2.

3.3 Mercury in Produced Water

Mercury has been found to occur naturally in the Crux reservoir and therefore is expected to be present in condensed water and formation water.

Utilising the selected design techniques, the concentration of mercury into the Produced Water Treatment system is ~1.3 to 2.3 µg/L. At these concentrations, the predicted discharge loading of mercury into the marine environment commingled with the produced water discharge would be ~0.1-2.6 kg/yr depending on design case and/or year of production.

Fuel gas is used in the Produced Water Degasser dissolved gas flotation tubes to produce “whitewater”, to float very small oil droplets to the surface of liquids to improve separation performance. The fuel gas usage rate is small, between 8 to 18 kg/h with estimated mercury concentration of 183-202 µg/Sm^3. This was calculated to correspond to a low mercury generation rate of 0.015 to 0.030 kg/yr. Through process modelling work, it was found that this trace mercury amount will remain predominantly in the gas stream and leaves the Degasser with the flash gas to the LP flare.

In early life production, only condensed water is expected and the mercury in produced water discharge is ~0.1 kg/yr. During End of Plateau Case, formation water would potentially start to break through. With higher produced water rates during the End of Plateau Case, the mercury rate is increased to ~1.4 kg/yr. In Late Life Case, at maximum potential produced water rates, it was estimated that ~2.6 kg/yr of mercury to be discharged with the produced water.

Crux facility performance / production quality requirements do not change in late life and hence it is expected not to affect the mercury partitioning in late life. The higher mercury rate seen in late life is due to the higher formation water rate.

The estimated range for mercury concentration in the overboard discharge water is ~1.3-2.3 ug/L (or ppbw). Shell has engaged with mercury treatment unit vendors and understands that there is no proven technology/treatment or existing facilities that can treat below this estimate. Whilst many technologies may reduce mercury concentrations, Shell was not able to establish suitable vendor performance guarantees which would treat the very low mercury concentrations in the Crux produce water stream.

Further, Shell understands that two other developments in the same region have a mercury treatment unit in place, with an outlet specification of 10 ug/L. The mercury concentration for Crux is considerably lower, even when considering the high case of 2.3 ug/L, and below the treated outlet concentration of these regional developments.

3.4 Mercury in Atmospheric Emissions

3.4.1 Fuel Gas Users and LP / HP Flare Gas

The fuel gas sourced from the Crux wells may contain trace impurities from the reservoir, such as mercury, that gets partitioned into the gas stream. A minor proportion of this gas will be used as fuel gas for variety of uses: to supply fuel to gas turbine generators, for monoethylene glycol (MEG) tanks blanket gas, stripping gas used in the TEG regeneration system, purge gas for the HP and LP flare headers, fuel gas supply to Produced Water (PW) Degasser and fuel gas to the flare pilots.

The partitioning study predicts that the trace quantities of mercury present in the fuel gas have a concentration of ~183-226 µg/Sm^3 (Table 2).

Fuel gas supplied to the Gas Turbine Generators (GTG) will be combusted with air to produce electrical power for the Crux facility. The resultant combustion products will be sent to atmosphere via the GTG exhaust stacks.

Based on complete combustion and stoichiometric rate of air, with the presence of N_2, CO_2 and H_2O in the flue gas, the mercury concentration in the exhaust gas was assessed to be ~11-29 µg/Sm^3 (Ref: TEC_CRU_014506_02). This concentration is significantly lower than the most stringent Group 6-point source concentration target for exhaust flue gases (200 ug/Sm^3) under the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW).

The emissions associated to other fuel gas users will be to the LP and HP flare systems. Along with fuel gas, the LP Flare Gas waste stream will also consist of flash gas from the TEG Flash Drum and the off gasses from the TEG Reboiler and Produced Water Degasser.

Based on the partitioning study, the LP Flare Gas is expected to have a mercury concentration of ~187-566 µg/Sm^3 prior to combustion. The flare combustion process will result in rapid dispersion of this point source concentration.

It is estimated that a mass rate of ~2.6-2.9 kg of mercury per year will be emitted through the GTG exhaust; ~3.8-9.5 kg of mercury per year emitted through the LP flare system; and approximately ~0.2 kg of mercury per year emitted through HP flare system.

At the End of Plateau Case production, the worst-case mercury emissions are made up by the sources detailed in Table 3.

Table 3 Fuel Gas to Gas Turbines and Flare Gas Sources Emission Rates for End of Plateau Case

Options	Fuel Gas source kg/h	Flash Gas source kg/h	Total Gas Rates kg/h	Hg Mass Rates from Fuel Gas kg/yr	Hg Rates from Flash Gas kg/yr	Total Hg Mass Rates kg/yr
Gas Turbines Exhaust	1478	-	1478	2.9	-	2.9
TEG Flash Gas from Flash Drum	-	362	362	-	1.8	1.8
TEG Off Gas from Reboiler	638 (note1)	1239	1877	1.2 (note1)	0.57	1.8
Produced Water Degasser Off Gas	16.9	408	425	-	5.7	5.7
LP Flare Header Purge Gas	12.4	-	12.4	0.02	-	0.02
LP Flare Pilot Gas	3.5	-	3.5	0.01	-	0.007
MEG Storage Vessel Blanketing	92	-	92	0.2	-	0.2
HP Flare Gas Sources	101	-	101	0.2	-	0.2
Totals	**2342**	**2009**	**4351**	**4.5**	**8.1**	**12.6**

Note1: TEG Off Gas from Reboiler (= Stripping gas optimisation in Table 6) can possibly reduce Hg mass rate from 1.2 to ~ 0.2 kg/yr since minimum fuel gas rate for dehydration performance is required in TEG reboiler.

For the LP Flare Gas, the main contribution is the Produced Water Degasser off-gas, when it is letdown from high operating pressure of 100-123 barg to near atmospheric pressure, liberating dissolved gasses which contains trace mercury. The Produced Water Degasser off-gas, TEG off-gas generated at the Reboiler, and the TEG flash gas generated at the Flash Drum, are low pressure waste gas streams amounting to 8.1 kg/yr of mercury which cannot be treated unless it gets compressed to higher pressure.

When assessing fuel gas mercury reduction options, the total mercury associated with fuel gas usage is 4.5 kg/yr. This includes 4.3 kg/yr of mercury for fuel gas users connected to LP flare and 0.2 kg/yr of mercury associated with HP flare purge and pilot gas rates. As noted in the table above, there is an opportunity to optimise fuel gas usage for TEG stripping gas that could reduce mercury emissions by ~1 kg/yr (Table 4 summarises these sources).

Mercury emitted to the air on the Crux facility will undergo rapid dispersion into the atmosphere after release at the GTG stacks and flare system (with negligible predicted discharge via fugitive emission sources).

Table 4 Summary of Mercury Removal Opportunity from Fuel Gas Sources

Sources	Hg mass rate reduction from Fuel gas (kg/yr)
LP Flare Gas sources (Table 3)	4.3
HP Flare Gas sources (Table 3)	0.2
SUM total	**4.5**
Attributed to reduction in:	
TEG off gas from Reboiler (=stripping Gas)	1.0 (refer note 1, Table 3)
Other FG consumers	3.5

3.4.2 Intermittent Releases from HP Flare

During normal operation, the HP Flare system will only have minimal purge and pilot fuel gas consumption. The high pressure (HP) flare system is designed to enable pressure relief from high pressure hydrocarbon system and emergency depressurisation of the facilities in a sufficient time that reduces the risk of vessel failure and loss of facility integrity in the event of confirmed fire or gas, and for safely depressurising the facility during shutdowns.

Given the HP flare system is designed to depressurise the production facility, consisting of gas with mercury, it is expected that each HP flare event has the potential to emit mercury to the atmosphere. Based on blowdown calculation and modelling work, it is predicted that these intermittent events will emit ~75 grams of mercury per year on average (Table 5).

Table 5 Intermittent High Pressure Flare Gas Rates

Process Area	Design Case	Mass flow (kg/h)	Concentration Gas (µg/Sm^3)	Hg Mass Rates (kg/yr)
HP Flare Gas (normal production)	Ref Case	101	183	0.2
	End of Plateau	102	202	0.2
	Late Life	101	226	0.2
HP Flare Gas (intermittent)	Blowdown	36.9	200	0.069
	Controlled shutdown	3.1	200	0.006

The blowdown calculation assumes three unplanned emergency shutdowns with blowdown each year and one controlled planned shutdown with depressurisation every four years for major maintenance campaigns. The mass of production gas per blowdown was calculated by taking a constant two-thirds of peak blowdown rate over 15 minutes depressurisation. This is a conservative assumption given that the blowdown curve is a decaying curve; with 7 barg reached within 15 minutes; and to account for the final depressurisation to atmospheric pressure. The mercury mass rate is then calculated by multiplying mercury concentration in the gas stream (200ug/Sm^3 was taken) by the blowdown volumetric rates.

4 ALARP Assessment for Crux Mercury Emission and Release Controls

4.1 ALARP Decision Context

The ALARP assessment was conducted in accordance with NOPSMEA guidance and Shell's internal framework. This approach includes an assessment of good industry practice combined with engineering risk assessment, which was used to demonstrate the risks and impacts associated with releases of mercury from the Crux facility are ALARP and acceptable.

When performing the engineering risk assessment, the options were screened against key assessment criteria and the relative evaluation outcome was ranked with the following colour coding:

- Green – better outcome
- Yellow – outcome not a differentiator, some risks are present, but it is possible to address them
- Orange – worse outcome with major risks, and they are challenging to address
- Red – significantly worse outcome / feasibility concerns

As mentioned previously, the Crux platform facility design incorporates several features that inherently prevent or reduce mercury releases, ensuring that 99% of the mercury is directed through the gas and condensate streams to the Prelude FLNG facility (~95% in late life cases). These features are detailed in the engineering risk assessments together with an evaluation of treatment and control options which may achieve an incremental reduction of the remaining sources of mercury emissions/discharges on the Crux topsides.

The ALARP assessment for treatment options are based on the engineering risk assessments. Application of precautionary principles have also been applied in the form of a Mercury Adaptive Management Framework owing to the uncertainty relating to actual mercury production concentrations, speciation, partitioning and water chemistry; availability of proven technologies for mercury removal; and consideration of NNM operations.

As part of the ALARP assessment, mercury removal technology was assessed at four key locations (Figure 2), with the objective to reduce mercury discharged to the environment.

The main target streams are the produced water stream, the fuel gas stream and the flare gas stream. A fourth location, the main gas stream, was also included into the assessment, to evaluate the scale and cost of having this MRU in comparison with the other streams. These locations are illustrated in the process block diagram below, with a summary of the feasibility studies presented in the subsequent section.

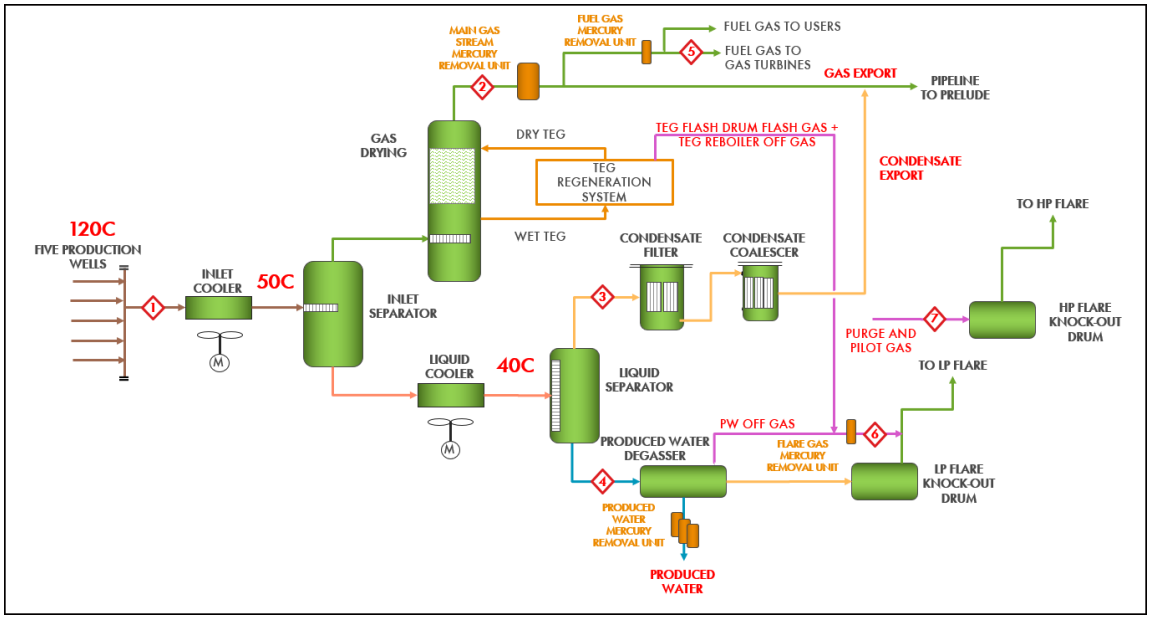


Figure 2 Crux Simplified Process Flow Diagram showing MRU locations

When considering additional hardware treatment options, a brownfield execution strategy will be required. A greenfield execution strategy would require delay of the Crux topsides sail-away and overall Crux start-up. As all hardware options considered would be expected to have execution schedules greater than 2-years, there will be significant cost impacts, which far exceed the brownfield execution cost (assessed in Sections 4.2 and 4.3). Delaying Crux start-up by more than 1 year would result in significant project value erosion in the order of many hundreds of millions of dollars, due to increased project costs (i.e. delay related capital and operational costs beyond the installation of the MRU) and delayed production and revenue stream. For this reason, the cost of a greenfield execution strategy is clearly grossly disproportionate to any incremental decrease in mercury emissions or discharges that may be expected.

The Mercury Adaptive Management Framework, further detailed in Section 5, will be implemented to continually manage potential impacts of the produced water discharge and atmospheric emissions to ALARP and acceptable levels over field life. The framework ensures the nature, extent, and potential effect of emissions and discharges is adequately assessed and helps determine and assess the nature and scale of any changes to water quality or emissions in relation to applied triggers and thresholds.

The framework will allow operational mercury data to be compared to design and trends to be analysed over time. The data collected will be combined with modelling predictions and used to assess whether the defined threshold / trigger values are likely to be exceeded and for how long this is expected to occur (duration). This methodology is typical to most offshore gas installations in Australia for all produced water components. Further details are included in Section 4.4.

For clarity, the ALARP assessments for produced water and atmospheric emission control options are presented separately.

4.2 Produced Water Treatment

4.2.1 Good Industry Practice

4.2.1.1 Minamata Guidance

The Crux project began its concept design in 2016, completed FEED in 2020, and reached FID in 2022. Consequently, the Crux facility is an ‘existing source’ under the Minamata Convention and supporting guidance, in contrast with new facilities, which have greater opportunities to integrate BAT early in their project development stages.

Given the scope of this EP only deals with the installation and cold commissioning of the Crux facility, the ongoing operation, maintenance, and decommissioning activities are not part of the scope of this EP. Therefore, details on the assessment of ALARP for mercury management on the Crux facility related to anything other than the installation methods, design, and construction of the facility, will be contained within future EPs.

The decision process was documented internally for concept selection and sanctioned in the design basis, and no further consideration has been given in the design to further produced water treatment measures for other contaminants, as the risks remain ALARP and acceptable. To expand on this statement further,

- Hierarchy of controls assessed (but did not adopt) options to eliminate discharge of produced water into the marine environment (i.e., disposal options other than overboard discharge).
- Engineering controls have been designed and engineered to maximise partitioning of any trace mercury toward the gas and condensate production streams (rather than produced water).
- As a result of Crux engineering design temperature controls, Shell has conducted mercury partitioning modelling studies and documented a conservative basis for partitioning of mercury into the produced water system, with a range of ~1.3 to 2.3 µg/L. This represents low influent mercury concentrations into the degasser, relative to other facilities operating with cold temperatures, continuous chemical injection (e.g., MEG or methanol) and/or condensate stabilisation facilities, unlike Crux. Mercury can exist in various forms, including elemental mercury, inorganic compounds, and organic mercury, however, Shell modelling and available data predicts that any produced mercury from the reservoir will be predominantly in the form of elemental mercury, which is expected to partition into the hydrocarbon gas and then condensate streams, given the Crux temperature regulation.
- In concept engineering phase, engineering controls for the treatment or removal of mercury in the produced water stream were assessed (by accounting for best available techniques, best environmental

practices, and standard industry practice as inputs into the demonstration of ALARP and acceptability) (refer Produced Water Treatment Options Review, 401012-02528-PR-REP-0005). As the Crux facility design inherently minimises mercury content in produced water, no additional engineering controls for mercury treatment or removal in the produced water stream were justified for the Crux platform. The assessment of studied technologies detailed in Section 4.2.2.

- Shell has designed engineering controls to prevent or reduce mercury releases to the environment in produced water by the design or provision for:
  - Routing of ~99% (~95% in late life) of mercury generated from Crux wells to Prelude FLNG gas and condensate systems including MRU.
  - Design of temperature control to maximise mercury to partition to gas and condensate stream for export to Prelude FLNG.
  - Design of a low temperature alarm to enable temperature and process optimisation and alert operators of upset conditions that could impact partitioning of mercury into water streams.
  - Design-out of continuous MEG and methanol injection into subsea wells, therefore eliminating chemicals which influence mercury to partition toward water streams. MEG and methanol increase the solubility of mercury in water.
- As already noted, Shell has conducted mercury partitioning modelling studies and documented a conservative basis for partitioning of elemental mercury into the produced water system, with a conservative range of ~1.3 to 2.3 µg/L. The ANZG guideline value for 99% species protection in marine waters is 0.1 µg/L. Assuming the maximum expected mercury concentration, the produced water would need to be diluted 24 times for the ANZG 99% species protection levels to be met in the receiving waters. Based on the produced water dispersion modelling carried out, 480 dilutions are achieved (99th percentile) within <40 metres for the future produced formation water breakthrough rates (and much sooner for the initial produced condensed water rates), suggesting dilution to below ANZG 99% species protection levels would occur within a few metres of the discharge point.
- The effects of mercury on marine ecosystems are highly dependent on mercury speciation (which affects bioavailability), concentration, and exposure duration (Wiener, 2013). The low bioavailability of the mercury expected to be present in the PW discharge and the very small area within which mercury concentrations in marine waters may exceed ANZG 99% species protection levels (RPS 2024) precludes significant acute toxicity effects on pelagic biota in the waters surrounding the platform. It also limits the potential for bioaccumulation, given the duration and extent of exposure of any pelagic community, including plankton, would be very low.
- Following discharge into the marine environment, dissolved mercury in the PW will likely form precipitates due to changes in pH and/or availability of reactants (e.g. oxygen, sulphide etc.) in the seawater. Precipitates are initially very small and will have low settling velocities (or may remain suspended). Some of the discharged mercury may become adsorbed onto the surface of natural suspended solids present in the receiving waters. Glenn (2004) showed that sediments locally derived from the water column in the region are generally very fine (i.e. silt and clay sized particles). Considering the small size of mercury precipitates/ adsorbed particles and the water depths (~160 m) at the platform location, they are likely to be widely dispersed at very low concentrations before ultimately settling to the seabed. Baseline studies indicate that sediment mercury levels in the Crux Project area are around an order of magnitude below ANZG 99% species protection levels for marine sediments (AECOM 2017). Due to the effective dispersal of discharged mercury, mercury levels in seabed sediments around the platform are expected to remain below ANZG 99% species protection levels and no discernible effect on regional sediment mercury levels is anticipated.
- Shell will develop, maintain and implement a Mercury Adaptive Management Framework, which forms part of Shell's controls to ensure mercury emissions and discharges from the Crux facility are reduced to ALARP throughout the life of the asset. This is further detailed in Section 5.

4.2.1.2 National Standards – National Water Quality Default Guideline Values

Shell has accounted for national water quality default guideline values (DGVs) defined in the ANZG, through modelling of the discharge stream and subsequent framing of future adaptive management monitoring programs once Crux is operational. The ANZG guideline value for 99% species protection in marine waters is 0.1 µg/L.

When considering the maximum mercury concentration (240ug/Sm^3 - High Case), the produced water is diluted within the defined mixing zone to achieve this ANZG guideline value. Dilution to below ANZG 99% species protection levels is expected to occur within a few metres of the discharge point. Shell commits to further and ongoing evaluation as part of ongoing Mercury Adaptive Management Framework (Refer to Section 5).

4.2.1.3 Assessment of Analogue Data

Mercury limits are often specified in commercial agreements for gas (LNG and domestic gas) and condensate products which can inform the requirement for mercury removal equipment. Mercury may also impose materials integrity risks for some facilities processing (such as liquid metal embrittlement). These reasons may typically justify the installation of Mercury Removal Units (MRUs) for the purposes of meeting safe product specifications and/or process safety management (i.e. materials protection), generally upstream of LNG liquefaction, which is relevant the case on Prelude, not the Crux platform. There are many precedents in Australia for facilities that have operating MRUs upstream of LNG liquefaction, and some wet gas installations upstream of acid gas removal.

Trace contaminants, including metals such as mercury, are common in gas reservoirs and therefore trace components would be expected in produced water streams for many facilities. However, the quantification of mercury is challenging and complex until well production commences, when sampling and analysis programs can then be undertaken. The composition of elemental and inorganic mercury forms and site-specific water chemistry is critical for the design of removal systems. For these reasons, if the facility does not introduce a risk of significant mercury partitioning to the water stream, it has not historically been typical for offshore gas installations to include mercury removal equipment on produced water discharge streams.

There are facilities with proposed designs that are different to Crux and have an increased partitioning to the water stream due to operating at colder temperatures, removal of mercury from condensate as part of stabilisation processes and/or continuous injection of hydrate inhibitor chemicals (such as MEG and methanol which increase mercury solubility in water). Due to their different design to Crux, these facilities have process conditions that result in higher partitioning and concentrations of mercury in produced water streams. This increases the requirement for mercury reduction resulting in the selection and implementation of engineering solutions.

Removal of mercury in produced water streams in the offshore gas industry does not have decades of precedent / analogue data (in Shell or within industry) and good practice is not well defined. In the recent decade there has been an emergence of vendor solutions for mercury removal on offshore water streams which have required ongoing maturation and proving. Whilst many technologies may reduce mercury concentrations, Shell was not able to establish suitable vendor performance guarantees which would treat the very low mercury concentrations in the Crux produced water stream.

For example, available data from vendor suggests that analogue facilities proposing organoclay media for adsorbent beds for mercury removal in produced water streams indicate that the treatment specification for the discharge stream of 10 ug/L is higher than the estimated influent concentration for Crux (~1.3 to 2.3 ug/L). This technology has been assessed as part of the alternative's evaluation (refer to Section 4.2.2).

4.2.1.4 Assessment of NNM Considerations

Crux is designed for a not normally manned philosophy with a campaign visit frequency of up to once every 12-weeks. The NNM philosophy results in considerably fewer hours spent offshore by personnel and considerably fewer opportunities for personnel to be exposed to health and safety risks. Offshore oil and gas industry statistics clearly show a strong correlation between the hours worked offshore and the number of health and safety incidents. Hence, the considerable reduction in hours worked offshore for an NNM platform compared to a manned platform yields a significant safety benefit to employees and contractors.

To achieve this objective, NNM platforms have additional requirements to maximise simplicity to minimise the requirement for platform visitations / minimise offshore manhour exposure. Treatment options requiring frequent interventions (such as adsorbent bed changeout) require evaluation of potential health and safety trade-offs.

Shell (and industry), typically manage the occupational health and safety aspects via mercury management procedures. Shell is not aware of a not normally manned offshore platform (with 12-week no touch time design basis) with mercury removal equipment for produced water discharge streams. Good practice for mercury management on NNM facilities is not well defined.

4.2.2 Engineering Risk Assessment

4.2.2.1 Existing Design

The Crux design results in routing of ~99% of produced mercury during early operations phase (~8-9 years) and ~95% in late life, to Prelude which maximises the utilisation of the existing Prelude MRU.

This strategy optimises the use of existing equipment, avoiding the need for additional MRUs on the Crux platform, and thus preventing resource inefficiency. The design, operations, and maintenance of the Prelude FLNG facility's MRU are detailed in the current Prelude FLNG EP, and the processing of Crux gas and condensate will only commence once a revised EP is accepted by NOPSEMA. The remaining <1% of mercury not directed to Prelude FLNG is managed on the Crux facility primarily through temperature control at the Crux facility inlet, significantly reducing mercury in the facility emissions and discharges.

During the design process, engineering solutions for the control of any mercury that may partition into the produced water discharge were assessed. This included assessment of best available techniques and best environmental practices is in alignment with the Minamata Convention and Guidance.

The following is a summary of design measures that were adopted and incorporated into the existing design.

- MRU at Prelude FLNG (adopted at concept engineering phase) – the existing MRU on Prelude FLNG was assessed for capability to process Crux hydrocarbon production fluids alongside concept phase studies on other technologies detailed below. The Prelude MRU has sufficient capability to treat additional mercury received from the Crux platform within gas from the Prelude acid gas removal unit and gas recovered from the Prelude condensate stabilisation system. To utilise this capability, the Crux platform facility was designed to maximise the partitioning of mercury into the hydrocarbon production fluids utilising measures such as temperature control and minimisation of production chemicals.
- Crux Facility Temperature control (adopted at front end engineering and execution phase) - temperature management is a critical component in the Crux design. Temperature control is primarily required to manage the effectiveness of gas and condensate dehydration processes. However, higher temperature is also an effective control in reducing mercury content in the water stream. The multiphase wellstream is initially cooled from 120°C to ~50°C in the Inlet Cooler. At this temperature, 70-85% of the mercury in the inlet stream will remain in the gas phase. The liquids (condensate and produced water) are separated and further cooled at the Liquid Cooler to ~40°C. At this temperature, the mercury partitions to condensate at ~9 to 28%. The use of this control in the Crux process system is expected to result in ~99% of produced mercury (~95% in late life) of the mercury partitioning to the hydrocarbon phase and routed to Prelude FLNG.
- Low temperature alarm (adopted at front end engineering and execution phase) - a temperature controller with low alarm is installed upstream of the inlet separator, providing operators with surveillance of process temperatures prior to the bulk separation stage. A low temperature alarm system has been installed with 43°C Inlet Cooler and 35°C Liquid Cooler limits. These temperature limits ensure mercury partitioning in water remains <~0.01% (Early Life Reference Case) and ~1.0% (Late Life Case).
- Elimination of continuous chemical injection (adopted at concept engineering phase) – the presence of chemicals such as MEG and methanol (commonly used for continuous hydrate control in subsea production systems) increases solubility of mercury in water. The Crux facility concept has designed out the requirement for continuous chemical injection within the Crux production fluids, therefore eliminating the possibility of chemicals increasing the mercury concentrations in the produced water. Furthermore, drains that may contain glycol / chemical contaminates are collected and routed to a separate oil collection bucket within the Open Drains Separator. This enables fluids to subsequently be pumped to a portable Waste Oil Storage Tank for onshore disposal. This configuration ensures glycol / chemicals are not returned into the process that could contaminate the produced water stream.

4.2.2.2 Alternative Treatment Options

In addition to the design techniques that have been adopted in the existing design, the following alternative treatment and control technologies were assessed for mercury removal from produced water stream:

- Liquid-Liquid Solvent Extraction Media: utilisation of a vessel containing media with solvent extraction properties. A Macro Porous Polymer Extraction (MPPE) system was considered for this technique. The capability for MPPE to remove mercury was assessed alongside its effectiveness in oil in water treatment.
- Adsorbent Beds using Activated Carbon or Organoclay: pressure vessel installed in the produced water stream containing either sulphur-impregnated activated carbon technologies or organoclay adsorbent media. For this ALARP assessment, a proprietary media based on modified organoclay technology named (CrudeSorb MR) was assessed in detail for its feasibility and its vendor was contacted to gather more information on the technology and cost. Organoclay is produced by combining clay with a cationic quaternary amine salt, which replaces adsorbed sodium by ion exchange. Resulting clay surfaces become organophilic. The quaternary amines create organic "pillars" between the clay platelets that increase the interlamellar distance and facilitate the formation of a hydrocarbon partition. Once the media is spent, it needs to be replaced.
- Membrane / Filtration: membrane filtration involves passing water through a semi-permeable membrane with precisely designed pores. These pores allow smaller molecules and particles to pass through while blocking larger ones, such as mercury ions. The process can be categorized based on pore size. Membranes are available in a range of materials and pore size ranging from micro, ultra, nano, or reverse osmosis. Before membrane filtration, a pretreatment step is used to cause the mercury to form precipitates that can be more effectively removed by this technology. A ceramic membrane filtration technique has been assessed in the options assessment.

The following treatment technologies were evaluated but not included in the ALARP assessment due to there being significant technology maturity issues for offshore usage:

- Chemical Precipitation – utilises chemical precipitants such as sodium sulphide (Na_2S) or lime ($Ca(OH)_2$) added to the water stream. These chemicals react with mercury ions to form insoluble mercury compounds. The solid precipitates are then separated from the water through sedimentation or filtration. This leaves the water with reduced mercury levels. Typically used for bulk mercury removal and may be inadequate as a standalone means for reducing mercury concentrations below stringent discharge limits. Often used as part of a larger treatment train, where it typically functions as a primary treatment step prior to other water treatment steps. Requires several step processes which includes to first oxidise elemental mercury to form ionic mercury before it can be treated, followed by using chemicals to precipitate out the solid mercury compound, and then with clarification or filtration to remove the sludge and solids. Proven designs utilise large tanks and filters which is not suitable for offshore application with limited footprint. As the technique removes ionic mercury that has not been measured in Crux or regional samples, it would require additional information on Crux mercury speciation for technical assessment. It is currently not considered technically feasible to deploy this technique and will not be further evaluated. CAPEX: USD$ +120 mln.
- Ion Exchange Resin - ion exchange resins are typically small, porous beads made from organic polymers. These beads are functionalised with specific chemical groups that can selectively bind to mercury ions. When water passes through the resin, mercury ions (Hg^{2+}) in the water are exchanged with less harmful ions (such as Na^+ or H^+) that are initially present on the resin. This process effectively removes mercury from the water. Upstream filtration step is necessary to prevent plugging, as the suspended particles in the feed should normally be less than 50 mg per litre. The resin can be regenerated by washing it with a concentrated solution of a regenerant (e.g., hydrochloric acid), which removes the bound mercury ions and restores the resin's capacity for further use. Requires extensive maintenance and regeneration which is not suitable for NNM. Narrow operating windows for flows, temperatures and pressures and typically used for final stage polishing. As with chemical precipitation, this technology has not been proven for offshore use and removes ionic mercury that has not been measured in Crux or regional samples. It is currently not considered technically feasible to deploy this technique and will not be further evaluated. CAPEX: USD$ +120 mln.

4.2.2.3 Evaluation of Treatment and Control Alternatives

Technically feasible options were screened based on key value drivers and the relative evaluation of risk assessment outcome were ranked with colour coding, with green being the best and red the worst (Table 6).

Table 6 Mercury Removal Options Assessment for Produced Water Stream

Options	Mercury that can be removed	Deployability (Technology Maturity)	Lifecycle Cost (CAPEX / OPEX)	Module weight & Footprint	Environment & GHG Impact	HSE Risk & NNM	Outcome
1. Existing Design (inc. operational control techniques)	Controls reduce mercury emission to ~0.1 to 2.6kg/yr	Yes	~USD $2 mln OPEX	No Impact	Base Case	Base Case	Adopted
2. Liquid-Liquid Solvent Extraction Media (e.g. MPPE)	Unknown (effective for solid mercury removal)	Yes	~USD 120 mln CAPEX ~USD 50 mln OPEX	~360 MT Major topside and substructure design weight exceeded. ~200 m2	Steam regeneration required. Increased GHG emissions Further reduces OIW levels	Higher offshore manhours to operate and maintain equipment	Rejected, subject to future revalidation
3. Adsorbent Media using Activated Carbon / Organoclay	Removes ~0.02 to 1.5 kg/yr elemental mercury @ ~57% efficiency	Possible but concentrations beyond vendor proven technology.	~USD 75 mln CAPEX ~USD $30-50 mln OPEX	~90 MT ~70 m2	Reduced mercury emissions. Offset by increased solid absorbent wastes	Higher offshore manhours to replace adsorbent media (change-out every 9-weeks)	Rejected, subject to future revalidation
4. Ceramic Membrane Filtration	Unknown (effective for solid mercury)	Requires de-risking	~USD 100 mln Capex ~USD $40 mln OPEX	~300 MT Major topside and substructure design weight exceeded. ~330 m2	Reduced mercury emissions. Collected solids require disposal.	Backwash system complex requiring increased offshore manhours	Rejected, subject to future revalidation

Risk Assessment Evaluation Legend:

Relative Evaluation	Descriptor
	Significantly worse outcome / feasibility concerns
	Worse outcome with major risks, and they are challenging to address
	Outcome not a differentiator, some risks are present, but it is possible to address them
	Better Outcome

Option 2 (MPPE). Challenges included:

- Only treats solid mercury, not elemental mercury, which is the expect form on Mercury in the Crux produce water stream.
- The weight of approximately 360 MT and footprint of 200 m^2 will requires a significant deck extension and is considered a major exceedance of the current topside and substructure design weight limits; therefore, preliminary analysis demonstrates that there is a very high risk that the outcome of further feasibility work would demonstrate that the required extension is not technically feasible.

- Introduced mercury wastes handling on Crux.
- Requires low pressure steam which is not available on Crux (and would require increase in energy demand).
- Requires addition of ~1MW boiler to produce the steam. This increases platform electrical power or fuel gas requirements and associated GHG and atmospheric emissions.
- Requires four MPPE columns and other equipment in the package, such as pumps, water condenser and heat exchanger, which are all high maintenance items and increase parts count and complexity.
- Bed regeneration creates additional water, hydrocarbon liquid and vapour streams – each requiring management adding significant operational complexity for NNM.
- MPPE skid is large at ~10 x 11 x 17m (L x W x H), excluding utilities.
- No precedent for offshore upstream gas processing platforms.
- Not used specifically for removal of mercury with vendor guarantees. Incremental increase in offshore manhours and platform visits.
- Increase in design and operations complexity.

For these reasons, the potential benefits in reduced mercury emissions are outweighed by many engineering challenges, including a significant weight and size-based feasibility risks. Even if these barriers could be overcome, the costs (~USD$170 mln) of adopting this option is considered grossly disproportionate to the incremental decrease in mercury discharges.

Option 4 (Ceramic membrane filtration). Challenges included:

- Only treats solid mercury, not elemental mercury, which is the expect form on mercury in the Crux produce water stream.
- The weight of approximately 300 MT and footprint of 330 m^2 will require a significant deck extension and is considered a major exceedance of the current topside and substructure design weight limits; therefore, preliminary analysis demonstrates that there is a very high risk that the outcome of further feasibility work would demonstrate that the required extension is not technically feasible.
- Upstream filtration (UF) is also used for mercury removal applications. As UF has large pores and unable to capture dissolved mercury ions, it is used following precipitation, which results in larger particles. UF requires additional step to precipitate out the dissolved elemental mercury prior to filtration.
- High footprint requirement compared to other technologies.
- UF step is required to avoid plugging of membrane.
- Technology not yet fully deployed and require further derisking trials to establish field specific fouling of membranes.
- Limited precedent in offshore gas processing for PW treatment to remove oil and solids form PW, and no known application for mercury removal.
- In Shell, not deployable technology as it requires project specific derisking to determine performance (sustainable flux/require membrane area, cleaning frequency, etc.).

For these reasons, the potential benefits in reduced mercury emissions are outweighed by many engineering challenges, including a significant weight and size-based feasibility risks. Even if these barriers could be overcome, the costs (~USD$ 140 mln) of adopting this option is considered grossly disproportionate to the incremental decrease in mercury discharges.

Based on this technical assessment of the various technologies that are available, the most potentially suitable technology for mercury removal for Crux produced water is the Adsorbent Beds (Table 6, option 3). This option is shown in Figure 3 and assess in detail below.

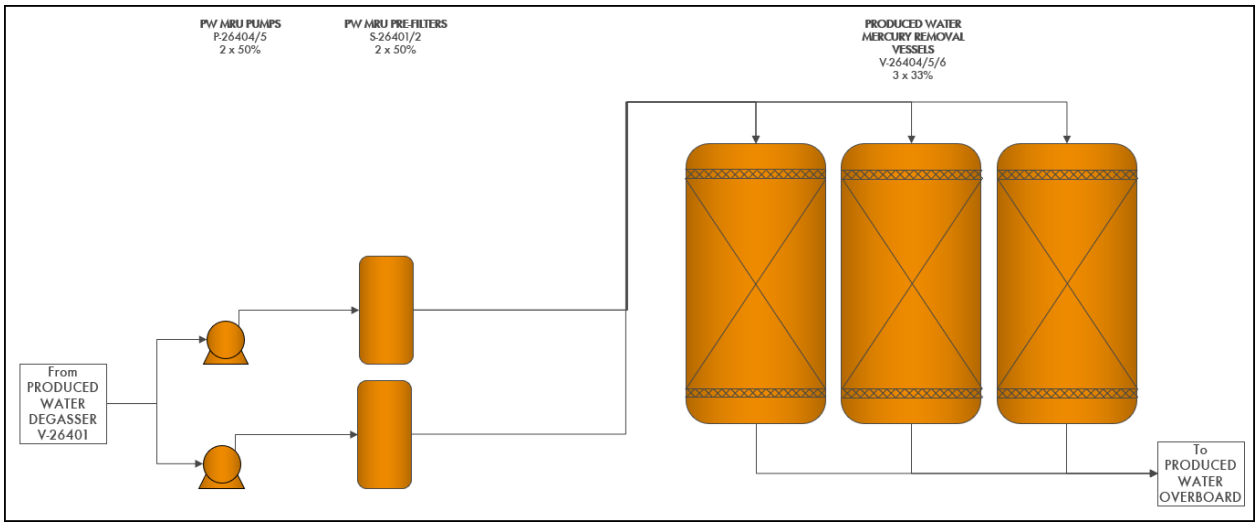


Figure 3 Flow Diagram for Option 3 Adsorbent Bed Mercury Removal Unit for Produced Water

Option 3 (Adsorbent Beds). The areas that were considered challenging for the Adsorbent Bed technology application are:

- Technical capability / maturity – although technically deployable, the performance of adsorbent media under the Crux design parameters is uncertain. The estimated worst-case Crux inlet concentration of mercury (2.3 ug/L), is considered to be very low, in comparison with the other two analogues developments in the region which have treated outlet concentrations of up to 10 ug/L. Large footprint and weight is grossly disproportionate when compared to the reduction in impact or risk reduction gained. The CrudeSorb MR adsorbent media offered by Cetco has been proposed for two projects in Western Australia, but they are not yet installed, with no proven permanent operations experience (Figure 3). No precedent for NNM gas processing platforms.
- Capex - The cost was exacerbated by executing the work offshore, which involves transport and installation vessel and labour rates, referenced from existing contracts and other in-house cost data. The installation of Produced Water MRU needs a deck extension to the existing facility, which is included in the total costs.
- Footprint – Due to the size of the beds and hence footprint, it is not possible to fit this skid into the existing platform. This entails the addition of a deck extension, which is estimated to incur a high cost of approx. USD$14 mln.
- NNM – Crux is designed for a not normally manned philosophy of a campaign visit of up to once every 12-weeks. The vendor recommended change-out frequency of every 9-weeks will result in more frequent and additional offshore hours, requiring changes to the NNM philosophy and erode safety benefits (Section 4.2.1.4). Furthermore, the bed change-out frequency is uncertain. Several factors may reduce adsorption capacity and increase the frequency of change-out. Media performance based on Crux produced water composition would need to be demonstrated.

Given these challenges, the cost, effort, feasibility constraints and operational impacts for Adsorbent Bed technology is considered grossly disproportionate to the potential environmental benefits that may be gained.

Therefore, the concept engineering and ALARP assessment to utilise the existing design techniques without additional produced water treatment remains valid based on currently available data.

4.3 Atmospheric Emission Treatment

4.3.1 Good Industry Practice

4.3.1.1 Minamata Guidance

As per liquid discharges, engineering solutions for the control of any mercury from atmospheric emission sources were assessed during the design phase.

Whilst the Minamata Convention is not applicable for atmospheric emissions from oil and gas production facilities, the Minamata Guidance was used as a consideration in the ALARP analysis throughout the design phase. This included assessment of good practice, BAT, and BEP in system concepts and designs, documented through engineering phases, and was considered against factors such as uncertainty of fuel gas composition outcomes, safety, health, NNM, operability, cost, and waste minimisation drivers.

4.3.1.2 Atmospheric Emissions

National Pollutant Inventory Reporting - Mercury emissions and discharges from the Crux facility are reduced in compliance with the OPGGS(E) Regulations, thereby minimising environmental impacts and risks to ALARP. As required by legislation, Crux will report relevant types and amounts of relevant National Pollutant Inventory substances as required by the *National Environment Protection (National Pollutant Inventory) Measure 1998* (established under the *National Environment Protection Council Act 1994* (Cth)).

Ambient Air and Air Toxics - Mercury is not a regulated substance under the *National Environment Protection (Ambient Air Quality) Measure* or the *National Environment Protection (Air Toxics) Measure*. Not all Australian jurisdictions have point source emission standards, however, the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW) is generally the most comprehensive state-based legislation and often applied to projects throughout all Australian jurisdictions.

Not all Australian jurisdictions have standards for emissions from point sources such as those from the flare and power generation exhaust. However, the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW) is generally the most comprehensive state-based legislation and often applied to projects throughout all Australian jurisdictions.

Shell partitioning studies predict that the trace mercury composition in the fuel gas to GTG will be low (~0.2% of mercury produced from Crux wells is modelled to partition into the fuel gas stream). Using this fuel gas concentration, the mercury concentration in GTG exhaust gas was assessed to be ~11-29 µg/Sm^3 (Ref: TEC_CRU_014506_02). This concentration is significantly lower than the most stringent Group 6-point source concentration for exhaust flue gases within the *Protection of the Environment Operations (Clean Air) Regulation 2022* (NSW).

4.3.1.3 Workplace Exposure Standards

For occupational exposure, Safe Work Australia sets the Workplace Exposure Standards (WES) for airborne contaminants, including mercury. The current exposure standard for mercury (elemental and inorganic) is 0.025 mg/m^3 Time-Weighted Average over an 8-hour workday.

Occupational exposure limits are achieved at all accessible areas on the platform and mercury concentrations are below detectable limits at sea-level. Shell will manage occupational exposure to mercury on the Crux platform through a Mercury Management Procedure.

4.3.1.4 Assessment of Analogue Data

As noted in the produced water assessment, installation of MRUs for the purposes of meeting safe product specifications and/or process safety management (i.e. materials protection) is common. There are many precedents in Australia for facilities that have operating MRUs upstream of LNG liquefaction (which Prelude FLNG currently includes), and some wet gas installations upstream of acid gas removal. Whilst it is technically possible to utilise MRUs to remove mercury from fuel and flare gases, limited precedent exists for mercury concentrations expected within the Crux facility.

Mercury is a common contaminant in gas reservoirs and formations and therefore is a trace component in power generation exhaust and flare emissions for many facilities. As with produced water streams, the quantification of mercury is challenging and complex. Whilst limited mercury was measured during the Crux exploration campaign, the Crux mercury design basis has a large range as it incorporates maximum mercury concentrations from regional analogues. The composition of mercury species within the reservoir as well as the performance of facility processes is critical in determining potential treatment techniques. Due to these

factors, it is typical for facilities to apply sampling and analysis programs for monitoring and adaptive management (as proposed for Crux).

Unless the design of the facility introduces a risk of significant accumulation / recycle of mercury within the process, it is not typical for offshore gas installations to include mercury removal equipment within systems associated with atmospheric emissions (e.g. fuel gas or flare systems). The Crux facility design does not introduce these accumulation risks as the process is designed to maximise export of mercury for processing at the Prelude FLNG facility.

Whilst direct mercury removal from atmospheric emissions has been utilised for onshore industries subject to Minamata Article 8 (such as coal fired power stations), offshore oil and gas facilities typically have comparatively lower total emissions and by their nature acute physical layout constraints. Therefore, these techniques are not adaptable for use on offshore oil and gas facilities. As such, there is little precedent in the offshore gas industry (in Shell or within industry) for use of treatment techniques for the purpose of removal / reduction of mercury in atmospheric emissions.

4.3.1.5 Assessment of NNM Considerations

Not normally manned platforms have additional requirements to maximise simplicity to minimise the requirement for platform visitations / minimise offshore manhour exposure. For treatment of mercury from the gas phase, adsorbent beds are able to be designed with 4-yearly change out frequency. Whilst this longer change-out frequency compared to produced water treatment reduces the risk to the NNM philosophy, there is an increased maintenance work scope requiring evaluation for health and safety trade-offs.

Compression facilities will be required for treatment options removing of mercury from low pressure flash gases. These compression facilities would require a significant increase in offshore manhours (~15% additional manhours) to operate and maintenance the equipment. Shell is not aware of a not normally manned offshore platform (with greater than or equal to a 12-week no touch time design basis) with mercury removal equipment for fuel gas or flare systems.

4.3.2 Engineering Risk Assessment

4.3.2.1 Existing Design

The atmospheric emissions of mercury from the Crux facility are a result of fuel gas and flare sources. These sources have also been addressed when considering GHG emissions. As a result, the Crux project incorporates a range of inherent design and operational efficiencies committed to during the front-end engineering phase which reduce GHG intensity. As these measures either reduce the fuel gas consumption or improve emissions, they will also result in reduced mercury emissions.

The key aspects of the design measures include:

- Selection of a Not-Normally Manned (NNM) platform concept reduces GHG emissions intensity from upstream operations by 80%;
- Selection of gas turbine generators during design process considering energy efficient (i.e. low emission) equipment, in alignment with the selected concept;
- Confirmation of a 3x50% Gas Turbine Generator (GTG) configuration with the spare GTG in a “cold” operationally ready status. The alternative of having an online spare GTG would result in 27% additional fuel usage;
- The selection of TEG off-gas flaring over venting improves the GHG footprint of flaring hydrocarbons versus venting hydrocarbons. Flaring emissions will also promote dispersion of mercury within the stream;
- Optimisation of the TEG Regeneration System has reduced the requirement for stripping gas that is used to aid dehydration. This has reduced overall TEG off-gas flaring by 15%. Further optimization during operations may be possible, dependant on equipment performance. Refer to section 5 for further details;
- GTG exhaust stacks and the flare piping are designed with sufficient height to maximise dispersion of plumes away from the facility;
- Inclusion of energy efficient equipment in the platform design (pumps, fans) has resulted in a 15% reduction in overall electrical demand for the Crux facility; and

- HP Flare tip includes a variable slot design, with fuel gas purge requirements ~60% lower than the standard purge rates;

4.3.2.2 Evaluation of Treatment and Control Alternatives

The assessment for treatment options to reduce mercury emissions to atmosphere was conducted in design phase and revalidated for this EP. Various options to remove or reduce mercury discharged through air emissions and are presented in Table 7 below.

Table 7 Mercury Removal Options Assessment for Fuel Gas and Flash Gas Stream

Options	Mercury that can be removed	Production Impact	Lifecycle Cost (CAPEX + OPEX)	Module weight & Footprint	Environment & GHG	HSE Risk & NNM	Outcome
1. Operational Optimisation of Stripping Gas	Removes up to 1 kg/yr	Lower dewpoint margin for pipeline	~USD$ 1 mln OPEX	No additional equipment	Reduction in mercury Reduction GHG emissions	None	Hardware included in existing design, Adopted, subject to future operational study outlined in section 5.
2. MRU for Fuel Gas stream and Stripping Gas	Removes up to 4.5 kg/yr	No production impact	~USD$ 16 mln CAPEX ~USD$ 6 mln OPEX	~12 MT	Reduction in mercury emitted	Bed changeout once in 4-yrs	Rejected, to be reconsidered in future engineering study outlined in section 5.
3. MRU for Fuel gas, Stripping Gas and Flash Gas streams without compression	Removes up to 12.6 kg/yr	Impact to Oil in Water and TEG purity	~USD$ 46 mln CAPEX ~USD$ 20 mln OPEX	~74 MT May exceed the topside and substructure design weight.	Reduction in mercury emitted Exceedance of oil in water (30mg/L)	Bed changeout once in 4-yrs	Rejected, subject to future revalidation
4. MRU and Flash Gas Compressor to send to Fuel Gas and Stripping gas	Removes up to 12.6 kg/yr	Impact fuel gas quality for power generation	~USD$ 110 mln CAPEX ~$40 mln OPEX	~135 MT Topside and substructure design weight exceeded.	Reduction in mercury emitted Increased GHG emission for compression power	Adding complexity to NNM operations and maintenances offshore	Rejected, subject to future revalidation
5. MRU and Flash Gas Compressor to send to Production Inlet Manifold	Removes up to 12.6 kg/yr	Impact fuel gas quality for power generation	~USD$ 125 mln ~$50 mln OPEX	~144 MT Topside and substructure design weight exceeded.	Reduction in mercury emitted Increased GHG emission for compression power	Adding complexity to NNM operations and maintenances offshore	Rejected, subject to future revalidation
6. MRU for Main Gas Stream	Removes up to 12.6 kg/yr	No production impact	~USD$ 140 mln ~$20 mln OPEX	~400 MT Major topside and substructure design weight exceeded.	Reduction in mercury emitted	Bed changeout once in 4-yrs	Rejected, subject to future revalidation

Risk Assessment Evaluation Legend:

Relative Evaluation	Descriptor
	Significantly worse outcome / feasibility concerns
	Worse outcome with major risks, and they are challenging to address
	Outcome not a differentiator, some risks are present, but it is possible to address them
	Better Outcome

- **Option 1 (Optimisation of Stripping Gas):** involves operational optimisation of stripping gas used in the TEG regeneration system. The current Crux design uses up to 638 kg/h of stripping gas to increase the performance of the TEG dehydration system and achieve export gas water content specifications. The use of stripping gas ensures that gas exported into the pipeline is dehydrated with no free water in order to prevent corrosion, hydrate formation and to maintain the pipeline integrity. Following start-up, the performance of TEG system can be validated, and optimisation of the stripping gas may be possible whilst ensuring that hydrates and pipeline corrosion can still be managed. An estimated reduction of up to 1 kg/yr of mercury emission to air, could potentially be achieved. This option is recommended, and a TEG Gas Stripping Optimisation Study will be undertaken as detailed in Section 5.
- **Option 2 (MRU for Fuel Gas stream, including Stripping Gas):** this option considers treating the fuel gas stream with an adsorbent bed MRU. To utilise the MRU, sufficient gas pressure is required to overcome the bed pressure drop and meet outlet condition requirements. For this reason, this option excludes the treatment of flash gas streams which are currently designed to be at low pressure. The adsorbent media used in a gas phase MRU is designed with an impregnated active phase that enables a chemical reaction with mercury to form cinnabar (HgS). Cinnabar is a non-hazardous and in a stable form of mercury. The MRU media is not regeneratable, and the adsorbent beds are designed with 4-yearly change out frequency. This option may remove mercury from the fuel gas stream of up to 4.5 kg/yr (and 3.5 kg/yr if Option 1 is adopted and effective as estimated).

  This option requires the MRU to be installed as part of a brownfield installation campaign offshore and includes a deck extension. The estimated lifecycle costs of ~USD$22 mln is considered to be grossly disproportionate to the incremental decrease in mercury emission to air. Whilst this option is not adopted, it will be considered in a future engineering study (as outlined in Section 5), as part the Mercury Adaptive Management Framework.
- **Option 3 (MRU for Fuel gas, Stripping gas and Flash Gas streams without compression):** considers two separate MRUs to treat the fuel stream and the flash gas stream. An additional MRU compared to Option 2 is included to operate at low pressures to treat the flash and off gasses from TEG Flash Drum, TEG Reboiler and Produced Water Degasser. This option may remove up to 12.6 kg/yr of mercury present in the air emission streams, however there are feasibility, weight and cost concerns which present major risks and engineering challenges.

  Whilst operating at pressures as low as possible, the additional MRU will require the pressure in the TEG system and Produced Water Degasser to be increased. This would result in degraded performance of the TEG Reboiler dehydration system and Produced Water Degasser, due to backpressure created by the MRU's installed downstream. This backpressure results in modelling outcomes demonstrating an exceedance of the 30 mg/L oil-in-water discharge design limit, which is considered an unacceptable outcome given the existing performance requirement of this system. The reduced performance of the TEG dehydration system increases the risks of pipeline corrosion and integrity issues.

  Additionally, the weight of this equipment is considerable when compared to Crux topside and substructure design limits, and a detailed weight feasibility study will likely result in the erosion of existing options for future weight bearing infrastructure on Crux (i.e. the option to install a future chemical injection skid).

  For these reasons, the potential benefits in reduced mercury emissions are outweighed by the unacceptable outcome related to produced water discharges, increased pipeline integrity risks and

weight-based feasibility concerns. On this basis, this option is not adopted, however, even if these barriers could be overcome, the cost (~USD$66 mln) of adopting this option is also considered grossly disproportionate to the incremental decrease in mercury emission to air.

- **Options 4 and 5 (MRU and Flash Gas Compressor):** require installation of a compressor to recover the flash and off gases and passing it through an MRU before sending it to the Fuel Gas and/or Production Inlet Manifold. The estimated installation and lifecycle costs of both options is high (in excess of (~USD$150 mln).

  A deck extension is needed to locate both the MRU and compressors, and this requires a technical feasibility study to confirm if the additional size and weight of this equipment can be supported. The estimate weight of this infrastructure exceeds the current topside and substructure design weight limits; therefore, preliminary analysis demonstrates that there is high risk that the outcome of this study shows the extension is not technically feasible.

  The utilisation of compression resulting in an increase in fuel burn and associated increase in GHG emissions. The type of compressor required also adds complexity to NNM operations due to increased maintenance requirements and reliability concerns.

  For these reasons, the potential benefits in reduced mercury emissions are outweighed by the weight-based feasibility risks, increase in GHG emissions and erosion of the NNM philosophy. On this basis, these options are not adopted, however, even if these barriers could be overcome, the costs (in excess of ~USD$150 mln) of adopting these options are considered grossly disproportionate to the incremental decrease in mercury emission to air.

- **Option 6 (MRU for Main Gas Stream):** is expanded to the removal of mercury from the main gas stream. As the current design for Crux is such that the production gas mercury will be treated by the Prelude MRU, the incremental benefit of this option is a potential reduction in 12.6 kg/yr of mercury from the fuel and flash gas stream on Crux.

  As the diameter of the vessel is large at 3.6m with a footprint of about 80 m^2, and a dry weight of approximately 400 MT, a deck extension will be required to provide space for this type of MRU. The estimate weight of this infrastructure results in a major exceedance of the current topside and substructure design weight limits; therefore, preliminary analysis demonstrates that there is a very high risk that the outcome of further feasibility work would demonstrate that the required extension is not technically feasible.

  For these reasons, the potential benefits in reduced mercury emissions are outweighed by the weight and size-based feasibility risks. Even if these barriers could be overcome, the costs (in excess of ~USD$160 mln) of adopting this option is considered grossly disproportionate to the incremental decrease in mercury emission to air.

4.4 Mercury Treatment Options - Evaluation Outcome

Based on the assessments conducted, the technically deployable mercury control options are summarised in Table 8. As an indicative measure, the incremental cost to control mercury contained in the Crux inlet during End of Plateau conditions is also noted.

The conclusion from the assessments and considerations for produced water and atmospheric emission treatment options is that all reasonably practicable design measures have been included in the existing design. Therefore, the risks and impacts are considered to have been reduced to ALARP. The existing Crux design results in routing of ~99% of produced mercury during early operations phase (~8-9 years) and ~95% in late life, to Prelude, which maximises the utilisation of the existing Prelude MRU.

For the remaining mercury emitted at Crux via the produce water outfall and air emissions streams, the cost, effort, feasibility constraints and operational impacts for additional treatment options are considered grossly disproportionate to the environmental benefit gained. The cost impacts are also displayed in Figure 4.

The evaluation of treatment options concluded that whilst no new mercury treatment infrastructure is required to be installed at Crux based on currently available information, the TEG Stripping Gas Optimisation and Fuel Gas MRU options had less significant technical feasibility concerns. Future engineering study of these options will be included as part of the adaptive management framework as operational data becomes available (Table 9).

Table 8 Summary of Potential Options to Control Crux Inlet Mercury for End of Plateau Design Case

Mercury Control Options	Incremental Mercury Removed / Controlled (kg / yr)	Lifecycle Cost (CAPEX + OPEX $m)	Cost of Mercury Control Option ($ / kg Hg)	Outcome
Existing Design (inc. Operational Controls)	1436	2	85	Adopted
Flare - TEG Stripping Gas Optimisation (Table 6, option 1)	1	1	76,923	Adopted, subject to future study
Fuel Gas – MRU & Stripping Gas (Table 6, option 2)	4.5	22	376,068	Rejected, subject to future study
Fuel Gas and Flash - Combined MRU, compression & Stripping gas (Table 6, option 4)	8.1	150	1,424,501	Rejected
Produced Water - Adsorbent Media (Table 5, option 3)	1.5	115	5,897,436	Rejected

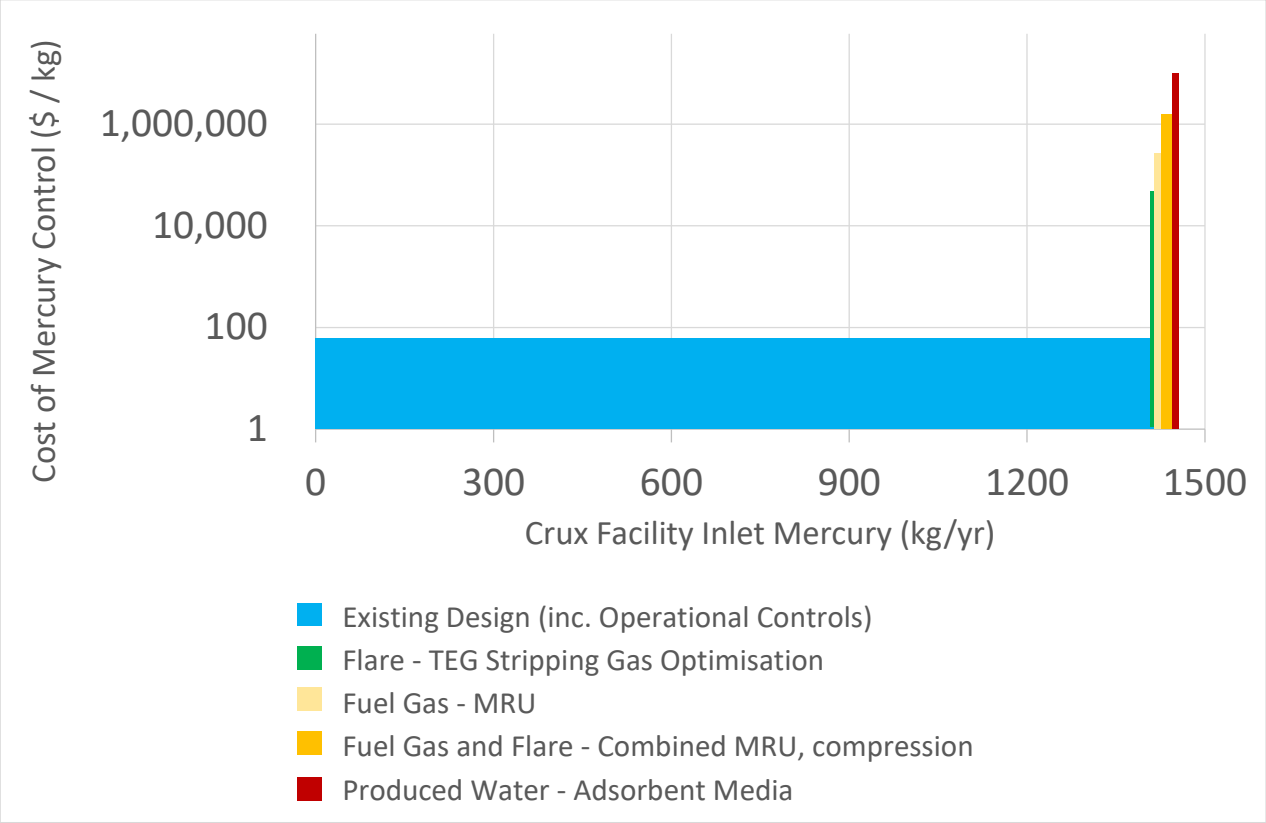


Figure 4 Marginal Cost of Potential Options to Control Crux Inlet Mercury (Note Exponential Scale)

5 Summary of Measures Adopted

Table 9 below summaries the control measures adopted related to mercury control and reduction for the Crux project which are outlined within this document. These control measure will be replicated and further expanded upon (where necessary) in the Crux Completions, Hot Commissioning, Start-up, and Operations Environment Plan, including update of the Implementation Strategy of that EP where relevant.

Table 9 Summary of Control Measures Adopted for Crux

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
Mercury Adaptive Management Framework which includes: • Reviewing maturation of mercury removal technologies, including economic assessment. • Mercury monitoring on topsides discharge and emissions streams. • Mercury Partitioning Study Validation. • Environmental monitoring, which includes mercury in water and sediments surrounding the platform.	The objective of the Mercury Adaptive Management Framework (framework) is to ensure mercury emissions and discharge sources on the Crux facility are reduced to ALARP continuously throughout the life of the asset. The ALARP assessment has been based on currently available information. As noted in the mercury design basis, there is uncertainty relating to actual mercury production concentrations, speciation, partitioning and water chemistry; availability of proven technologies for mercury removal; and consideration of NNM operations. In order to manage these uncertainties during operations, a lifecycle adaptive management framework will be applied. This approach enables appropriate techniques to be assessed at the right time, with reliable information and operating data. The framework will be implemented to continually manage potential impacts of the produced water discharge and atmospheric emissions to ALARP and acceptable levels. The framework ensures the nature, extent, and potential effect of mercury releases are adequately assessed as operational data becomes available. The framework also helps determine and assess the nature and scale of changes to water quality and atmospheric emissions in relation to applied triggers and thresholds. The framework eliminates the risk of installing removal equipment based on assumed design data (i.e., avoids selecting a novel technology that may not work) whilst remaining compliant with legislation, standards and ALARP principles consistent with the OPGGS(E) Regulations. This approach is aligned with the proposed adaptive management principles of the produced water effluent. The framework will be integrated with other relevant environmental management processes that will be in-place for the operational phase of the Crux facility. For example, the GHG and	A-1.0	Develop, maintain and implement a Crux facility Mercury Adaptive Management Framework prior to and dedicated for the future operate phase. This Framework will include as a minimum, provision for: • Periodically reviewing maturation of mercury removal technology • Mercury monitoring on topsides discharge and emissions streams. • Mercury Partitioning Study Validation. • Environmental monitoring, which includes mercury in water and sediments surrounding the platform. Individual ALARP justification and Environmental Performance Standards (EPS's) for each of these elements are described below.	The Crux facility Mercury Adaptive Management Framework, which includes the minimum stated provisions.

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
	Energy Management System includes a Fuel and Flare Forum. This forum is used to review fuel gas efficient and flaring performance, suggest new fuel and flare minimisation ideas and track progress on GHG abatement opportunities and projects. This forum will be used to provide input for the Mercury Adaptive Management Framework. The framework will allow results to be compared and trends to be analysed over time. The data collected will be combined with modelling predictions and used to assess whether the defined threshold/trigger values are likely to be exceeded and for how long this is expected to occur (duration).			
Mercury Adaptive Management Framework: • Review maturation of mercury removal technologies, including economic assessment.	Mercury removal technologies are improving gradually. Therefore, although not considered ALARP to adopt any additional engineering hardware barriers for the Crux project at this stage, developments in technologies may change what is ALARP in future. Undertaking a biennial (once every two years) screening exercise for new technologies, which have not previously been assessed is considered an appropriate mechanism to identify new technologies as they become available. Reviewing technologies every 4 years is considered a reasonable basis for informing Shell's Mercury Adaptive Management Framework moving forward. The cost of doing such a review is anticipated to be ~$250k. Therefore, doing a review more frequently is not warranted. For projects without significant complications (extensive modifications) and without technical feasibility concerns, it would be expected to take an estimated 3-4 years from a decision being made to implement the project. Therefore, Shell commits to seeking to mature a project as soon as is practicable, given the process constraints	A-1.1	Carry out periodic reviews of mercury removal technology for emission and discharge sources as relevant to the Crux facility. These reviews will include: • Biennial (once every two years) screening for new or emerging mercury removal technology that has not previously been assessed for use on the Crux facility. • Where screening identifies new or emerging technology, progress to formal review to establish suitability (as per the below considerations). • A detailed review and revalidation every four years (with the first review occurring within 2 years from the facility start-up[3] to account for verified mercury rates). Reviews will include consideration of: • Maturation of existing technologies, checking for advancements in treatment capacities and cost efficiency. • Assessment of new technologies (when applicable) • Technical feasibility of available technology. • Engineering risk assessment. • Verified mercury rates within Crux product stream and/or emission sources. • Assessment of related aspects (e.g., health, safety, operability & maintenance). • Economic viability. • Weighting of cost compared to environmental benefited gained for adopting technology. Reviews will include a decision point on whether to proceed with a front-end engineering design (FEED) mercury removal project.	Biennial (once every two years) Screening Outcomes documented in the Crux Environment in Design Process Outcomes for Mercury Treatment (2200-010-PX-5721-00001). If new technology is identified in biennial screening, document review of technology in updated Crux Environment in Design Process Outcomes for Mercury Treatment (2200-010-PX-5721-00001). Four-yearly reviews document in updated Crux Environment in Design Process Outcomes for Mercury Treatment (2200-010-PX-5721-00001).

[3] Start-up is defined within the Crux Completion, Hot Commissioning, Start-up and Operations Environment Plan, as a 9 to 24-month period following completion of hot commissioning activities and prior to the commencement of the operations phase.

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
	to ensure projects are delivered according to Shell's standards.	A-1.2	Within 6 months of completing FEED (EPS A-1.1) a final investment decision will be made, which will take into account the principle of ALARP. Installation will occur as soon as practicable within the appropriate planned major turnaround (shutdown maintenance program) for Crux, which occurs on a 4-year cycle.	FID decision dated within 6 months of FEED completion. Where triggered, as-built records showing installation of selected mercury removal technology.
Mercury Adaptive Management Framework which includes: • Mercury monitoring of topsides product and emissions streams. • Mercury Partitioning Study Validation	Monitoring for mercury in the product stream and in emissions streams is key to confirming the design basis is accurate and the Crux facility is operating within predicted ranges outlined within Section 3. This is a fundamental component of the Mercury Adaptive Management Framework, as where monitoring results and forecast mercury emissions show deviation to the design basis (i.e. an increase in emissions at Crux), adaptive management can be taken to mitigate unplanned mercury emissions.	A-1.3	Mercury monitoring of PW, fuel gas and flare source streams will be carried out in accordance with the Mercury Adaptive Management Framework and/or sampling and analysis plan. This monitoring will: • Verify mercury rates are within Crux design basis. • Forecast any potential deviation to the design basis. • Validate the mercury partitioning study. Adaptive management actions to reduce mercury emissions will be taken where: • Sustained[4] mercury rates are found to be trending towards exceeding the maximum basis of design parameters (mercury loading rates on the fuel/LP flare gas and produce water streams). • Sustained[4] mercury partition to the produced waste-water stream beyond design basis. The range of adaptive management actions includes: • Cycling of wells. • Review of facility surveillance data to confirm inlet conditions are operating as designed. • Review of mercury removal technologies as per P.S A1.1 and A1.2.	Completed mercury sampling and analysis program prior to start-up of the Crux Facility. Monitoring records which compare mercury rates to expected basis of design and partition study assumptions. Where applicable, records of initiation of adaptive management actions.
Mercury Adaptive Management Framework which includes: • Periodic environmental monitoring of mercury in water and sediments surrounding the platform, including initial pre-operations baseline monitoring.	The existing pre-operations baseline monitoring will include monitoring of mercury in water and sediments. This information will be used to compare results of the periodic water and sediment quality monitoring program executed throughout the operations phase of Crux. This is an existing program and therefore the cost are already accounted for. By linking the results of the monitoring program with the Mercury Adaptive Management Framework, there is a clear pathway to demonstrate how the potential impacts to the environment will continue to be managed to ALARP throughout the operations phase of Crux.	A-1.4	Refer to EPS 4.5 which extends to Section 10.4.2 (of this EP), regarding Shell's commitment to pre-operations baseline monitoring, and monitoring commitment during operations. Mercury in sediment and water will be included in the pre-operations baseline monitoring and subsequent operations monitoring program. Where sediment and/or water quality monitoring confirms mercury exceeds ANZG values, or mercury is trending above baseline, trigger P.S A-1.1 and A-1.2.	Monitoring report demonstrates analysis of mercury in water and sediment. Records demonstrate adaptive management initiated as per P.S A-1.1 and A-1.2, where mercury exceeds ANZG values, or mercury is trending above baseline.

[4] *When trending mercury production rates, sustained increases are considering those that track towards the maximum design basis continuously over a six-month period.*

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
Temperature Regulation and Low Temperature Alarm	Control on Crux inlet to ensure partitioning to the product stream is optimised and in line with predictions outlined with Table 2. Temperature management is a critical component in the Crux design. Temperature control is primarily used to ensure gas and condensate dehydration. However, higher temperatures also reduce mercury content in the water stream. The multiphase well stream is initially cooled from 120°C to ~50°C in the Inlet Cooler. At this temperature, 40% of the mercury in the inlet stream will remain in the gas phase. The liquids (condensate and produced water) are separated and further cooled at the Liquid Cooler to ~40°C. At this temperature, the mercury has a much higher solubility and remains in condensate. Use of this control in the Crux process system is expected to result in up to ~99% (~95% in late life) of the mercury partitioning to the hydrocarbon phase and routed to the Prelude FLNG MRU.	A-1.5	Production limits will be maintained with deviation outside of the operating window indicated by a low temperature alarm.	DCS/PI records of temperature trends. Alarm and trips setting register shows alarm configuration.
TEG Gas Stripping Optimisation Study	A TEG Gas stripping optimisation study is a planned mitigation to further reduce flaring and associated mercury emissions from the Crux platform. This study will be conducted and implemented not more than one year following commencement of operations. Early estimate indicates this may reduce mercury emissions by up to 1 kg/year. Early work indicates it is feasible, however further study work can only occur once Crux is in stable operations, to ensure technical integrity of the pipeline is maintained throughout operations.	A-1.6	Shell will carry out a TEG Fuel Gas stripping optimisation study and implement its outcomes within one year following the start of operations at Crux. The outcomes of the optimisation study will be implemented as soon as practicable, where a reduction of flaring rates and associated mercury emissions from the Crux platform may be realised.	Technical Note and Instruction to Operations to change operational parameters for revised Operating Mode and optimize stripping gas usage whilst maintaining dehydration performance criteria.
MRU for Fuel Gas Study	The current assessment for a MRU on the fuel gas stream concluded that the cost (~USD$22 mln) is considered to be grossly disproportionate to the incremental decrease in mercury emission to air (Section 4.3). Given there are currently limited precedents on MRUs installed specifically to treat Fuel Gas stream prior to GTG combustion for analogous offshore facilities, maturation of a formal study to further establish cost, technical feasibility and expected environmental outcome is required. Progression of this engineering study for this treatment option is seen as a best practice approach. This enables the refinement in costs and further establishment of technical feasibility.	A-1.7	Conduct engineering design study for MRU on the fuel gas stream prior to the commencement of operations. This study will consider: • Technical feasibility of installing the available technology. • Engineering Risk Assessment. • Verified mercury rates within Crux product stream and/or emission sources. • Economic viability. • Assessment of related aspects (e.g., health, safety, operability & maintenance). • Weighting of cost compared to environmental benefit gained for adopting an MRU on the fuel gas stream. The engineering design study will be validated using mercury sampling and analysis data during the start-up[3] phase.	Engineering design study report which includes a conclusion for entering FEED or rejecting an MRU on the Crux fuel gas stream.

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
	The use of operational data also enables the verification of mercury rates in the fuel gas stream, which will further quantify the actual benefit gained from implementing this technology. This approach provides risk mitigation for higher-than-expected mercury rates and/or realisation of costs-based efficiencies, which may change the current assessment outcome for a fuel gas MRU. The timeframe required for completion of engineering processes and reaching an FID decision are aligned to industry standards. Typically, FEED for this scale of modification would be completed within 1 year, and by progressing the engineering design study prior to start-up, and validating it using operational data, FEED and the proceeding to an FID can be accelerated if required.		FEED, FID and implementation will be aligned to EPS A-1.1 and A-1.2. Performance standard A-1.1 still applies should this study conclude that an MRU on the fuel gas stream is not suitable for adoption.	
Mercury removal techniques – Mercury Removal Unit (MRU) at Prelude FLNG for exported streams.	Crux inherent design (temperature regulation and low temperature alarm) and reservoir characteristics ensure that ~99% of produced mercury (~95% in late life) is directed through the gas and condensate streams primarily to the Prelude FLNG facility. An assessment of best available techniques and best environmental practices was undertaken during concept engineering. The existing mercury removal units on Prelude FLNG were assessed for capability to process Crux production alongside concept phase studies on other technologies detailed below. This MRU has the capability to treat mercury within gas from the acid gas removal unit and gas recovered from the condensate stabilisation system. This strategy optimises the use of existing equipment, avoiding the need for additional MRUs on the Crux platform and thus preventing resource inefficiency. The design, operations, and maintenance of the Prelude FLNG facility's MRU are detailed in the current Prelude FLNG EP, and the processing of Crux gas and condensate will only commence once a revised Prelude FLNG EP is accepted by NOPSEMA.	A-1.5	Refer to P.S A-1.5	Refer to P.S A-1.5
Prelude FLNG EP	The Prelude FLNG EP, as revised will detail further information related to the design/operation and effectiveness of the Prelude MRU. The Prelude MRU is the key mercury removal technology used by the Crux project and enables the most efficient use of	A-1.9	The Prelude FLNG Environment Plan revision will be accepted by NOPSEMA prior to Crux hydrocarbons coming onto the Prelude FLNG facility.	Prelude FLNG Environment Plan revision accepted by NOPSEMA.

Control Measure	ALARP justification	EPS No.	Environmental Performance Standard (EPS)	Measurement Criteria
	resources, to avoid replication of technology on Crux.			

5.1 Mercury Monitoring Program Overview

A key element of the adaptive management framework will be monitoring mercury levels within the Crux facility once operational. This will primarily be achieved via a monitoring program that will be implemented on Crux topsides following start-up. The following provides an overview of the mercury monitoring program, which is intended to assist in showing how the data referenced within Table 9, EPS A-1.3, will be obtained.

The mercury monitoring program for Crux will cover:

- All types of routine and non-routine sample collections required per stream;
- The frequency of analysis or test required per stream, including all sampling requirements for process monitoring and optimization;
- Details of the sampling equipment configuration and utilities / infrastructure required for each sample point;
- All utilities and infrastructure required to carry out the tests;
- Air quality monitoring; and
- All equipment and chemicals required to carry out sample analysis.

5.1.1.1 Process mercury monitoring

Sampling facilities have been installed at key locations through-out the facility (Figure 5). For mercury monitoring purposes, the sampling locations include:

- Well flowline, Export gas and Export Condensate – enables quantification of mercury within hydrocarbon streams and basis for overall partitioning estimates. As fuel gas offtake is from the gas export stream, sampling results will be used as an input to estimate mercury emissions from gas turbines.
- Upstream of the Produced Water Degasser – enables surveillance of process parameters and partitioning performance.
- Downstream of the Produced Water Degasser - to enable monitoring of produced water discharge and manage uncertainty associated with the composition of contaminants and overall toxicity, and to monitor temperature and process conditions upstream of the Produced Water Degasser which influence mercury partitioning into the gas and condensate streams.
- TEG Regeneration System – several sampling locations are available within the TEG Regeneration system. To estimate the mercury partitioning within the system, sampling points located at the Rich TEG Flash Drum and Lean TEG Surge Drum will be utilised.

During the start-up phase, laboratory technicians and a temporary laboratory will be located on the Crux platform. The Completions, Hot Commissioning, Start-up, and Operations EP will provide additional details of mercury monitoring program.

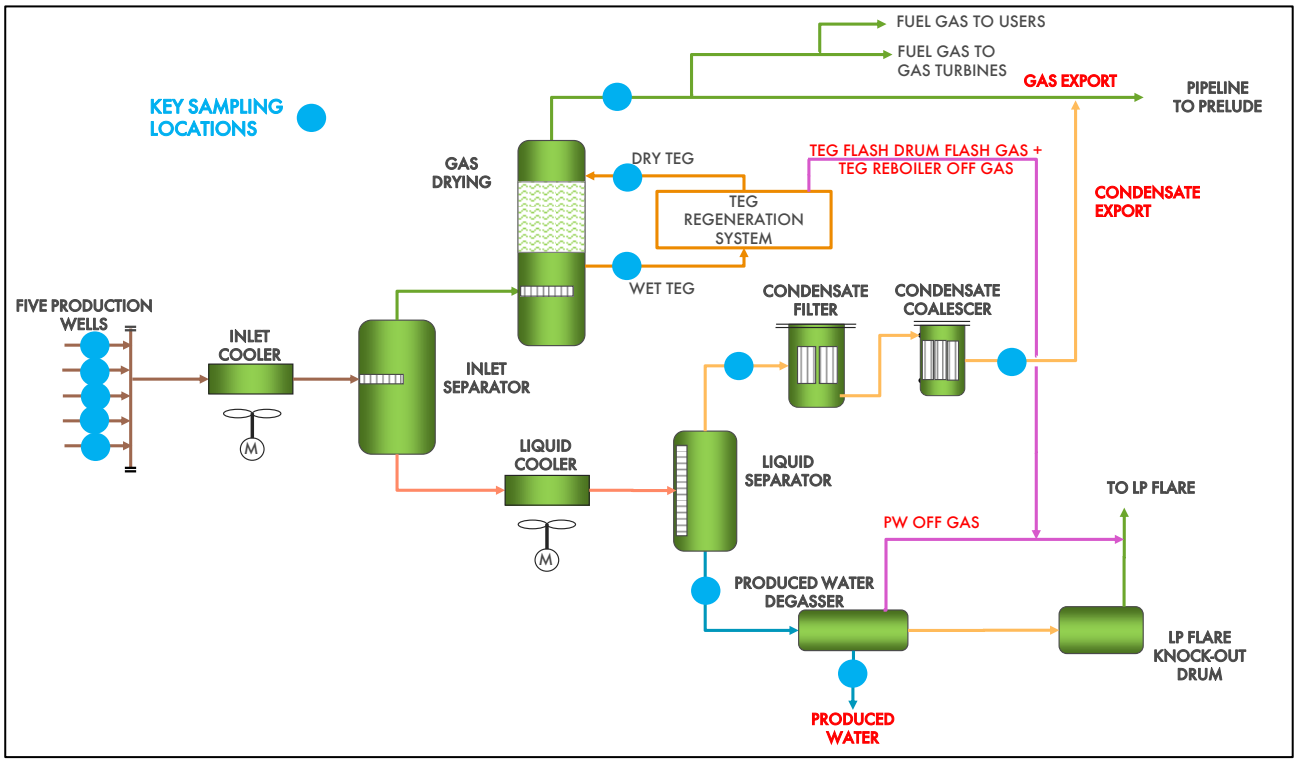


Figure 5 Existing Sampling Locations for Mercury Testing

5.1.1.2 Air Quality Mercury Monitoring

In addition to sampling of the process streams, field air quality monitoring will be conducted. This monitoring has been developed to define requirements to ensure the health and safety of personnel on the platform and the protection of the environment.

For this monitoring program, sampling and analysis requirements have been defined, including:

- Testing of airborne mercury vapor concentrations inside the equipment / pipework using mercury vapor monitoring equipment.
- A visual inspection inside the equipment / pipework and areas around the worksite for evidence of liquid mercury or spilled material likely to contain mercury, sludge, crystalline solids, or other material within which mercury compounds may be entrained within it.
- Atmospheric monitoring of airborne mercury vapor concentrations. This will be conducted periodically based on the level of risk and following initial inspection and testing.

The results from the sampling program and field monitoring will be integrated with other facility surveillance information (such as operating temperatures) to validate the mercury partitioning model.

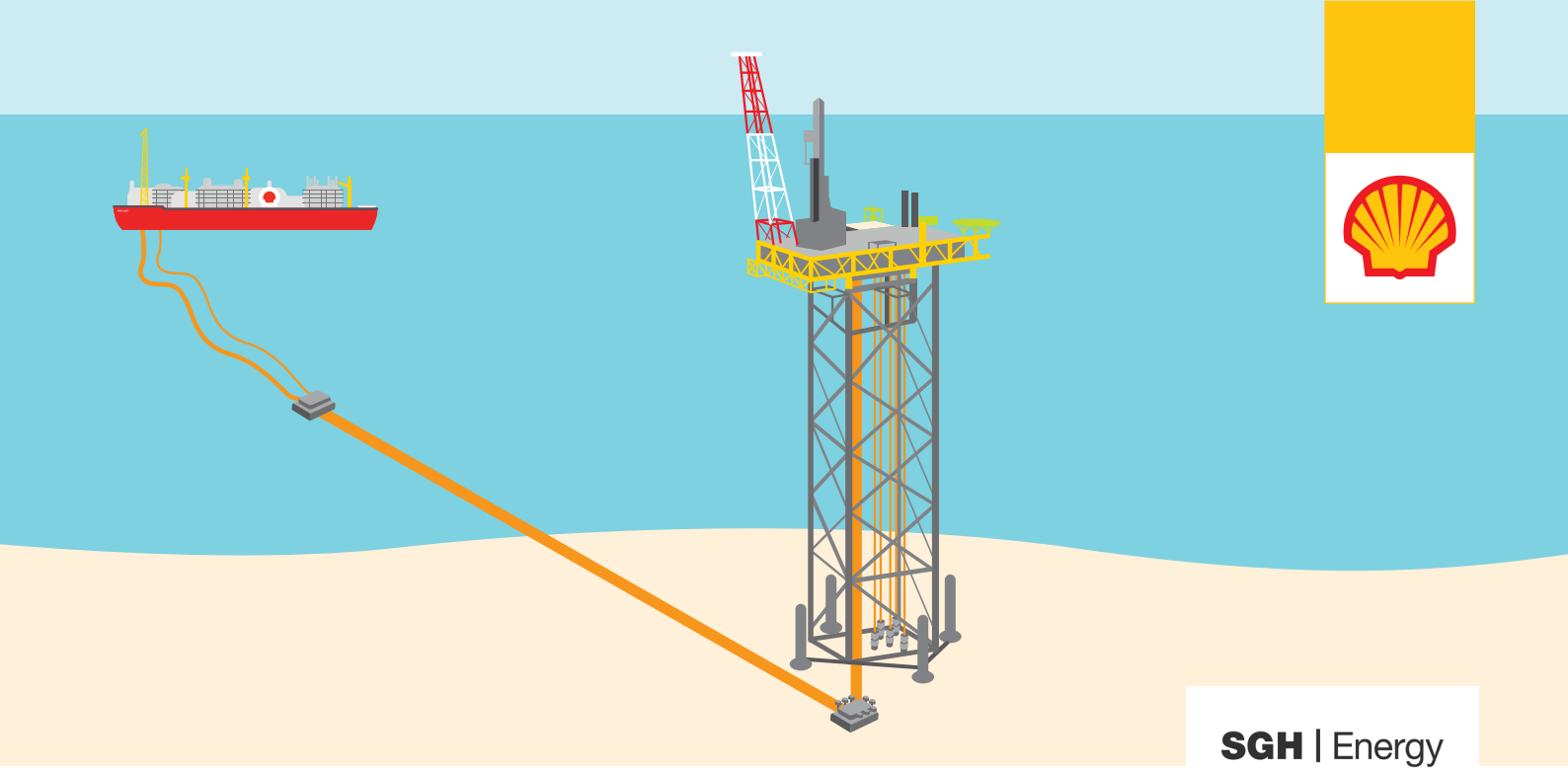
Appendix B Consultation Material

1. Consultation Material – Table of Content

Content	
1. Factsheets	1.00 Installation and Cold Commissioning EP Factsheet **Supporting Factsheets** 1.01 General Environment Plan Factsheet 1.02 Cultural and Social Values Factsheet 1.03 Hydrocarbon Release Factsheet
2. Information Booklet	2.00 Crux Information Booklet – *distributed in hard copy only.*
3. Maps	3.00 Planning Area Map 3.01 Community Map
4. Public Notices	4.00 Crux Campaign Overview 4.01 Print advert • ACM • Koori Mail • National Indigenous Times • Newscorp • SWM • The West 4.02 Social media post • Facebook • Linkedin 4.03 Radio ads 4.04 Drop-in session advert • Broome • Darwin • Exmouth • Port Hedland • Derby 4.05 Community briefing advert: • Broome • Darwin 4.06 Community drop-in session social media post
5. Community / Industry Presentations	5.00 Community Briefing – Darwin 5.01 Community Briefing - Broome 5.02 Industry Briefing - Perth
6. Videos	6.00 Crux Animation Video 6.01 Crux Animation Transcript
7. Indigenous relevant persons consultation material	7.01 Initial email invitation – March/April 7.02 Survey issued for Indigenous Forums (attached to email) 7.03 Presentation – Indigenous Forum 1 in Perth 7.04 Presentation – Indigenous Forum 2 in Broome 7.05 Presentation – Indigenous Forum 3 in Darwin 7.06 Presentation - Bardi Jawi, Mayala and Walalakoo Meeting – 15 August 2023 7.07 Presentation – Wunambal Gaambera Aboriginal Corporation – 15 September 2023 7.08 Presentation - Dambimangari Meeting – 19 September 2023 7.09 Email invitation to Broome forum – end of April 7.10 Email follow up – end of May

Content	
	7.11 Presentation – Larriakia meeting - 5 September 2023
8. NOPSEMA	8.01 NOPSEMA Consultation on Offshore Petroleum Environment Plan Brochure

Appendix A – 1.00 Installation and Cold Commissioning EP Factsheet



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CRUX INSTALLATION AND COLD COMMISSIONING ENVIRONMENT PLAN FACTSHEET

ABOUT CRUX

The Crux project forms an important part of Shell Australia's gas portfolio and will be backfill for the existing Prelude Floating Liquefied Natural Gas (FLNG) facility. The project consists of a not normally manned platform with five production wells, in ocean waters approximately 165m deep. The facility will be connected to Prelude via a 160km export pipeline and will be operated remotely from the Prelude FLNG facility.

The project is being progressed by operator Shell Australia in joint venture with SHG Energy.

Location:

Browse Basin, 190km offshore north-west Australia and 620km north-east of Broome.

Offshore Petroleum Titles:

Pipeline Licences AC/PL1 and WA-33-PL, Production Licence AC/L10.

Proposed Activity:

To install the Crux export pipeline, substructure and topsides (including subsea integration system and associated structures) and cold commission relevant infrastructure. The installed infrastructure will be integrated into the existing Prelude FLNG facility.

Water depth:

- Prelude-end: 250 m
- Export pipeline: 165-280 m
- Crux-end: 165 m

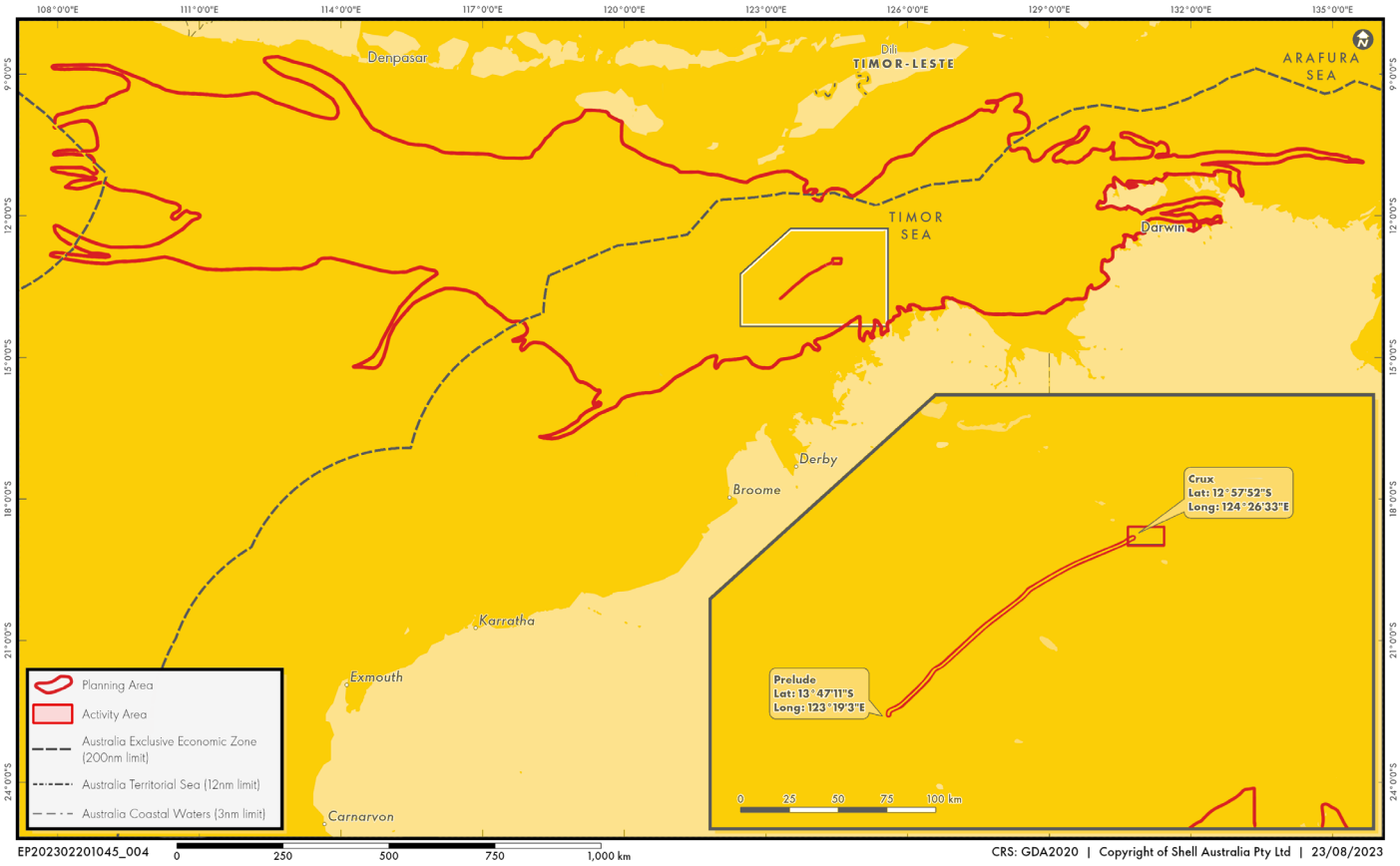
Timing:

Activities will commence in mid-2024, pending regulatory approvals.

Duration:

Up and until 2027.

*Dates for the commencement of activities and duration are subject to schedule change.



THE PLANNING AREA

This is the largest area where the Crux Installation and Cold Commissioning activity could potentially have a direct or indirect environmental or socio-economic impact.

The planning area represents the total area that a spill could travel along many possible pathways depending on surface conditions, currents and weather at the time of an incident. These combined pathways are developed using a sophisticated hydrocarbon release computer modelling, and the planning area boundary captures the greatest extent of the hundreds of potential release pathways produced by the modelling software.

This means that in the highly unlikely event of one of these scenarios occurring, only a small part of the planning area would be impacted. Understanding the greatest extent of a release allows Shell to ensure that it has adequate response plans to effectively respond.

ENVIRONMENTAL APPROVALS

Before Shell commences substantial work on major projects or existing facilities, regulatory, environmental and social impacts are assessed, alongside commercial and technical considerations.

The Crux Offshore Project Proposal was accepted in August 2020 by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) and is publicly available on the NOPSEMA website.

The Crux Installation and Cold Commissioning Environment Plan relates to installation and cold commissioning activities of key infrastructure that will connect the Crux production wells to the Prelude FLNG facility.

Other activities that will be completed as part of the Crux project include:

- The installation of a drilling template
- A vessel-based seabed survey
- Drilling of the Crux production wells
- The start-up, commissioning and operations of the Crux facility, including the completion of Crux production wells.

NOTIFICATION TO MARINERS

A notice to mariners will be issued via the Australian Hydrographic Office in advance of key offshore installation campaigns, detailing the Petroleum Safety Zone and associated restrictions of entry.

To read a full draft of the Cold Commissioning and Installation Environment plan, visit www.shell.com.au/crux

ACTIVITY DESCRIPTION

The activities include:

- Installation of a pipeline to export gas from Crux field to Prelude FLNG facility for processing into LNG. This includes associated subsea integration system to connect the Crux platform to the Prelude FLNG facility. The pipeline will be approximately 26 inches in diameter and approximately 165 km long. Subsea integration system includes pipeline end terminations and foundations, risers, spool, optic flying leads and umbilicals.
- For the installation of the Crux substructure and topsides, the substructure will be transported by a barge, launched approximately 5km from the installation location and then towed to the installation location. The substructure will be positioned then installed using drilled and piled foundations. After it is installed, the topsides including processing facilities and associated utility systems, will be floated into position, and fixed to the substructure.
- After the key infrastructure is installed, cold commissioning activities, which is part of the pre-start-up phase, will be undertaken to ensure the integrity of the infrastructure and its connections. This may include flood, clean, gauge and pressure testing, dewatering, preconditioning, nitrogen packing, flushing and hydrostatic leak testing.

The installation phase will be supported by helicopters and a range of vessel types, including barges, heavy transport vessels, Prelude FLNG, accommodation support vessels, construction vessels, anchor handling tugs and offshore support/supply vessels.

At Shell, we recognise the importance of environmental, heritage, social, cultural, and economic values. Shell has undertaken comprehensive surveys, studies and a review of available information to understand and detail the sensitivities and values within the region. We will demonstrate how these impacts and risks will be reduced to a level that is as low as reasonably practicable through additional control measures, seeking first to avoid and then minimise impacts.

We are committed to working with relevant persons as part of our ongoing efforts to engage and improve our understanding of the sensitivities and values within the region, and welcome and seek feedback on these.

Figure 1: Example installation campaign

ENVIRONMENTAL MANAGEMENT

Aspect	Control
Planned	
Physical presence	▪ Implement the national and international regulations and conventions for collision prevention, safety, and navigation at sea. ▪ Australian Hydrographic Office Notice to Mariners. ▪ Relevant Persons consultation process.
Seabed disturbance	▪ Position infrastructure within the design footprint, implement contractor lifting procedures and recover temporary equipment to reduce seabed disturbance. ▪ Establish an infrastructure inventory register to enable future decommissioning and removal responsibilities. ▪ Implement a vessel anchoring and mooring plan to protect known shoals and banks within the Region (noting no known shoals or banks are within the Activity Area). ▪ Implement the Shell chance find process to protect any potential underwater heritage artefacts or sites.
Vessel movements	▪ Comply with the Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans and Shell requirements relating to marine fauna interactions to mininise impacts to marine fauna.
Lighting	▪ Lighting required for safety of personnel will be used
Noise	▪ Implement pile driving procedure adapted from EPBC policy statement 2.1. This is planned to be applied using dedicated Marine Mammal Observers. ▪ Vessels and helicopters comply with EPBC Regulations Part 8.1 – Interacting with cetaceans.
Introduction of invasive marine species (IMS)	▪ Implement the Browse Basin Biosecurity Management Plan (includes biofouling, antifouling and ballast water management and requirements) to comply with regulations and reduce the risk of introducing IMS.
Discharges of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations.
Activity discharges	▪ The drilling method will omit drilling muds and will use untreated sea water only (e.g., no chemical additives). ▪ Store and use per- and polyfluoroalkyl substances (PFAS)-free fire extinguishers on the topsides and substructure. ▪ Implement pipeline hydro-test preservation flooding which will include dosing metering controls. ▪ Use the chemical selection process for all chemicals planned to be released to the marine environment. ▪ Fail-safe tensioner (locks on and contingency tensioners) and criticality mode software system is in place on the pipelay vessel to prevent loss of position incidents.
Atmospheric emissions and greenhouse gas (GHG) emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Comply with the *National Greenhouse and Energy Reporting Act* (2007) and National Greenhouse and Energy Reporting Regulations (2008) ▪ Report GHG emissions to the Clean Energy Regulator, where required.
Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Waste management procedures. ▪ Waste tracking process. ▪ The management and disposal of any quarantine risk material will be in accordance with state and Commonwealth regulations.
Unplanned	
Emergency events	▪ Comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Valid Shipboard Oil Pollution Emergency Plan (or equivalent) is in place. ▪ Implement the national and international regulations and conventions for collision prevention, safety, and navigation at sea. ▪ Offshore Vessel Inspection Database process. ▪ Australian Hydrographic Office Notice to Mariners to minimise disruption to their activities. ▪ NOPSEMA accepted Oil Pollution Emergency Plan is in place. ▪ Relevant Persons consultation process. ▪ Implement a vessel maintenance management system and vessel bunkering procedures (noting no bunkering of intermediate fuel oil will occur). ▪ Use of radar and associated alarms on project vessels and automatic identification system activated on topsides once installed. ▪ Confirm the Crux platform Petroleum Safety Zone (500 m exclusion zone) is in place and Crux infrastructure is marked on Australian nautical charts to reduce interactions with other marine users with Crux-end activities and infrastructure. ▪ A project vessel will act as a surveillance and intervention vessel near the pipelay vessel to reduce the likelihood of a vessel collision with other marine users. ▪ Implement a simultaneous operations plan (if required) to manage interactions between this activity and the Prelude operations (outside the scope of this EP) within the Prelude PSZ
Oil spill response strategies	▪ Ballast water exchange operations will comply with the international conventions and associated national regulations. ▪ Biofouling management for vessels in accordance with state, national and international biofouling management guidelines ▪ Biofouling management in compliance with state and Commonwealth regulations ▪ Vessels (of appropriate class) will have a valid International Anti-Fouling System Certificate ▪ Vessel anchoring and mooring to maintain a minimum 1 km buffer from shoals and banks.

CONTACT US Community Hotline: 1800 059 152 Email: SDA-crux-project@shell.com

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Appendix A - 1.01 General Environment Plan Factsheet

ENVIRONMENT PLAN GENERAL FACT SHEET

SHELL AUSTRALIA

Shell has operated in Australia for over 120 years. From operating Australia's first oil refinery, which was central to meeting Australia's fuel needs, to fuelling the first Qantas commercial flight in the 1920s, to playing a foundation role in building some of Australia's largest and most innovative natural resource developments - as the energy needs of Australia have changed, so have we.

Today, we are a leading natural gas producer and are playing our part in the transition to a low-carbon future by investing in the power sector, renewable energy solutions and carbon abatement activities.

WHAT IS AN ENVIRONMENT PLAN (EP)?

An Environment Plan, or EP, outlines all the environmental impacts and risks of an activity and how these are managed to minimise impacts and risks to the environment. It is required by the Australian Government regulator the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance, prior to starting an offshore oil and gas activity.

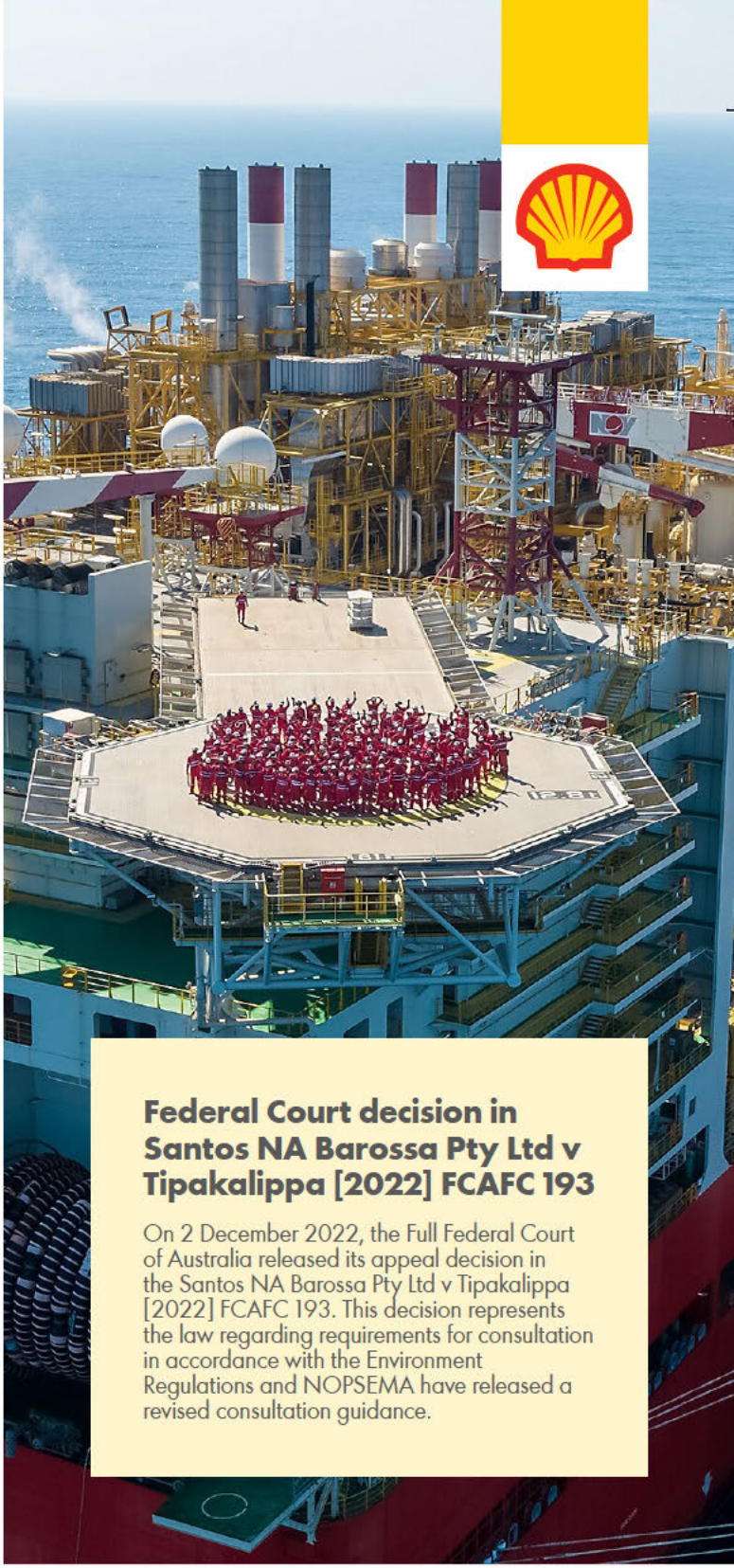
CONSULTATION IS KEY TO THE EFFECTIVE DEVELOPMENT OF AN EP

Guidelines for consultation are outlined in the Offshore Petroleum and Greenhouse Gas Storage Environment Regulation 11A.

The purpose is to ensure that authorities, persons or organisations that are potentially affected by oil and gas activities are consulted, and their input considered in the development of an EP.

Consultation is designed to ensure that relevant persons are identified and given sufficient information and a reasonable period to allow them to make an informed assessment of the possible consequences of the proposed petroleum or greenhouse gas activity on them. It is also intended to help inform a better understanding of the environment.

Shell Australia must consider and adopt appropriate measures in response to the matters raised by relevant persons. These actions will in turn inform the management of environmental impacts and risks to which the activity and EP relate.



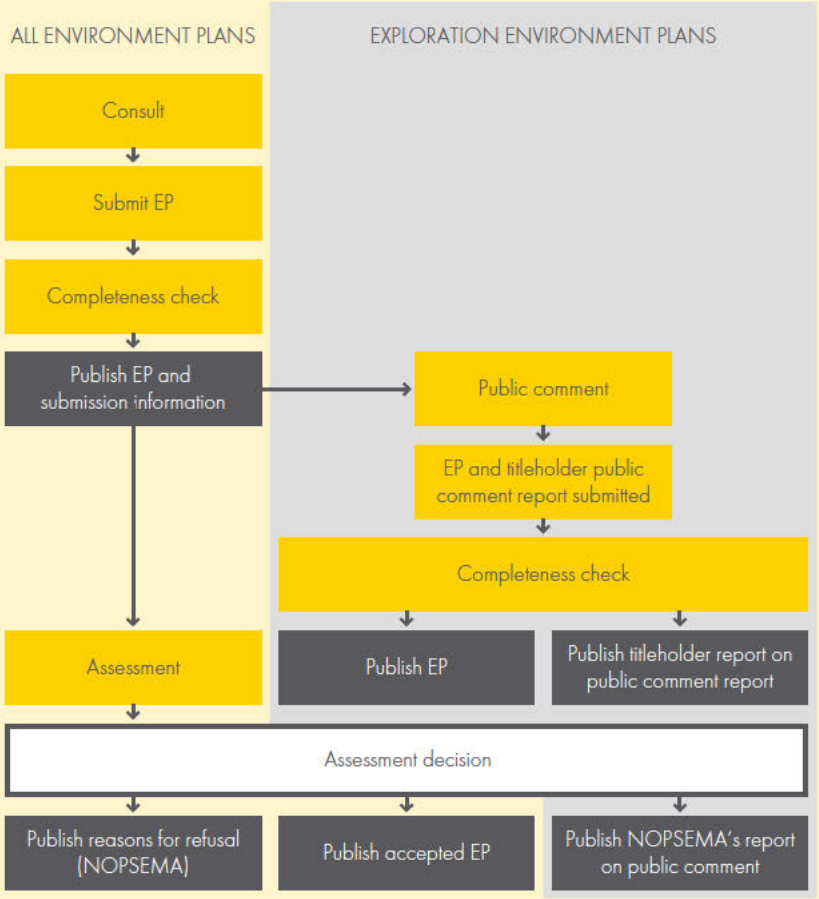
Federal Court decision in Santos NA Barossa Pty Ltd v Tipakalippa [2022] FCAFC 193

On 2 December 2022, the Full Federal Court of Australia released its appeal decision in the Santos NA Barossa Pty Ltd v Tipakalippa [2022] FCAFC 193. This decision represents the law regarding requirements for consultation in accordance with the Environment Regulations and NOPSEMA have released a revised consultation guidance.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is Australia's independent expert regulator for health and safety, structural (well) integrity and environmental management for all offshore energy operations and greenhouse gas storage activities in Commonwealth waters, and in coastal waters where regulatory powers and functions have been conferred.

NOPSEMA'S ASSESSMENT PROCESS FOR EPS



FEEDBACK

At Shell, we recognise the environmental, heritage, social, cultural, and economic values of the region. Shell has undertaken extensive surveys, studies, and a comprehensive review of available information in order to understand and detail the sensitivities and values within the region.

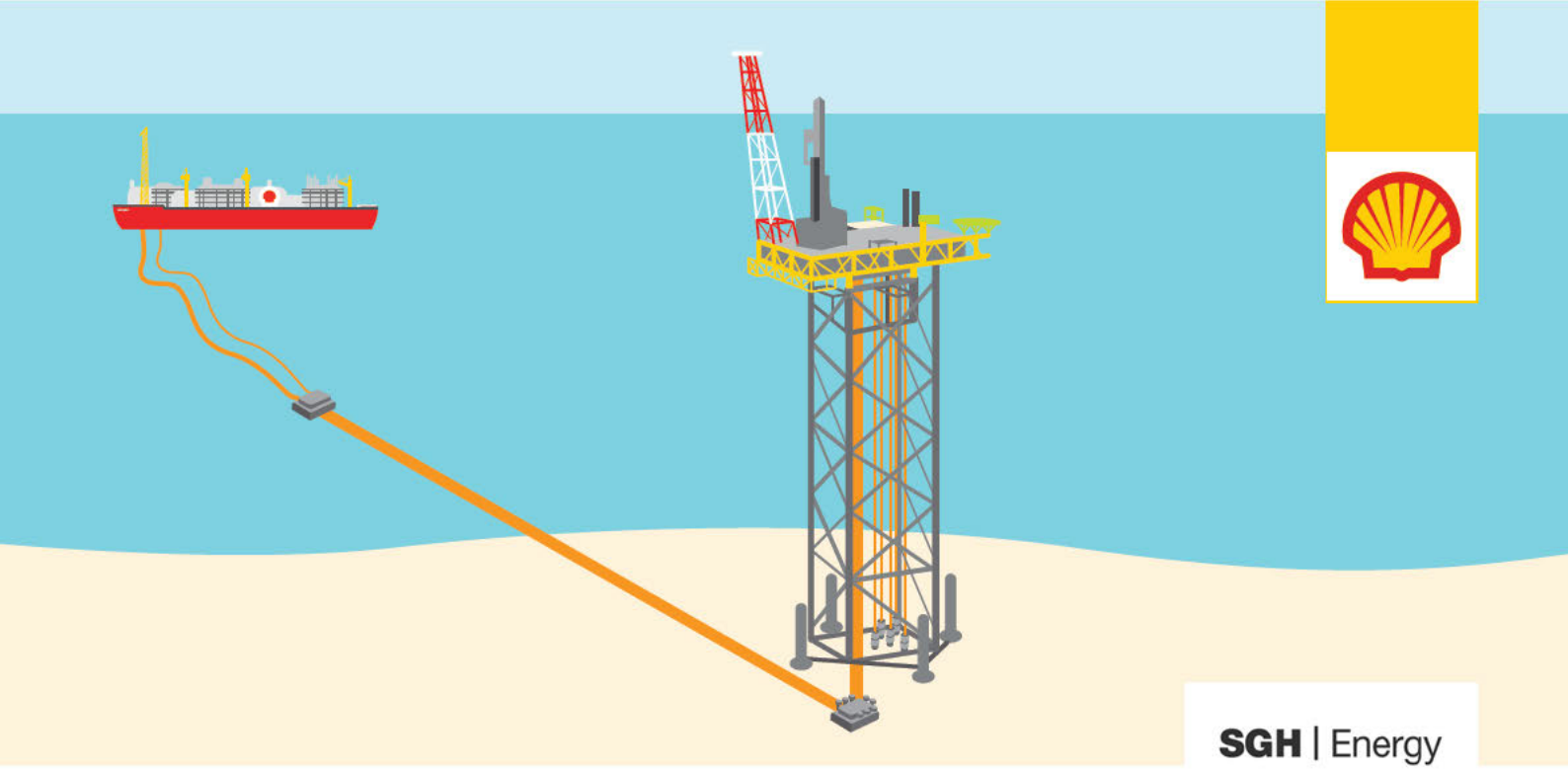
We welcome and seek feedback from relevant persons on our understanding of these values. We are committed to working with relevant persons as part of our ongoing efforts to engage and improve our understanding of the sensitivities and values of the region. Additionally, values and sensitivities are assessed during the risk and impact assessments for any project. Shell will demonstrate how those impacts and risks will be reduced to a level that is as low as reasonably practicable through additional control measures and/or project modifications.

Shell welcomes any feedback, including requests to receive further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

GLOSSARY

Term	Definition
Functions	Refers to "a power or duty to do something"
Activities	To be read broadly and is broader than the definition of 'activity' in regulation 4 of the Environment Regulations and is likely directed to what the relevant person is already doing
Interests	To be construed as conforming with the accepted concept of "interest" in other areas of public administrative law includes "any interest possessed by an individual whether or not the interest amounts to a legal right or is a proprietary or financial interest or relates to reputation"
Reasonable Period	The titleholder must allow a relevant person a reasonable period for the consultation.
Sufficient Information	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.
Relevant Persons	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.

Appendix A - 1.02 Cultural and Social Values Factsheet



EXISTING ENVIRONMENT CULTURAL AND SOCIAL VALUES SUMMARY

ABOUT CRUX

The Crux project forms an important part of Shell Australia's gas portfolio and will be backfill for the existing Prelude FLNG facility. The project consists of a not normally manned platform with five production wells, in ocean waters approximately 165m deep. The facility will be connected to Prelude via a 160km export pipeline and will be operated remotely from the Prelude FLNG facility.

The project is being progressed by operator Shell Australia in joint venture wi h SGH Energy

As part of the project's approvals process Shell is required to identify the cult ral and env ronmental values of the Prelude-Crux Planning Area which may be affected by Shell's activities.

At Shell, we recognise the importance of e vironmental, heritage, social, cultural, and economic values

Shell has undertaken comprehensive surveys, studies and a review of available information to understand and detail the sensitivities and values within the region

We wil demonstrate how these impacts and risks will be reduced to a level that is as low as reasonably practicable through additional control measures, seeking first to avoid and then minimise impacts.

We are committed to working with relevant persons as part of our ongoing efforts to engage and improve our understanding of the sensitivities and values of the region and welcome and seek feedback on these.

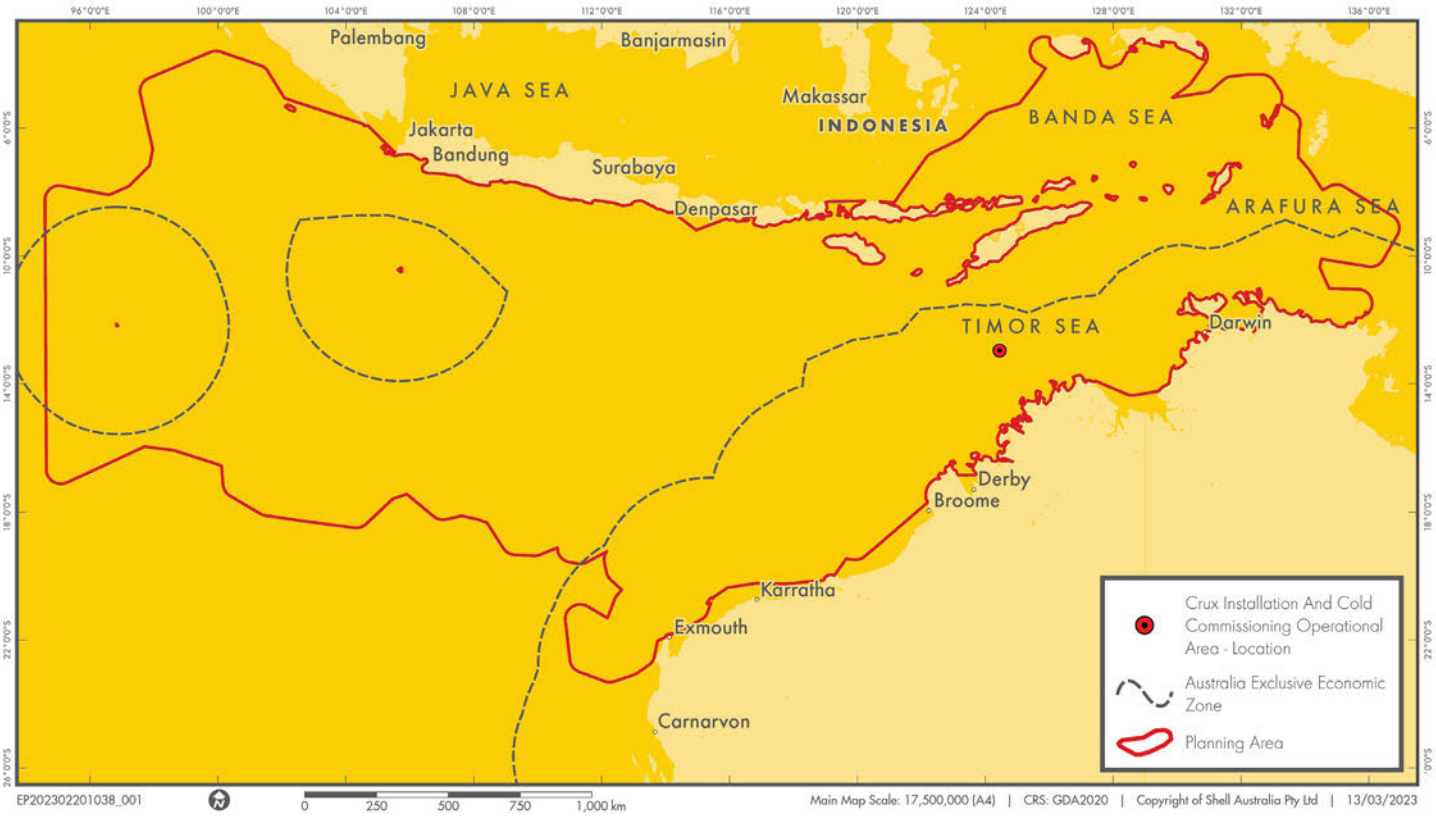


Figure 1: The planning area

THE PLANNING AREA

This is the largest area where the Crux Project could potentially have direct or indirect environmental impacts, as a result of an unplanned hydrocarbon spill. The planning area includes both inshore (State and Territory) and Commonwealth waters, as well as the claimable continental shelf beyond the Exclusive Economic Zone (Figure 1). The planning area extends to the highwater mark.

The planning area represents the total area of many possible pathways that a spill could travel, depending on sea surface conditions, currents and weather at the time of an incident. These combined pathways are developed using hydrocarbon release modelling, and the planning area boundary captures the greatest extent of hundreds of potential release pathways produced by the modelling software.

This means that in the highly unlikely event of one of these scenarios occurring, only a small part of the planning area would be impacted. Understanding the greatest extent of a release allows Shell to ensure that it has adequate response plans to effectively respond.

IDENTIFICATION OF CULTURAL AND SOCIAL VALUES

To understand the cultural and social values of the planning area, information on ecosystems and human activities in the planning area were gathered across the following themes:

- Biological and physical characteristics – identifying the biologically important areas and key ecological features
- Protected areas - including world, commonwealth, state and territory protected areas, Indigenous protected areas and their associated values
- Human activities - including recreational, commercial and research activities
- Community values and aspirations - cultural and social
- Indigenous values and aspirations and connection to land and sea Country
- Indigenous functions and activities with reference to land ownership (i.e., Native Title), Indigenous land, sea and resource management and use.

CULTURAL AND SOCIAL VALUES

The table below provides a summary of the key cultural and social values that exist within the planning area.

Cultural and Social Values	Description
Indigenous Culture	Indigenous peoples have connection to different and overlapping geographic locations within the planning area. Common cultural values link groups to land and sea. These values include an understanding that all natural features, flora and fauna, and marine processes (tides) are the result of journeys and actions taken by ancient creation ancestors. The planning area includes an extensive sea area. Sea country is equally important to Indigenous people as land country. Many of the Indigenous peoples along the Western Australia (WA) and Northern Territory (NT) coastline are saltwater people who have an intimate connection to the sea and associated marine and coastal habitats. For saltwater people all aspects of social, cultural, and economic life are intimately connected to the health of their lands and seas. Features such as reefs and shoals, and marine animals such as sawfish, turtle, whale and dolphin are elements of sea country that are deeply ingrained in Indigenous people's culture, including creation stories. Many of the marine and freshwater fauna species are totemic featuring in art, craft and stories. Connection to sea country is accompanied by cultural rights and responsibilities some of which have been recognized through Native Title determinations, the creation of Indigenous Protected Areas, and Land Trusts in WA and NT. Database searches identified more than 2000 coastal Aboriginal heritage places in WA that overlap with the planning area. These Aboriginal heritage sites include shell middens, fish traps, stone artefacts, stone arrangements and rock paintings and carvings (incl. petroglyphs).
Indigenous Land and Sea Resource Use	Contemporary Indigenous land and sea resource use within the planning area includes: ▪ Hunting and fishing for consumption, cultural and ceremonial purposes ▪ Collection of resources for medicinal and cultural purposes ▪ Commercial resource harvesting ▪ Land and sea management activities conducted by land and sea ranger groups across WA and NT.
Native Title	Native Title determinations within WA and the NT overlap with the planning area. These determinations include both land and sea areas. There are also a number of registered Native Title claims and Indigenous Land Use Agreements overlapping with the planning area.
Conservation Values and Sensitivities	The planning area includes the Ningaloo Coast and the Shark Bay World Heritage Areas, and the tentatively listed Murujuga Cultural Landscape World Heritage Area. Commonwealth, State and Territory protected areas overlap the Planning Area and include several Australian marine parks, biologically important areas, Indigenous Protected Areas, Ramsar wetlands, parks and reserves. These protected areas contain environmental and cultural values of significant interest, importance and value to individuals and communities including Indigenous peoples. Maritime archaeological heritage sites (e.g., shipwrecks), protected under national heritage, and state and local heritage legislation, are also located within the planning area.
Communities	There are many regional centres and remote communities, including Indigenous communities and outstations located along the coastline of the mainland and on islands located within or close to the planning area. Key regional communities include Exmouth, Port Headland, Broome, and Darwin.
Commercial Fisheries	Commercial fisheries overlap the Planning Area and include Commonwealth, WA and NT fishers. Fisheries activities in the planning area include net and line fishing as well as pearling and aquaculture. Indigenous commercial fishing activities are also undertaken in the planning area.
Commercial tourism activities	Protected areas in the planning area support a diverse range of nature-based recreational and tourism activities. Commercial tourism activities undertaken within the planning area include diving, snorkelling, sailing and kayaking, fishing, whale watching and sunset cruising. Nearby land-based activities include birdwatching and chartered tours of coastline areas. Indigenous based commercial tourism activities also occur within the planning area and include on-country experiences, camping with custodians, guided tours of land and sea, marine based fishing experiences. Tourism accommodation operations are located along the mainland coastline and on some islands within or close to the planning area. Many accommodation providers offer marine based tourism activities (for example charter fishing activities) to guests.
Recreational activities	Camping, fishing, beach combing, swimming, snorkelling, diving and kayaking, sailing and bird watching activities are undertaken within or close to the planning area. Many recreation-based interest groups (e.g. fishing, sailing and surf lifesaving clubs) conduct activities that overlap with the planning area

CONTACT US Community Hotline: 1800 059 152 Email: SDA-crux-project@shell.com **www.shell.com.au/crux**

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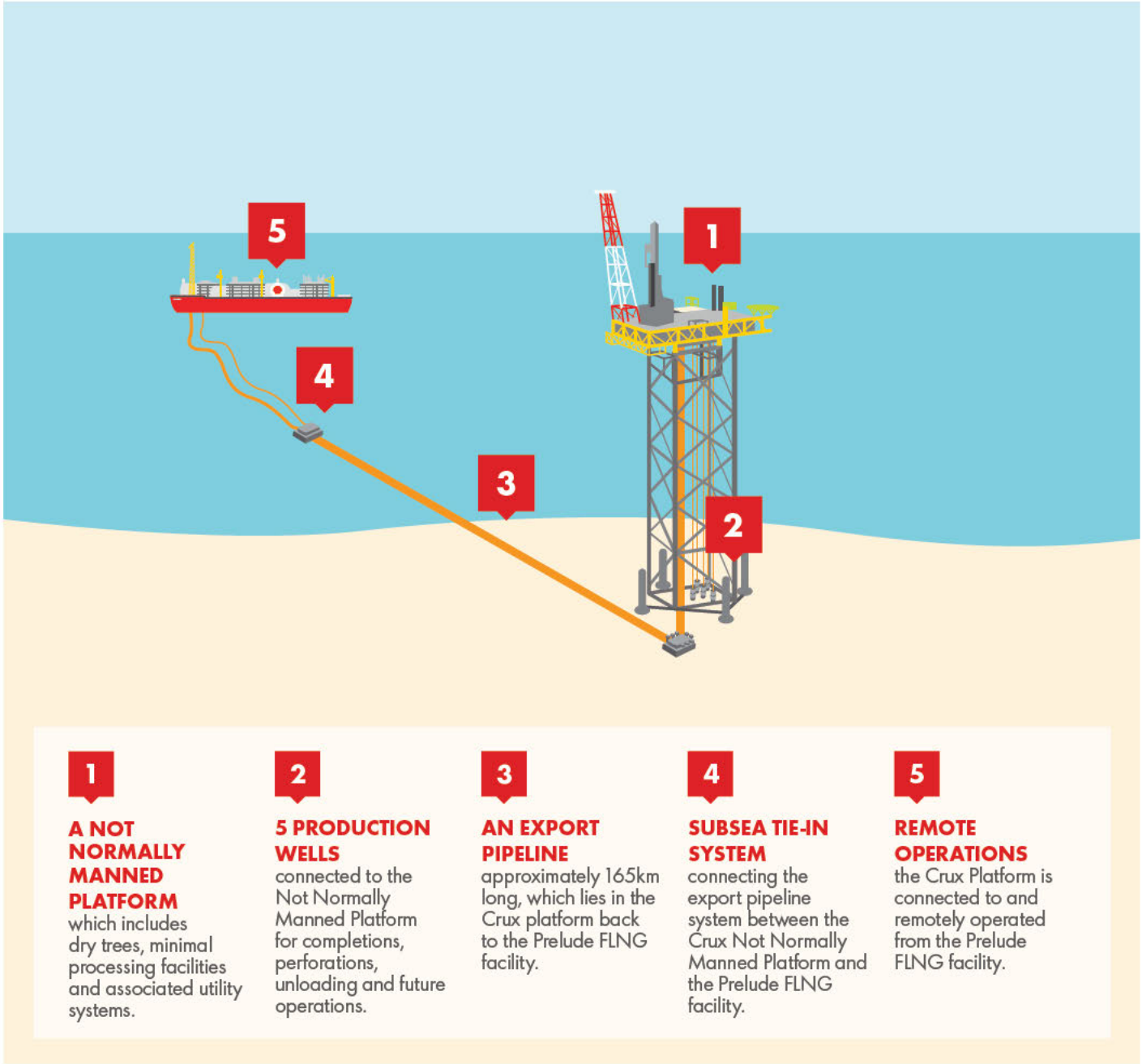
Appendix A - 1.03 Hydrocarbon Release Factsheet

CRUX HYDROCARBON RELEASE FACTSHEET

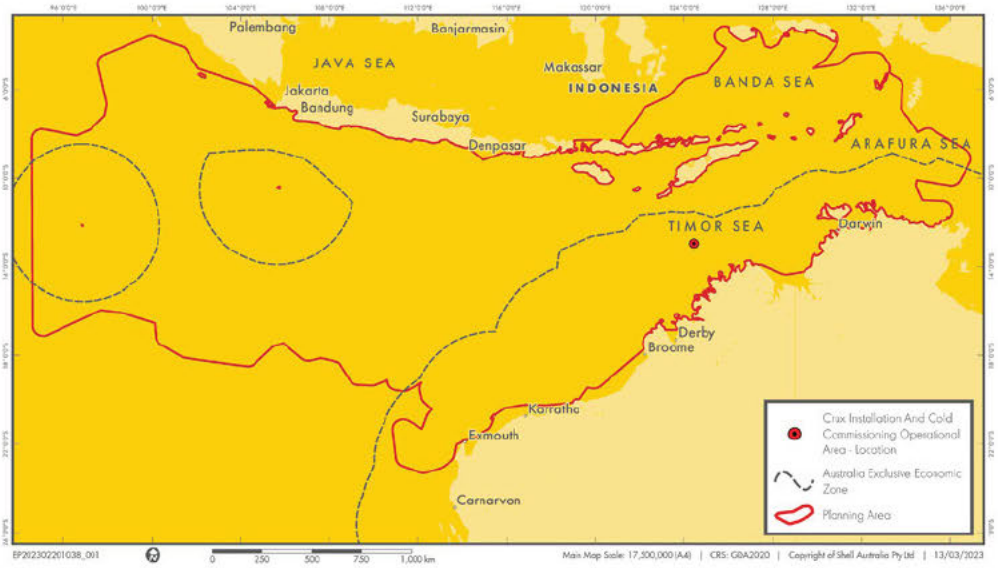
ABOUT CRUX

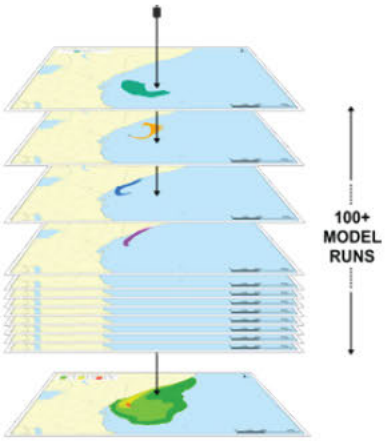
The Crux project forms an important part of Shell Australia's gas portfolio and remains an important backfill opportunity for the existing Prelude FLNG facility. The project consists of a not normally manned platform with five production wells, in ocean waters approximately 165m deep. The facility will be connected to Prelude via a 160km export pipeline and will be operated remotely from the Prelude FLNG facility.

The project is being progressed by operator Shell Australia in joint venture with SGH Energy.



Concept Schematic of the Crux Project





THE PLANNING AREA

This is the largest area where the Crux Project could potentially have a direct or indirect environmental impact, as a result of:

- loss of well control during drilling and operations
- loss of process storage tank containment on the Crux platform
- loss of subsea containment from the export pipeline, or
- loss of fuel from a vessel.

The planning area represents a combined area of many possible pathways that a spill could travel, depending on sea surface conditions, currents and weather at the time of an incident. These combined pathways are developed using a computer model, and the planning area boundary represents the greatest extent of the hundreds of potential release pathways produced by the modeling software.

This means that in the highly unlikely event of one of these scenarios occurring, only a small part of the planning area would be impacted. Understanding the greatest extent of a release allows Shell to ensure that it has adequate response plans to effectively respond.

SUMMARY OF THE MODELED HYDROCARBON SPILL SCENARIOS

SCENARIO	LOCATION NAME	LATITUDE	LONGITUDE	DEPTH (M)	HYDROCARBON TYPE	DURATION	TOTAL VOLUME (M^3)
LOSS OF WELL CONTROL	Platform	12° 57′ 12.46″	124° 26′ 33.21″	169	Crux condensate	80 days	206,225
LOSS OF PROCESS TANK CONTAINMENT ON CRUX PLATFORM	Platform	12° 57′ 12.46″	124° 26′ 33.21″	Surface	Crux condensate	Instant	88
LOSS OF CONTAINMENT FROM EXPORT PIPELINE	Near Haywood Shoal - export pipeline	13° 15′ 29.00″	123° 54′ 39.00″	199	Crux condensate	< 6 hours	2,037
LOSS OF FUEL FROM VESSEL	Platform	12° 57′ 12.46″	124° 26′ 33.21″	Surface	IFO - 180	1 hour	1,000

RISK MANAGEMENT

Shell has extensive experience with safe and environmentally responsible drilling and reservoir engineering worldwide and safe design and operation of subsea pipelines. Shell has developed a detailed understanding of the Crux field through historical seismic surveys and drilling.

The oil and gas industry routinely implements a range of design standards and operational inspections to ensure pipeline and infrastructure integrity. This is reflected in the very low likelihoods of significant hydrocarbon releases from pipelines in jurisdictions similar to Australia.

Australian regulations require that all environmental risks be managed to a level that is "as low as practically possible" and acceptable. This is done through NOPSEMA's Environment Plan (EP) framework. All petroleum activities will be undertaken under an accepted EP.

All wells will be drilled and operated in accordance with an accepted Well Operations Management Plan (WOMP) in accordance with the Offshore Petroleum and Greenhouse Gas Storage Act (OPGGS).

LOSS OF PROCESS STORAGE TANK CONTAINMENT

The Crux platform will process well fluids, before exporting the hydrocarbon to the Prelude FLNG facility for processing. The process equipment on the Crux platform will store considerable volumes of condensate, that could be released to the environment in the event of loss of containment from process infrastructure.

A significant loss of containment from process equipment is highly unlikely. The offshore oil and gas industry routinely implements safety by design to reduce the likelihood of a process loss of containment and reduce personnel exposure to significant risks (a key safety benefit of a Not Normally Manned design of the Crux platform). This is reflected in industry statistics, which indicate a significant release of liquid hydrocarbons from offshore process equipment is very low, particularly for unmanned platforms.

LOSS OF CONTAINMENT FROM CRUX EXPORT PIPELINE

The export pipeline will contain a significant volume of gas and condensate during production operations. A loss of containment from the pipeline may lead to the release of condensate to the marine environment. Pipeline loss of containment events can range from small 'pinhole' leaks (localised corrosion) through to complete rupture of the pipeline (significant mechanical impacts such as a drilling rig anchor being dragged over the export pipeline).

LOSS OF FUEL FROM A VESSEL

The Crux project will require considerable use of a range of project vessels, from small platform support vessels to heavy lift and pipeline installation vessels. The frequency and duration of vessel activities will vary considerably depending on the project phase.

Installation and decommissioning will be peak periods of vessel activity, and vessels will include heavy lift and construction vessels. The commissioning and operations phases (the longest phases of the Crux project) will involve relatively low vessel activity, comprised primarily of platform support vessels.

The nature and scale of the environmental risks and impacts from a loss of fuel from a vessel varies significantly based on the vessel type and activities. Vessels such as heavy lift and pipeline vessels typically store relatively large quantities of fuel. Often these types of vessels are fueled using relatively heavy fuel oils.

Smaller vessels, such as platform support vessels, typically store smaller quantities of fuel. Smaller vessels are typically fueled using lighter fuel oils such as marine diesel, which are less persistent in the environment than heavier fuel oils.

LOSS OF WELL CONTROL

The Crux project involves drilling and completion of, and production from, a series of subsea wells.

Shell's engineering standards require a range of features that manage the risk of a loss of well control to very low levels. However, there is a possibility that a loss of well control may occur during drilling and operation of the Crux platform.

While the likelihood is very small, a complete loss of well control (a well blowout) has the potential to release significant volumes of condensate into the environment. Such a release could result in significant environmental damage.

The likelihood and volume of condensate that could be released during such an event will change during different phases of the Crux project. Most loss of well control incidents do not result in a worst-case well blowout scenario, and typically release relatively small masses of hydrocarbons.

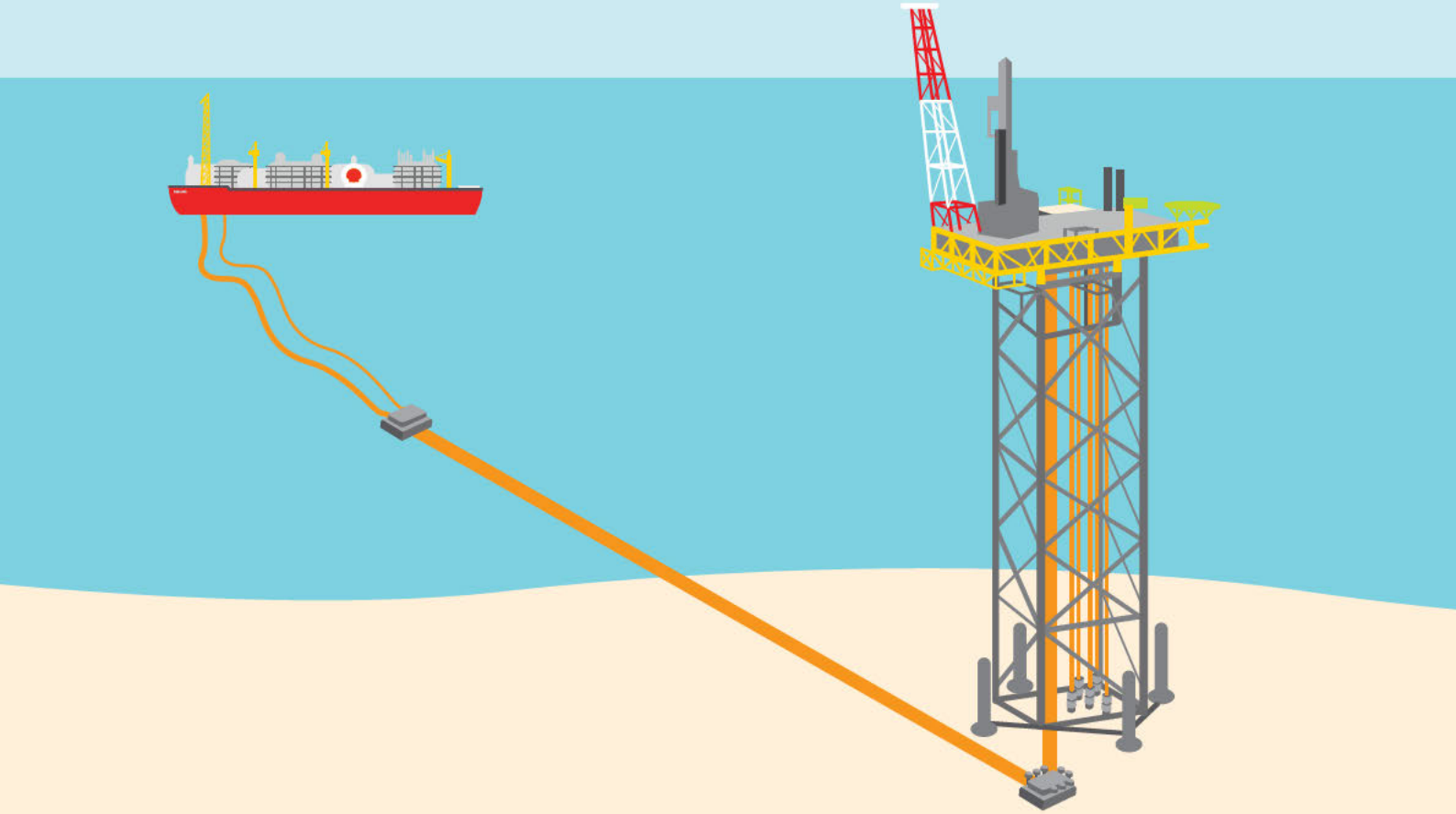
The likelihood of a well blowout from development drilling and production are considerably lower than a loss of containment from an exploration well, as are the likely release volumes. Exploration wells will not be drilled during the Crux project.

At Shell, we recognise the importance of environmental, heritage, social, cultural, and economic values.

Shell has undertaken comprehensive surveys, studies and a review of available information to understand and detail the sensitivities and values within the region.

We will demonstrate how these impacts and risks will be reduced to a level that is as low as reasonably practicable through additional control measures, seeking first to avoid and then minimise impacts.

We are committed to working with relevant persons as part of our ongoing efforts to engage and improve our understanding of the sensitivities and values of the region and welcome and seek feedback on these.



CONTACT US Community Hotline: 1800 059 152 Email: SDA-crux-project@shell.com **www.shell.com.au/crux**

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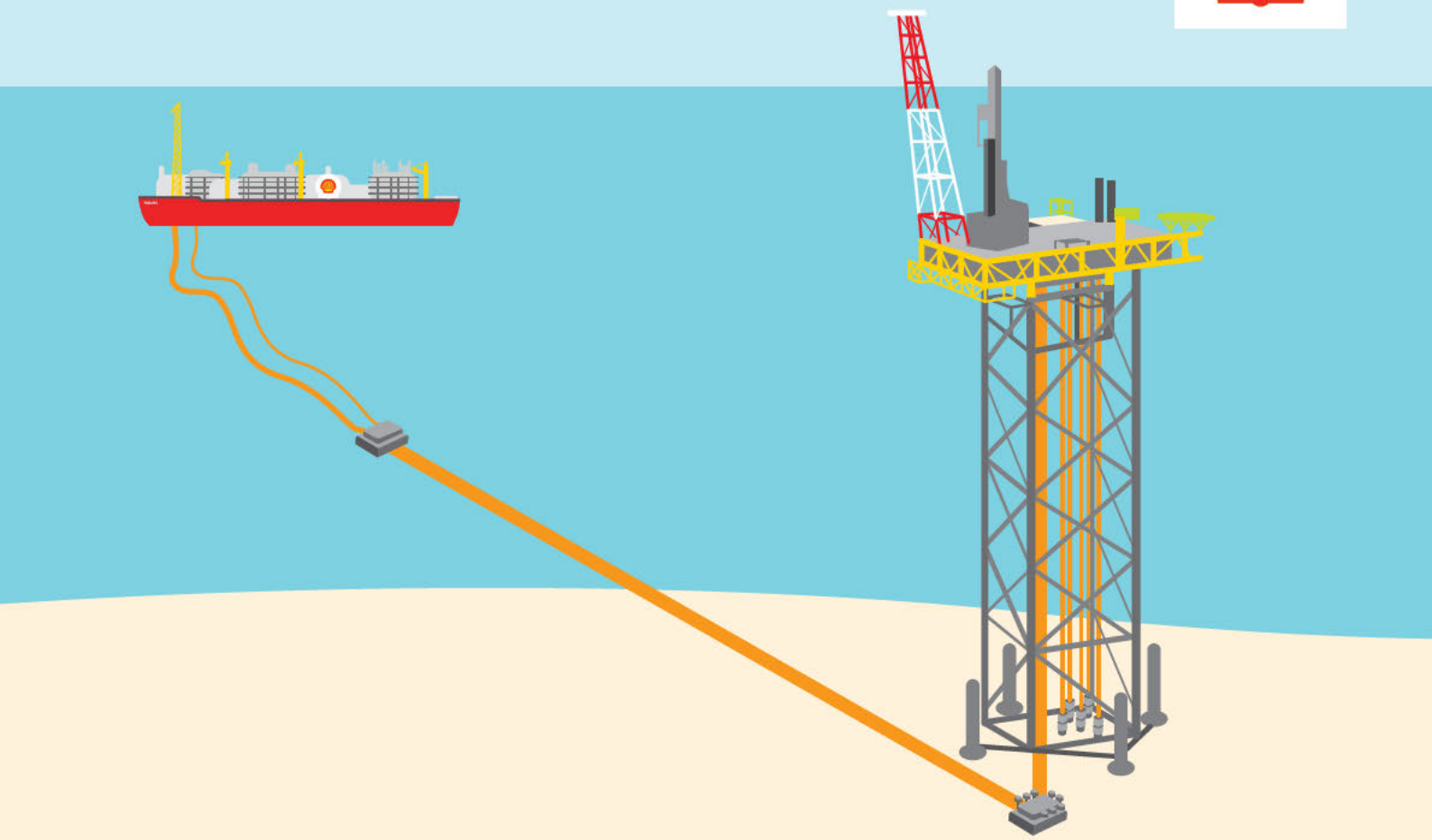
Appendix A - 2.00 Crux Information Booklet – distributed in hard copy only.



SGH | Energy

SHELL'S CRUX PROJECT

2023

INTRODUCTION

Shell has operated in Australia for over 120 years. From operating Australia's first oil refinery, which was central to meeting Australia's fuel needs, to fuelling the first Qantas commercial flight in the 1920s, to playing a foundation role in building some of Australia's largest and most innovative natural resource developments - as the energy needs of Australia have changed, so have we.

Today, we are a leading natural gas producer and are playing our part in the transition to a low-carbon future by investing in the power sector, renewable energy solutions and carbon abatement activities.

ABOUT CRUX

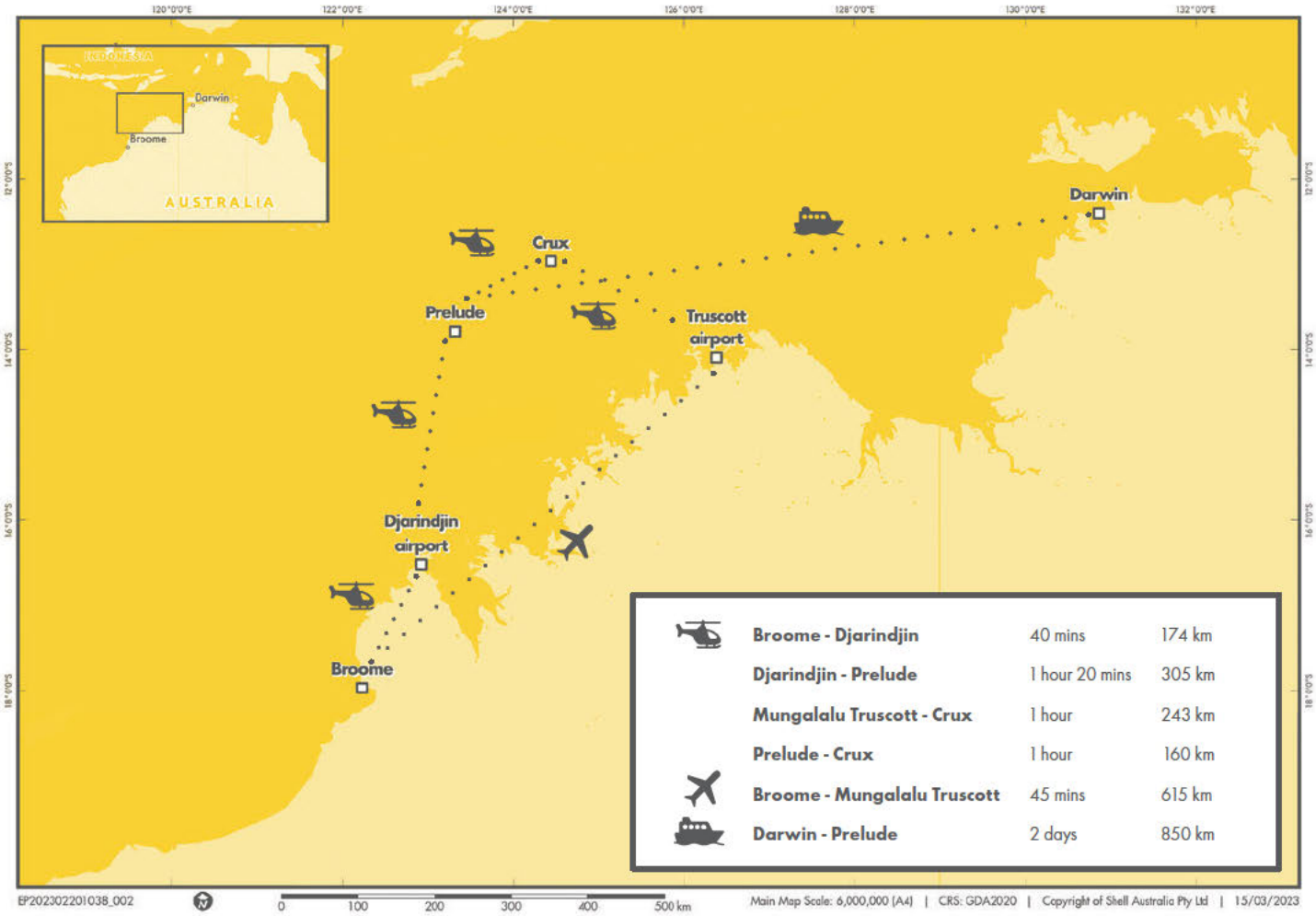
The Crux project forms an important part of Shell Australia's gas portfolio and remains an important backfill opportunity for the existing Prelude FLNG facility. The project consists of a not normally manned platform with five production wells, in ocean waters approximately 165m deep. The facility will be connected to Prelude via a 160km export pipeline and will be operated remotely from the Prelude FLNG facility.

The project is being progressed by operator Shell Australia in joint venture with SGH Energy.

THE LOCATION OF OUR OPERATIONS

Prelude is located approximately 475km north-east of Broome, Western Australia, in the Browse Basin.

Once installed, the Crux platform will be connected to Prelude via a 160km, located approximately 190 km off the Kimberley coast of Western Australia and 620 km north-east of Broome.



TIMING

MAR - MAY 2023
Environment Plan consultation for relevant persons

30 MAY 2023
Environment Plan consultation window closes

MAY - DEC 2023
Expected timing for Crux seabed survey

Second half of 2023
Environmental approval process

1 SEP 2023 - 1 APR 2024
Expected timing for Crux drilling template installation

LATE 2023 - EARLY 2024
Expected timing for Crux drilling activity

UP AND UNTIL 2026
Expected timing for Installation and Cold Commissioning

2027
First gas expected

**Dates for the commencement of activities and durations are subject to change and are pending regulatory approvals.*

Shell is planning to commence engagement with relevant persons end of March 2023.

Construction activities are planned to start in late 2023, with drilling planned to commence in early 2024.

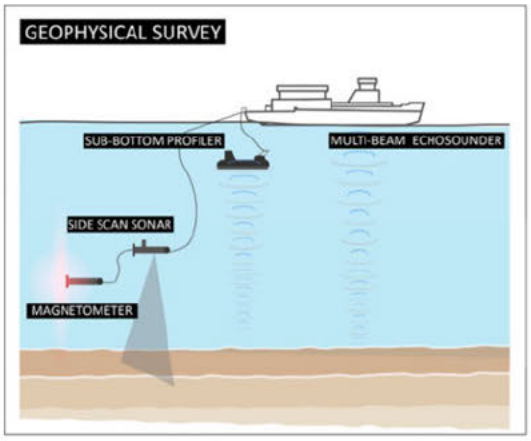
RELEVANT PERSONS

At Shell, we recognise the environmental, heritage, social, cultural, and economic values of the region. Shell has undertaken extensive surveys, studies, and a comprehensive review of available information in order to understand and detail the sensitivities and values within the region.

We welcome and seek feedback from relevant persons on our understanding of these values. We are committed to working with relevant persons as part of our ongoing efforts to engage and improve our understanding of the sensitivities and values of the region. Additionally, values and sensitivities are assessed during the risk and impact assessments for any project. Shell will demonstrate how those impacts and risks will be reduced to a level that is as low as reasonably practicable through additional control measures, seeking first to avoid and then minimise impacts.

PROJECT ACTIVITIES

SEABED SURVEY

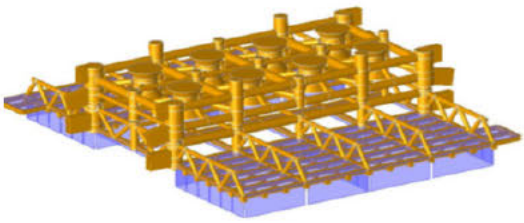


A survey of the seabed along the Crux pipeline route will be carried out using technology like sonar mounted on the hull of a survey vessel. The pipeline will connect the Crux field with the Prelude Floating Liquified Natural Gas (FLNG) facility.

The survey will make sure we have accurate information about the seabed along the pipeline, so construction of the pipeline can be carried out safely and all environment impacts are effectively managed.

The survey is expected to be completed within a five-day period during a single vessel-based campaign operating 24 hrs/day.

DRILLING TEMPLATE INSTALLATION



Drilling Template Structure including mudmats

The steel prefabricated drilling template will be installed on the seabed to act as a guide to the drill bit during drilling operations. Once installed the drilling template will remain in place for the life of Crux.

The drilling template includes eight drill slots to support an initial five well development drilling campaign.

Once installed the drilling template will remain in place for the life of the Crux activity.

The drilling template installation campaign is expected to occur over a one-month period subject to weather and subsurface conditions. The drilling template will be installed within approximately 24 hrs. The activity window is 1 month to account for variability in weather and subsurface conditions

Once installed the template will remain in place for the life of the Crux Project.

PROJECT ACTIVITIES

DEVELOPMENT DRILLING

Representative Mobile Offshore Drilling Unit

Drilling the wells includes the installation of guideposts and five deviated production wells via the preinstalled drilling template.

Installation of guideposts

This ensures that the Crux substructure and topsides are accurately positioned over the drilling template when installed during the subsequent installation campaigns.
The guideposts will remain on location at the seabed for the life of the Crux Project. The guideposts have an approximate structural footprint of Length 28 m X Width 9 m X Height 10 m.

Drilling and suspending the wells

The wells will be drilled from a Mobile Offshore Drilling Unit. They will be drilled from a single drill centre, via the pre-installed drilling template. The wells will be suspended and left in-situ with well completions planned to occur following installation of the Crux platform. The Mobile Offshore Drilling Unit will be a semi-submersible Mobile Offshore Drilling Unit – which will be held in position by anchor spread.

The drilling campaign is expected to be carried out for approximately 2 years with scope completed no later than the end of 2025. It will be supported by a range of services including helicopter transfers from mainland Australia, a dedicated installation vessel, four anchor handling, tug and support vessels and remotely operated vehicles undertaking inspection, maintenance and repair activities.

PROJECT ACTIVITIES

INSTALLATION AND COLD COMMISSIONING

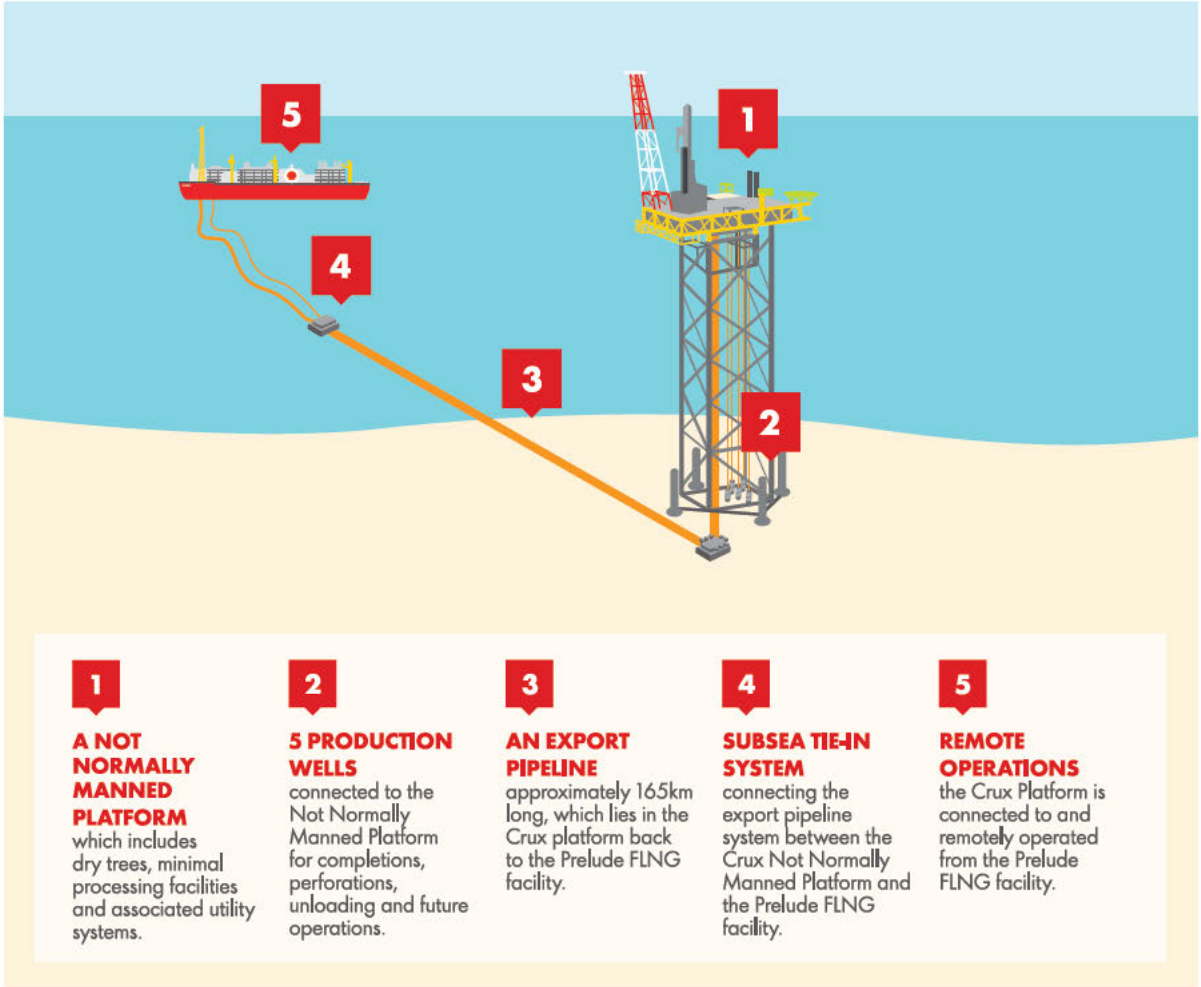
This covers a number of activities including:

- Installation of the subsea integration system, including the Crux pipeline to export gas from Crux field to Prelude FLNG facility for processing into LNG. The pipeline will be approximately 26 inches in diameter and approximately 165 km long.
- Installation of the Crux not-normally manned platform, jacket and topsides. The platform will be held in position by piled foundations on the seabed. It includes processing facilities and associated utility systems.
- Cold commissioning activities such as hydrotesting and dewatering of the pipeline.

The installation phase will be supported by crews being transported via helicopter from Broome, while supply vessels will be serviced from Darwin.

PROJECT ACTIVITIES

START UP AND OPERATIONS



Concept Schematic of the Crux Project

This is where operations to commence production will be completed including

- commissioning testing and monitoring topside equipment on the platform and the export pipeline
- well, flowline and riser operations
- remote production and processing operations

DECOMMISSIONING

This will include well abandonment, decommissioning of the platform and decommissioning of subsea facilities and export pipeline.

ENVIRONMENTAL IMPACT MANAGEMENT

Construction activities have been designed to operate and manage environmental risks to as low as reasonably practicable and acceptable levels.

LIGHT

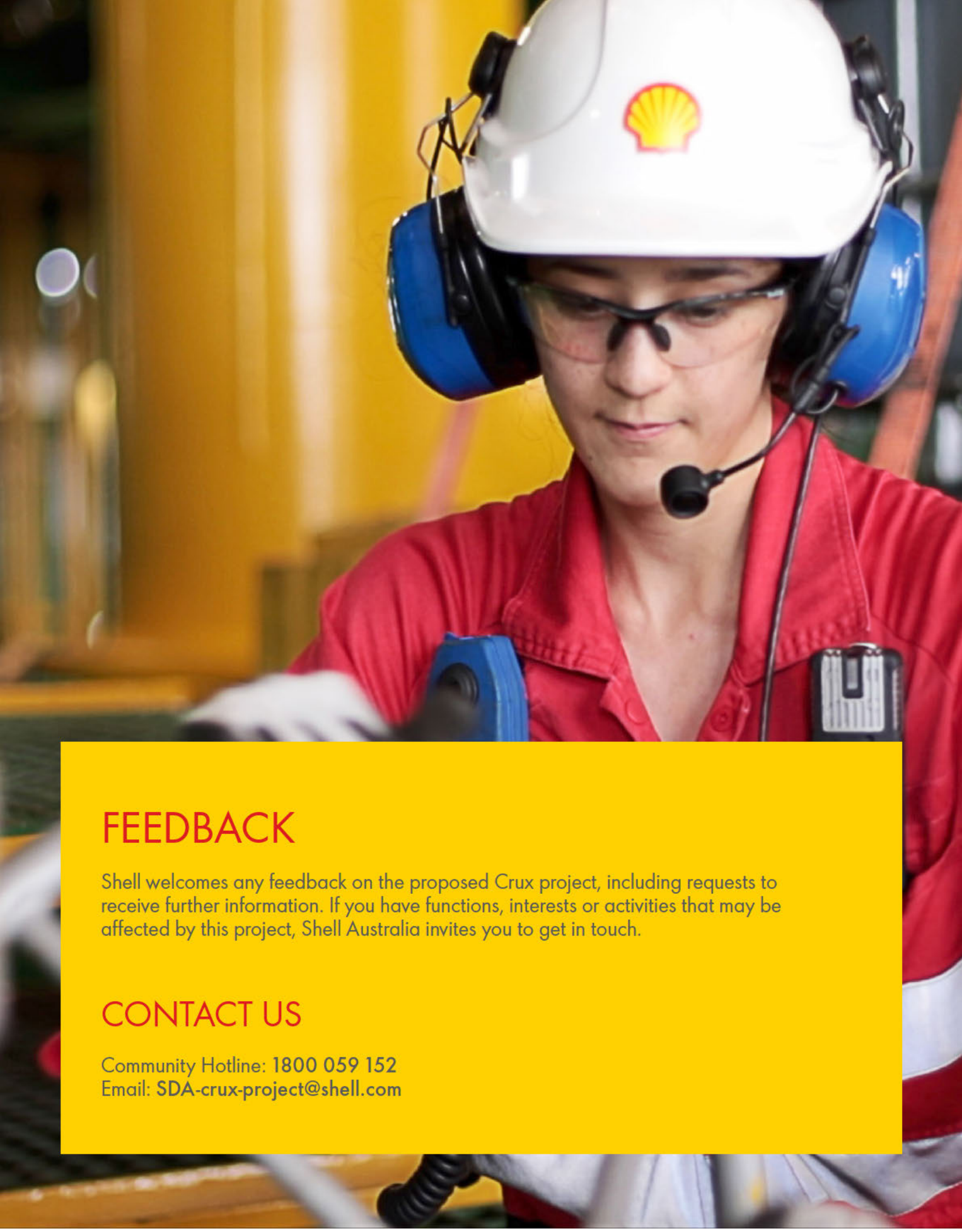
External lighting on offshore facilities have been minimised to the lowest levels possible to that required for navigation and safe operations on deck.

NOISE

There will be some noise during the day and night while the project is being constructed. Any marine life in the area will be monitored and there will be no activity within 1 km of any shoals.

NOTIFICATION TO MARINE USERS

The 500 m Petroleum Safety Zone will be in place and marked on all relevant marine navigation charts. The Safety Zone will remain in place for the life of the Crux project. A notice to mariners will be issued via the Australian Hydrographic Office in advance of any activities commencing.



FEEDBACK

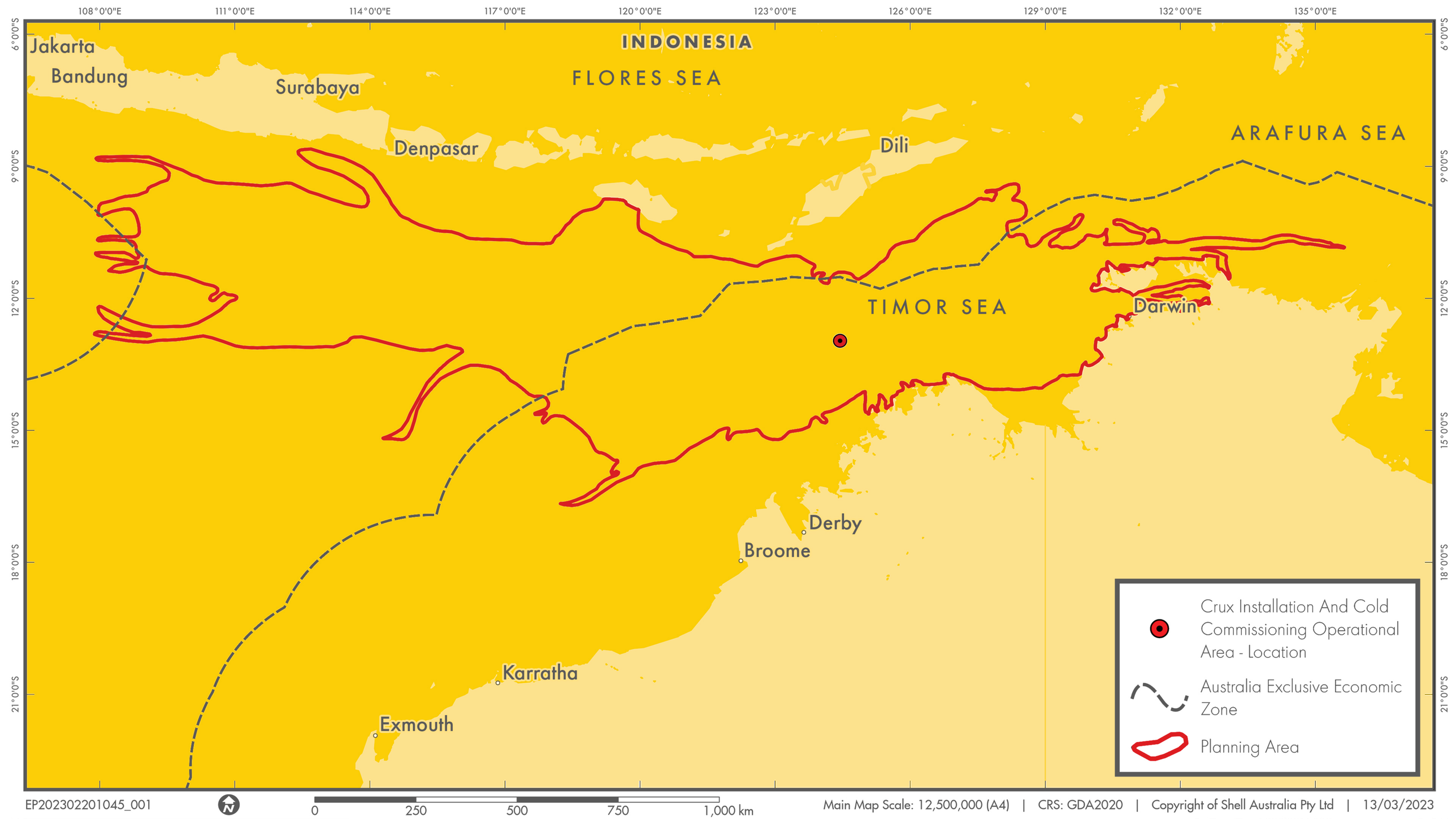
Shell welcomes any feedback on the proposed Crux project, including requests to receive further information. If you have functions, interests or activities that may be affected by this project, Shell Australia invites you to get in touch.

CONTACT US

Community Hotline: **1800 059 152**
Email: **SDA-crux-project@shell.com**

WWW.SHELL.COM.AU/CRUX

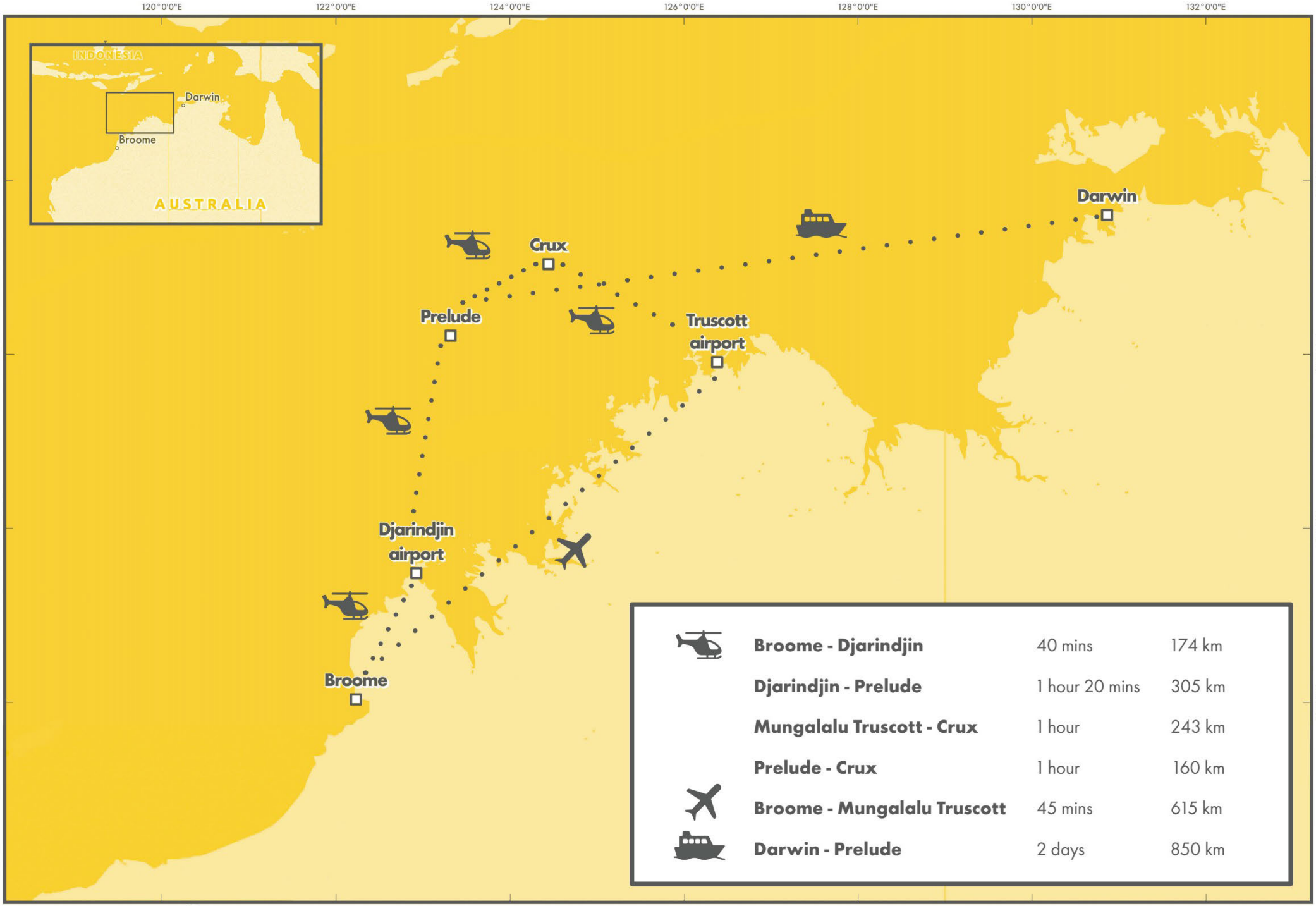
Appendix A - 3.00 Installation and Cold Commissioning EP Planning Area Map



EP202302201045_001

Main Map Scale: 12,500,000 (A4) | CRS: GDA2020 | Copyright of Shell Australia Pty Ltd | 13/03/2023

Appendix A - 3.01 Community Map



EP202302201038_002

0 100 200 300 400 500 km

Main Map Scale: 6,000,000 (A4) | CRS: GDA2020 | Copyright of Shell Australia Pty Ltd | 15/03/2023

Appendix A - 4.00 Crux Campaign Overview

Shell Crux Campaign 2023

Copyright of Shell International B.V.

Crux Media Plan – print and radio

OFFLINE					Est 1+ Reach (PX+)	2/5/2023	2/12/2023	2/19/2023	2/26/2023	3/5/2023	3/12/2023	3/19/2023	3/26/2023	4/2/2023	4/9/2023	4/16/2023	4/23/2023
SUPPLIER	MARKET	FORMAT / PLACEMENT	ROLE	METRIC	DEMO												
Newscorp / NT News	NT	Half Page Horizontal -EGN- Saturday	Reach	Impressions	Total People						1	1					
Newscorp / NT News	NT	Half Page Horizontal -EGN- M to F	Reach	Impressions	Total People						1	1					
Newscorp / Sunday Territorian	NT	Half Page Horizontal -EGN- Sunday	Reach	Impressions	Total People						1	1					
ACM - Katherine Times	NT	Half Page Horizontal - Wednesday	Reach	Impressions	Total People						1	1					
ACM - Farm Weekly		Half Page Horizontal - Thursday	Reach	Impressions	Total People						1	1					
Leba - National Indigenous Times	National	Half Page Horizontal - Monthly, Last Tues	Reach	Impressions	Total People						1						
Leba - Koori Mail	National	Half Page Horizontal - Fortnightly, Wed	Reach	Impressions	Total People							1					
ACM - The Senior	WA	Half Page Horizontal - Monthly	Reach	Impressions	Total People								1				
SWM - West Australian	WA	Half Page Horizontal - M-F	Reach	Impressions	Total People						1	1					
SWM - Sunday Times	WA	Half Page Horizontal - Sunday	Reach	Impressions	Total People						1	1					
SCA -HIT 106.5 Karratha		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Triple M Karratha 102.5		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Hit 91.7 Port Hedland		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Triple M Port Hedland 94.1		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Hit Northwest		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Triple M Northwest		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Hit 99.7 Carnarvon		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Triple M Carnarvon 666		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Hit 96.5 Geraldton		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
SCA - Triple M Geraldton 98.1		30's Audio - BMAD	Reach	Impressions	Total People							21	21	21			
Leba - One Mob Radio	National	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - BEAR GOVE FM	Nhulunbuy	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 8TEA TEABBA RADIO	NT	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 8YOL Yolngu Radio	Nhulunbuy	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 6CAN	Carnavon	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 6GME - Radio Goolari	Broome	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 6HCR Hedland Radio	Port Headland	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 6RM Radio Mama	Geraldton	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
Leba - 6WR	Kununurra	30's Audio - BMAD	Reach	Impressions	Total People							7	7	7			
ARN - HOT 100 FM Darwin	NT - Darwin	30's Audio - BMAD	Reach	Impressions	Total People							20	20	20			
ARN - MIX 104.9 Darwin	NT - Darwin	30's Audio - BMAD	Reach	Impressions	Total People							20	20	20			
ARN - Territory FM Darwin	NT - Darwin	30's Audio - BMAD	Reach	Impressions	Total People							20	20	20			
SBS - NITV	WA + QLD + NT	30's Audio - AM/FM & Digital TV	Reach	Impressions	Total People								3	3	3		
Meta	Postcode Targeting	Static Ads	Reach	Reach	P18+						1						
LinkedIn	NT + WA (Ex Perth)	Static Ads	Reach	Impressions	P18+						1						

Meta – targeted maps

Area 1

Area 2

Area 3

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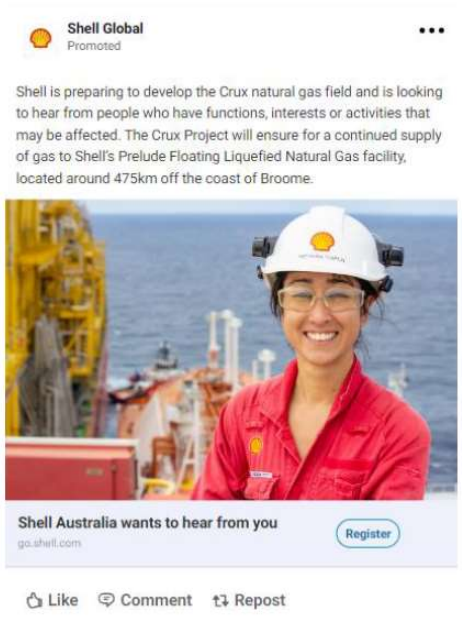
Creative

Identical creative and copy was used across LinkedIn and Meta.

LinkedIn



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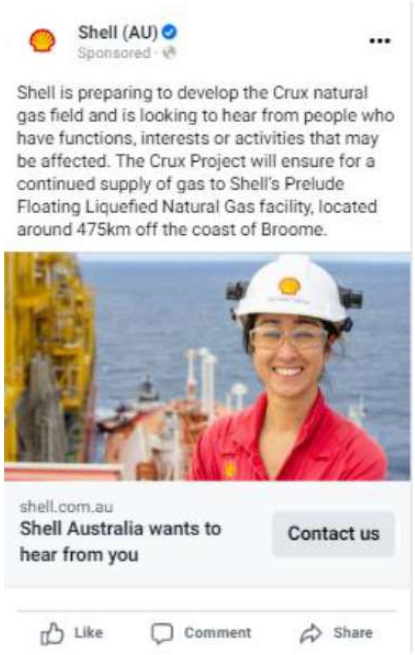

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MOST CONFIDENTIAL

Appendix A - 4.01 Print adverts

ACM

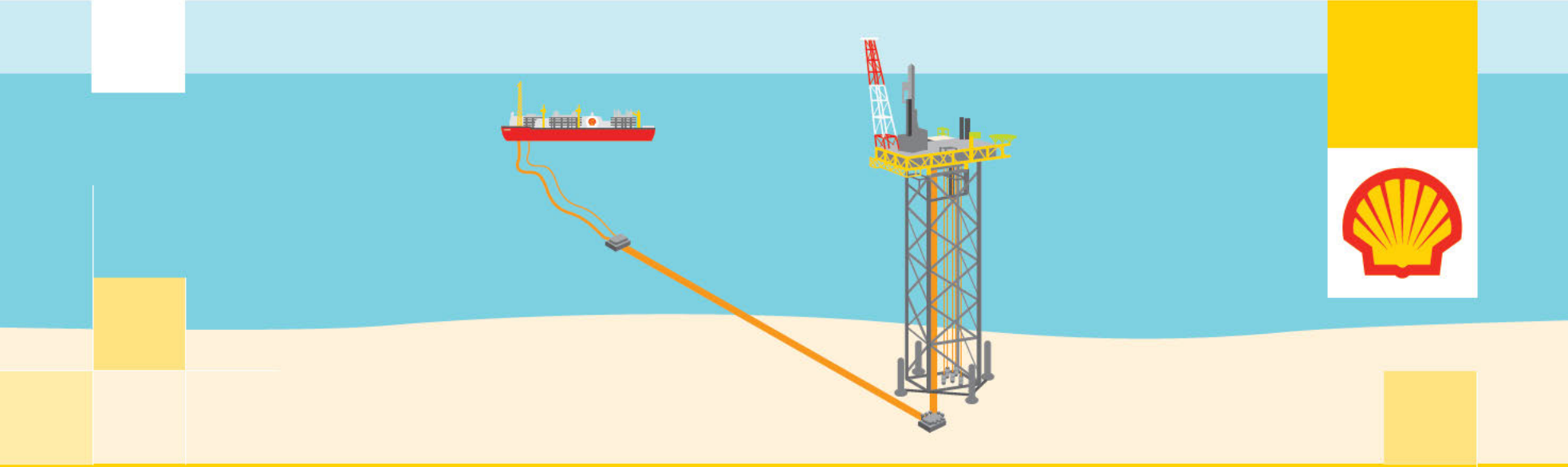
Koori Mail

National Indigenous Times

Newscorp

SWM

The West



SHELL AUSTRALIA INVITES YOU TO GET IN TOUCH ON THE CRUX PROJECT

In Australia, Shell has an integrated energy solutions portfolio which includes gas production and liquefaction, as well as renewable power and energy solutions businesses.

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CRUX PROJECT JOINT VENTURE PARTNER

SGH | Energy

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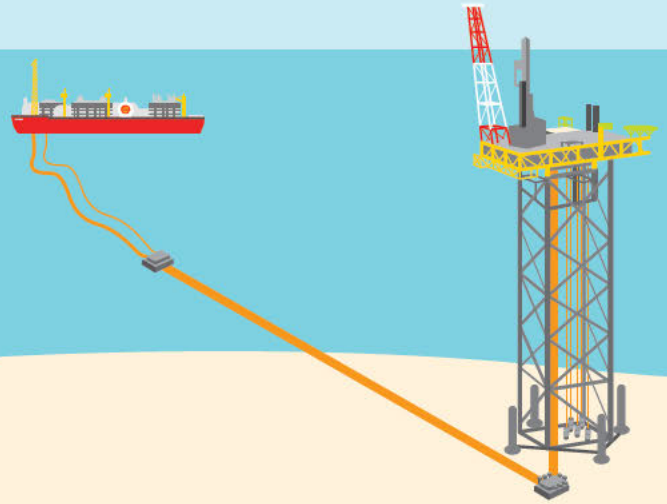
If you have functions, interests or activities that may be affected by this project, Shell Australia invites you to get in touch.

Please respond by 30 April 2023.

For more information please visit:
www.shell.com.au/crux



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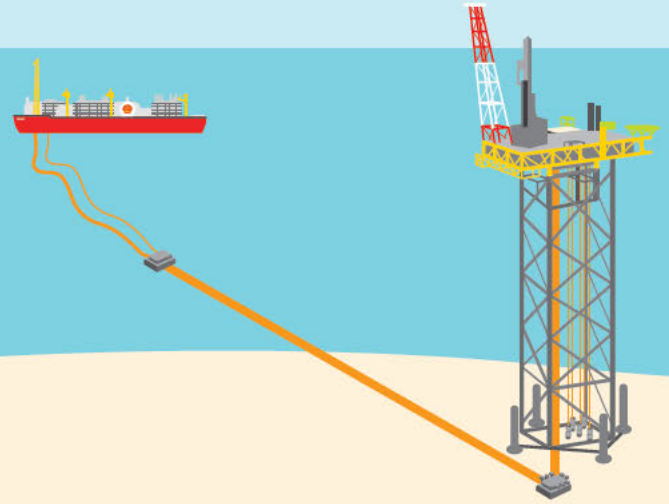

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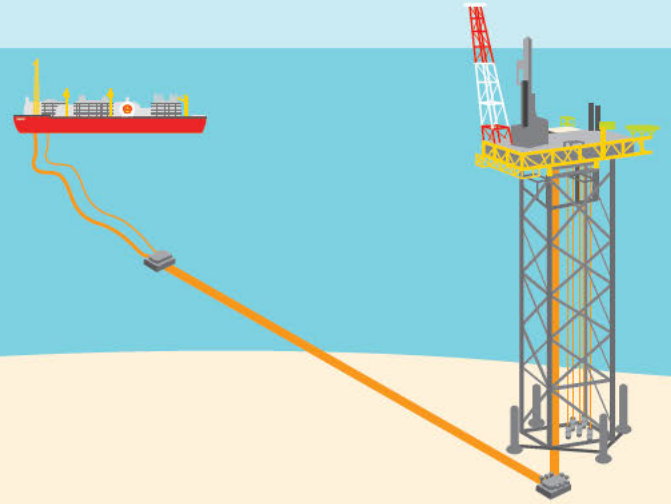

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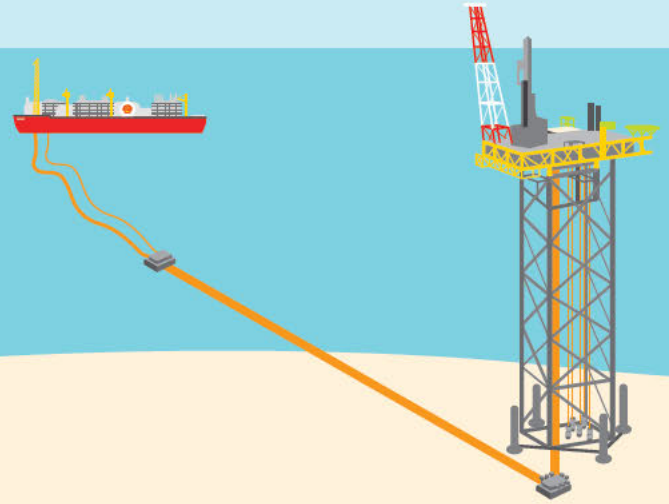

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CRUX PROJECT JOINT VENTURE PARTNER

SGH | Energy

Some Col comfort amid quit rumours

SHANNON HAMPTON

Police Minister Paul Papalia has rubbished rumours Police Commissioner Col Blanch is standing down as "ridiculous" amid law enforcement rivalries linked to massive drug bust off Perth.

Rumours have swirled for several weeks about the police chief's future, but Mr Papalia, pictured below, shot them down on Thursday.

It is understood the rumours may have stemmed from tensions between WA Police and Australian Federal Police after the operation that culminated in an Australian record 2.4-tonne cocaine sting.

The operation was carried out in co-operation with the US Drug Enforcement Administration — but without the AFP.

Mr Papalia said on radio that rumours Mr Blanch's career was "on the line" and that there were "issues that could cause him to stand aside" were "ridiculous".

"The Commissioner is doing an excellent job, as is the Western Australian Police Force under his leadership," he said. "Most recently, we saw Operation Beech, the biggest cocaine bust in history, where they were working closely with the DEA and the NSW Police, resulting in excellent outcomes and stopping massive amounts of illicit drugs coming into the nation.

"That's a result of the relationships and knowledge the Commissioner has of his days in the ACIC (Australian Criminal Intelligence Commission).

"I look forward to working with him in coming years to do an excellent job and continue to deliver on great reforms and great changes and better capacity in the Western Australian Police Force."

The West Australian

OPERATION BEECH MUST-READ EXCLUSIVE

GOTCHA!

How WA Police worked with US drug officers to bring down the Mexican cartel that ran Australia's biggest ever drug bust

As revealed by The West Australian this month, WA Police launched a sophisticated undercover operation to catch members of a Mexican drug syndicate operating in Perth after the DEA seized 2.4 tonnes of cocaine off the South American coast.

Before details of the record-breaking seizure were revealed, it was reported the AFP had complained about the two Sydney-based DEA agents involved in the operation and they were sent home to the US. The complaint was made by AFP Commissioner Reece Kershaw to US Ambassador Caroline Kennedy.

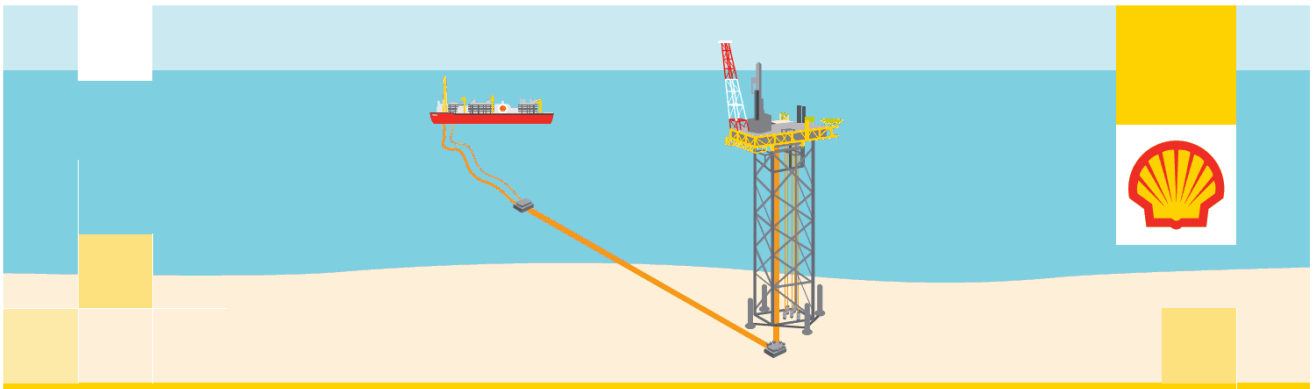
The AFP had said "it is imperative international agencies that operate in Australia adhere to Australian laws and respect Australia's sovereignty".

Mr Blanch told The West he had "nothing but praise" for the two agents.

"We do this job lawfully . . . we make sure we do these jobs properly. I've got nothing but praise for those officers on this particular case and they did a good job with us."

Mr Papalia acknowledged the AFP had "expressed some concerns with our relationships with the DEA" but said he also had no concerns about how the operation ran.

"I applaud our relationships with the DEA," he said. "I applaud the Commissioner's efforts with the DEA. I applaud the Commissioner's efforts to build those relationships."



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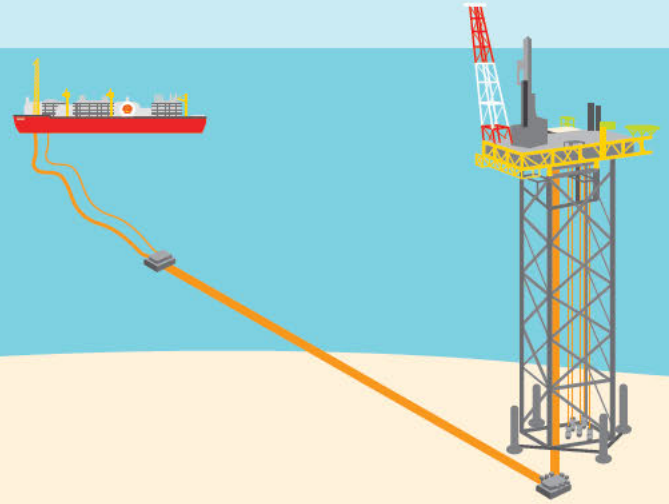
Please respond by 30 April 2023.

For more information please visit: www.shell.com.au/crux

CRUX PROJECT JOINT VENTURE PARTNER

SGH | Energy



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CRUX PROJECT JOINT VENTURE PARTNER

SGH | Energy

Appendix A - 4.02 Social media post

Facebook

Linkedin

Shell (AU)

Written by Sprinklr Ads [?] · 42m ·

Shell is preparing to develop the Crux natural gas field and is looking to hear from people who have functions, interests or activities that may be affected. The Crux Project will ensure for a continued supply of gas to Shell's Prelude Floating Liquefied Natural Gas facility, located around 475km off the coast of Broome.

SHELL.COM.AU

Shell Australia wants to hear from you

Get in touch on the Crux Project

Contact us

Shell Global
Promoted

Shell is preparing to develop the Crux natural gas field and is looking to hear from people who have functions, interests or activities that may be affected. The Crux Project will ensure for a continued supply of gas to Shell's Prelude Floating Liquefied Natural Gas facility, located around 475km off the coast of Broome.

Shell Australia wants to hear from you
go.shell.com

Register

Like Comment Repost

Appendix A - 4.03 Radio ads

Radio ad

https://creativehub.shell.com/m/244f29d784234f2a/original/SHEL0323CTA01.mp3

Transcript of radio ad.

'Shell have been providing energy to Australians for 120 years. In 2023, Shell is preparing to develop the Crux natural gas field, to ensure the supply of gas to their natural gas facility, Prelude, 475km NNE off Broome. Environmental approvals are being prepared. If you have functions, interest or activities that may be affected by this Project Shell invites you to get in touch. Responses are required by April 30. For more information visit shell.com.au/crux'

Radio ad

https://creativehub.shell.com/m/244f29d784234f2a/original/SHEL0323CTA01.mp3

Appendix A - 4.04 Drop-in session advert

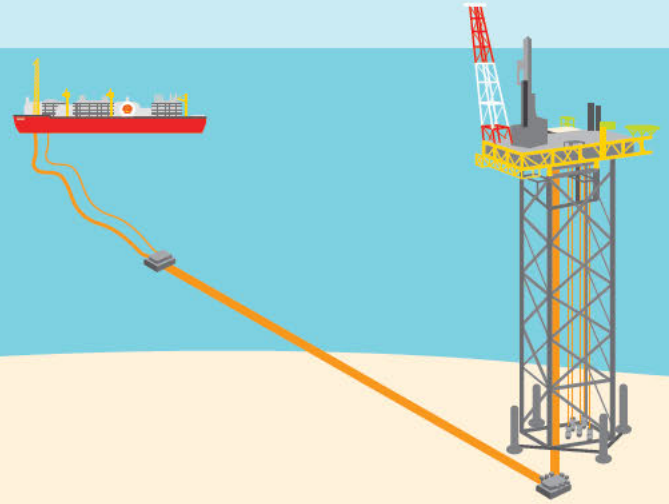
Broome

Darwin

Exmouth

Port Hedland

Derby



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SGH | Energy

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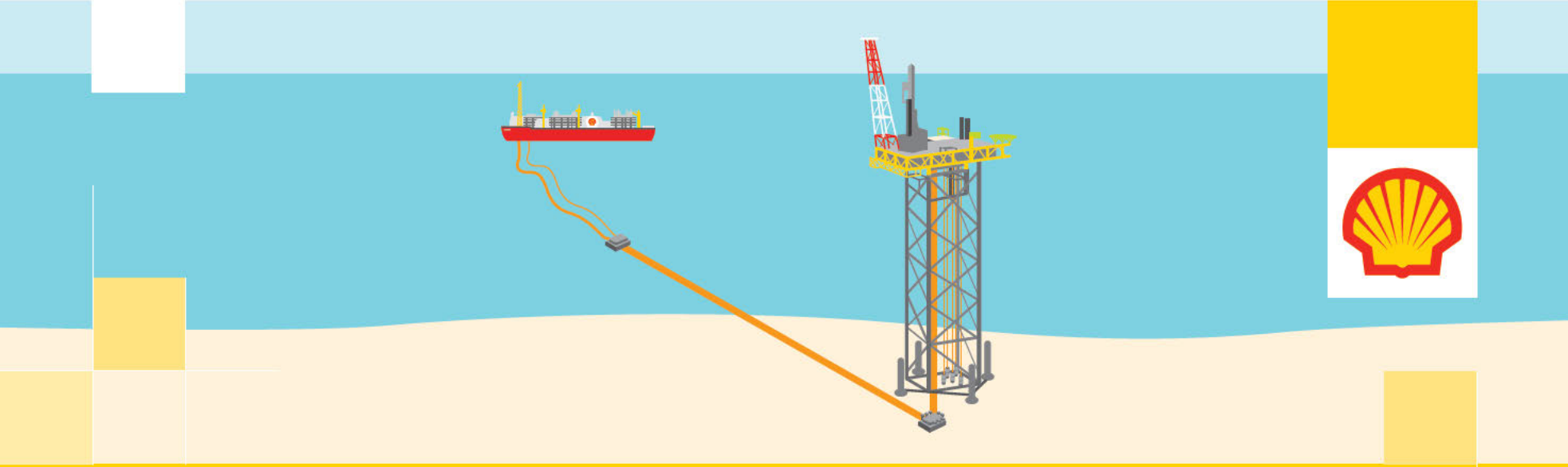
If you are interested in learning more, Shell Australia invites you to join us at a drop-in session as follows:

Date: Thursday 27 April 2023
Time: 15.00 – 17.00
Location: Mangrove Hotel, 47 Carnarvon Street Broome.

For more information please visit:
www.shell.com.au/crux



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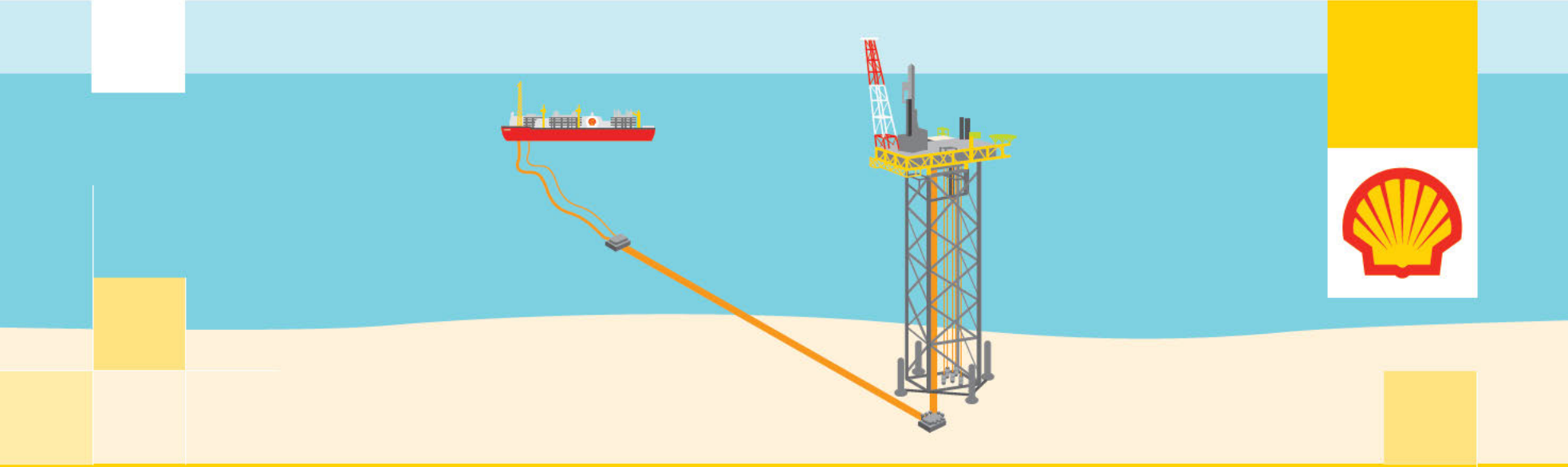
Date: Wednesday 17 May 2023
Time: 15.00 – 17.00
Location: GTNT Group- Harrison Room, 38 Woods St, Darwin City NT 0800

For more information please visit:
www.shell.com.au/crux



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In Australia, Shell has an integrated energy solutions portfolio which includes gas production and liquefaction, as well as renewable power and energy solutions businesses.

With our joint venture partner, SGH Energy, we are preparing to develop the Crux natural gas field. This is to ensure a continued supply of gas to Shell's Prelude Floating Liquefied Natural Gas (FLNG) facility, which extracts, liquefies and stores natural gas at sea, before it is transferred and shipped to customers. Prelude FLNG is located around 475km north-north east of Broome in Western Australia.

CRUX PROJECT JOINT VENTURE PARTNER

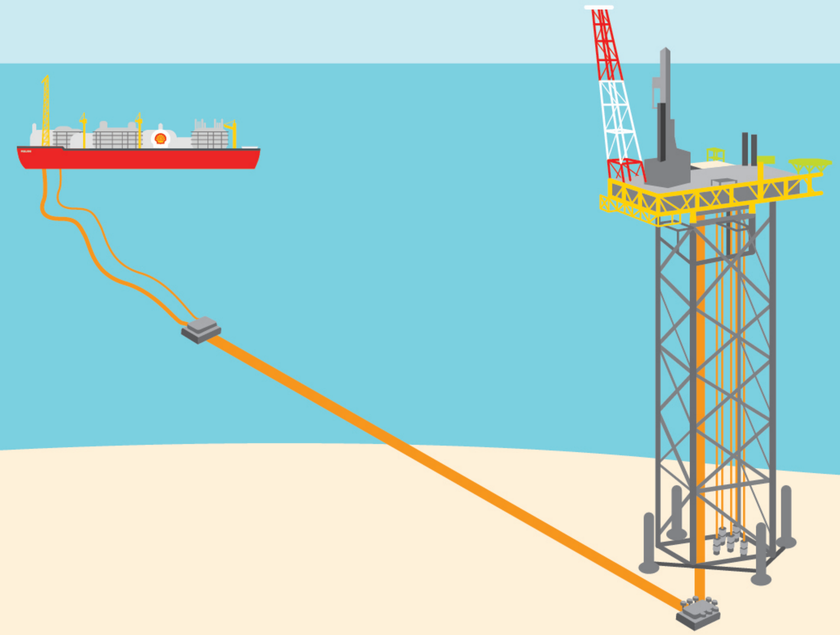
SGH | Energy

As part of the Crux development, we will be preparing environmental approvals for submission to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). Consultation with relevant persons is an important part of these approvals.

If you are interested in learning more, Shell Australia invites you to join us at a drop-in session as follows:

Date: Tuesday 4 April 2023
Time: Join us anytime between 7.30am to 6.00pm
Location: Derby Professional Centre – Conference Room, 2 Clarendon Street, Derby

For more information please visit:
www.shell.com.au/crux



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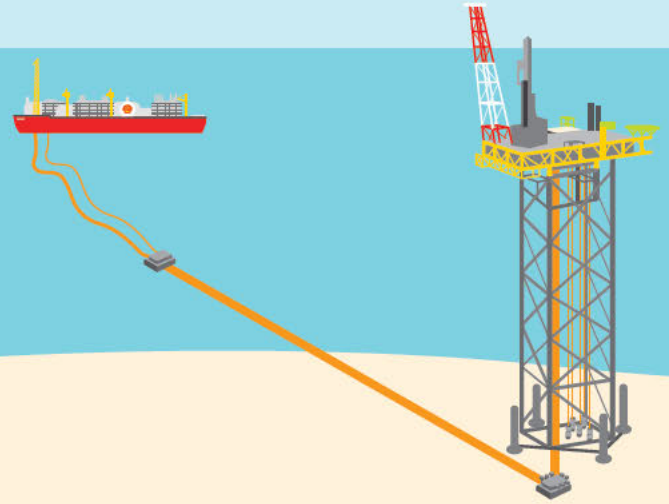
If you are interested in learning more, Shell Australia invites you to join us at a drop-in session as follows:

Date: Wednesday 10 May 2023 **Time:** 07.30 - 14.30

Location: Ningaloo Aquarium and Discovery Centre-Mandu Mandu Room, 2 Truscott Cres, Exmouth WA 6707

Lunch provided.

For more information please visit:
www.shell.com.au/crux



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CRUX PROJECT JOINT VENTURE PARTNER

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If you are interested in learning more, Shell Australia invites you to join us at a drop-in session as follows:

Date: Wednesday 3 May 2023 **Time:** 07.30 - 14.30

Location: Colin Matheson Pavilion, 17 Tinder St, Port Hedland WA 6721.

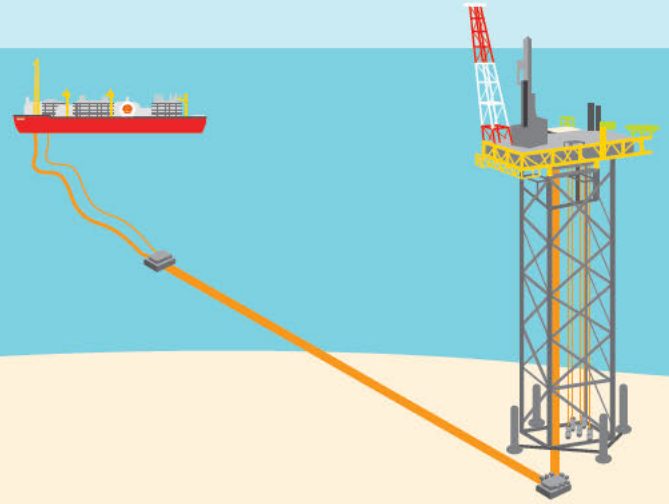
Lunch provided.

For more information please visit:
www.shell.com.au/crux

Appendix A - 4.05 Community briefing advert:

Broome

Darwin



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CRUX PROJECT JOINT VENTURE PARTNER

SGH | Energy

As part of the Crux development, we will be preparing environmental approvals for submission to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). Consultation with relevant persons is an important part of these approvals.

If you are interested in learning more, Shell Australia invites you to join us at an Information Session, led by our Senior Management and Environment team, as follows;

Date: Wednesday 17 May 2023 **Time:** 13.00 – 14.00
Location: GTNT Group- Harrison Room,
38 Woods St, Darwin City NT 0800

Lunch provided.

For more information please visit:
www.shell.com.au/crux

Appendix A - 4.06 Community drop-in session social media post

Shell
Sponsored ·

Shell is preparing to develop the Crux natural gas field and is looking to hear from people in Derby who have functions, interests or activities that may be affected. If you are interested in learning more, we invite you to join us at a community drop-in session on Tuesday 4 April 2023, between 7.30am to 6.00pm, at Derby Professional Centre – Conference Room, 2 Clarendon Street.

shell.com.au
Come and talk to us about the Crux Project

Learn more

9 1 comment 4 shares

Like Comment Share

Appendix A - 5.00 Community Briefing – Darwin

Shell in Australia Community Briefing Darwin

Agenda

Time	Agenda Item	Presenter
1.00pm	Introduction Welcome to Country	Dani Tassone Mary Williams
1.10pm	Welcome- why we are hear today, context setting	Bruce Lockyer
1.25pm	Asset and project overview	Bruce Lockyer
1.35-1.50	Environmental Plan Presentation Crux Development Drilling EP Crux Installation and Cold Commissioning Environment Plan Additional Environmental Plans: Crux Seabed Survey Crux Template Installation EP	Bruce Lockyer/Andy Gowing
1.50-2.00pm	Q&A	Bruce Lockyer/Andy Gowing
2.00pm	Light lunch	All

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respectfully acknowledges the many Traditional Owner groups of the lands and waters on which we operate and pay our respect to the Elders past, present and emerging.

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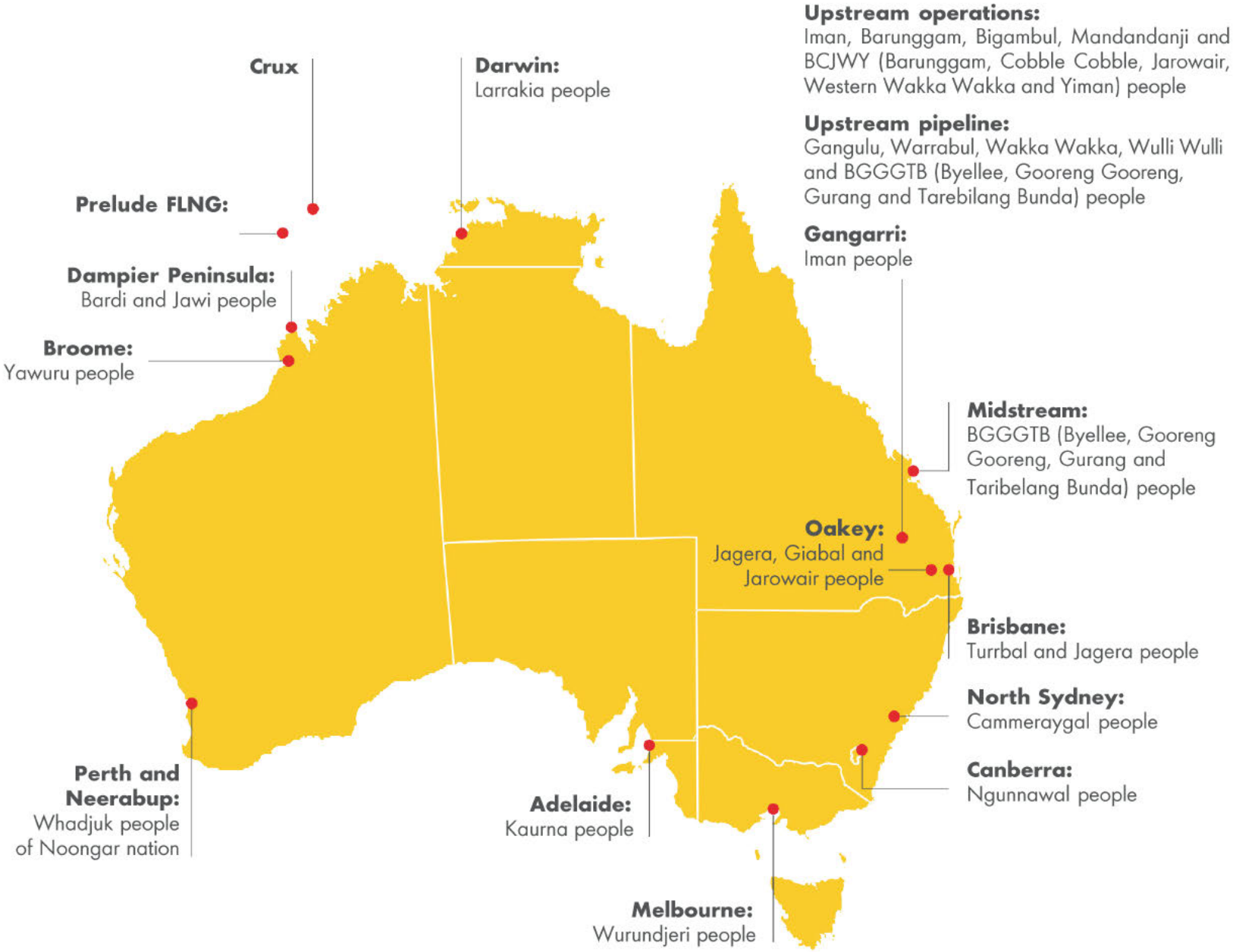

Definitions & cautionary note

Cautionary Note

The companies in which Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell Group" and "Group" are sometimes used for convenience where references are made to Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. "Joint ventures" and "joint operations" are collectively referred to as "joint arrangements". Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

Forward-Looking Statements

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', "milestones", ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this **[report]**, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, judicial, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Shell plc's Form 20-F for the year ended December 31, 2021 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this **[report]** and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 27 April 2023. Neither Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

Shell's net carbon footprint

Also, in this presentation we may refer to Shell's "Net Carbon Footprint" or "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" or "Net Carbon Intensity" are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCF target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with relevant persons whose functions, interests or activities may be affected by the activities we are proposing in relation to the development of the Crux project.

Shell is here to consult on the **Development Drilling Environmental Plan and** Crux Installation and Cold Commissioning Environment Plan

For your awareness we are currently consulting on 2 other Environmental Plans. Darwin is not within the planning area of these activities

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan

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Shell Australia's Footprint

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

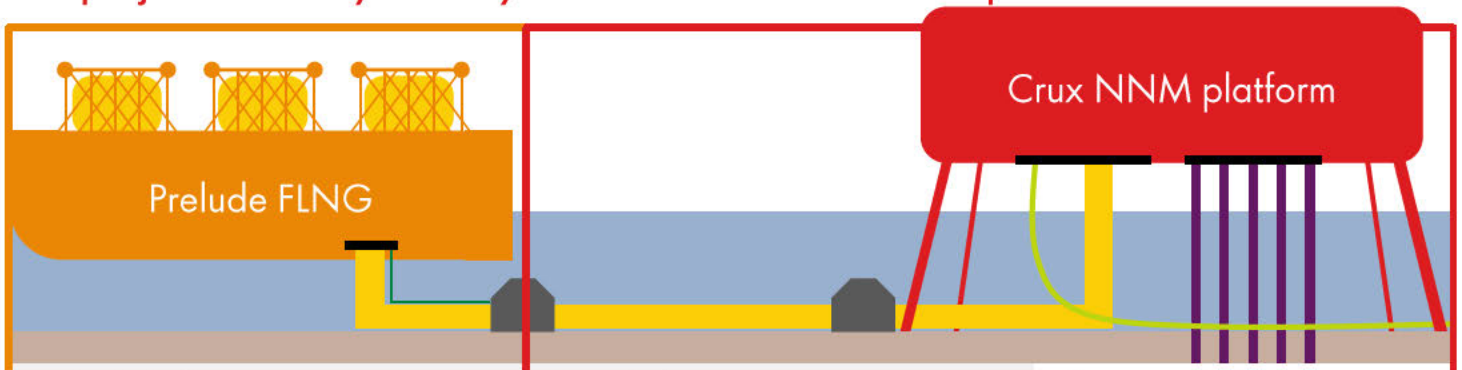
Prelude – Overview

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.
- Crux has a supply base in Broome (utilized for drilling activities)
- The Prelude FLNG facility is operated by Shell Australia in joint venture with Inpex, OPIC and Kogas.
- The Prelude Joint Venture has executed agreements to allow for processing of Crux hydrocarbons, which are expected to commence in 2027.

Prelude and Crux

Crux will leverage Prelude FLNG's existing infrastructure to its fullest extent to maximise capital efficiency and deliverability

Crux project boundary and key infrastructure under development



Prelude infrastructure

- Riser, umbilical, and receiver
- Pipeline termination point and subsea isolation valve

Prelude participants

- 67.5% (Operator)
- INPEX 17.5%
- KOGAS 10%
- CPC Corporation, Taiwan 5%

Crux infrastructure

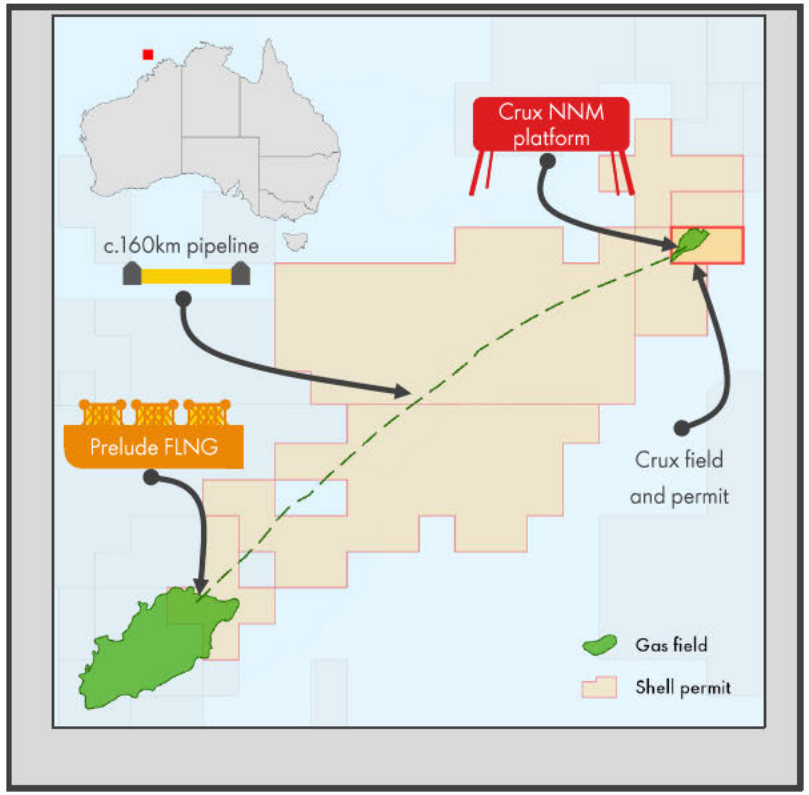
- 5x dry tree wells
- Pipeline termination point and subsea isolation valve
- Riser and fibre optic cable
- c.160km pipeline

Crux participants

- 84.5% (Operator)
- SGH | Energy 15.5%

Crux platform topsides and substructure

Crux field overview



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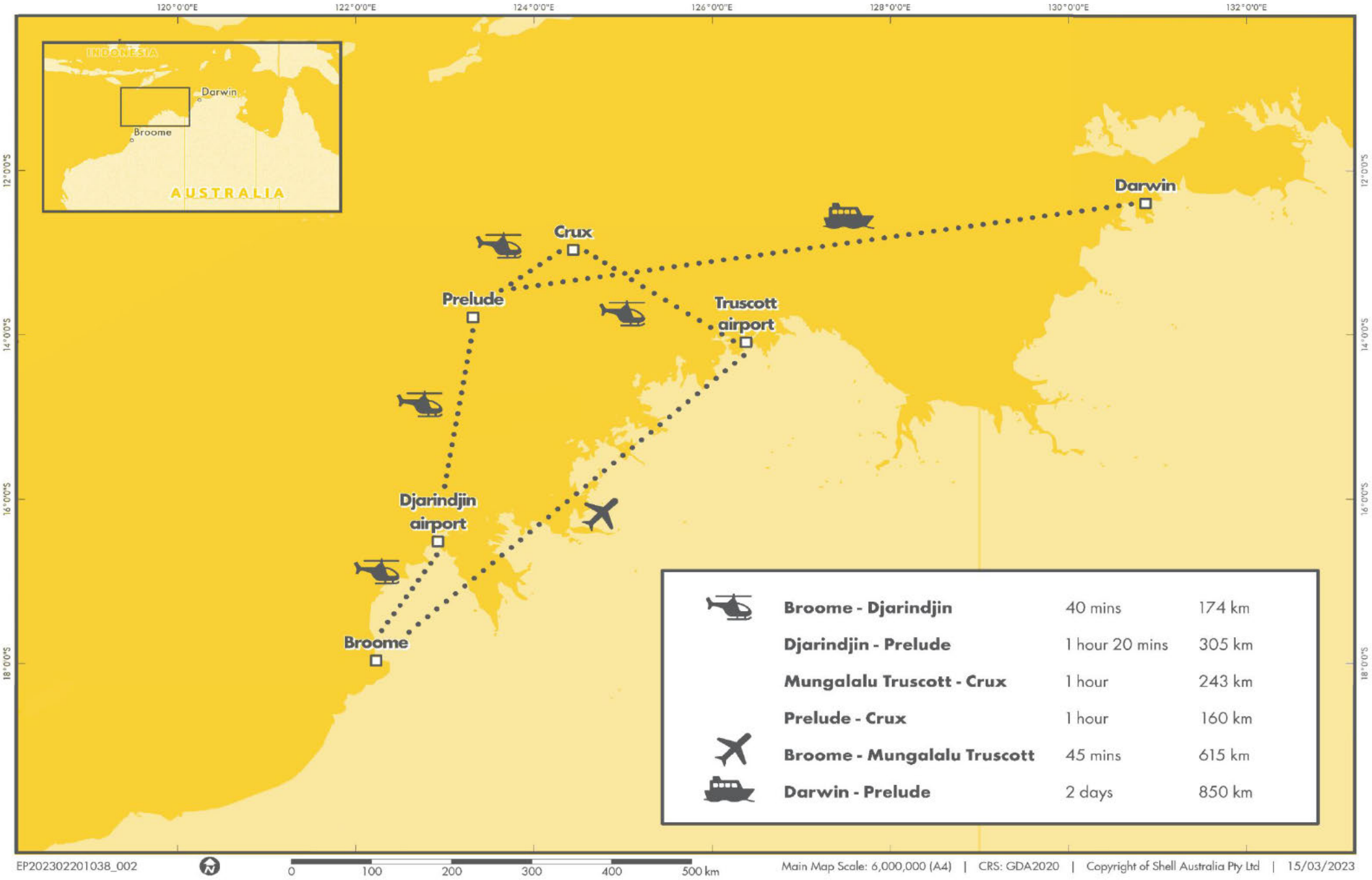
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Prelude
Truscott airport
Djarindjin airport
Broome
Broome - Djarindjin 40 mins 174 km
Djarindjin - Prelude 1 hour 20 mins 305 km
Mungalalu Truscott - Crux 1 hour 243 km
Prelude - Crux 1 hour 160 km
Broome - Mungalalu Truscott 45 mins 615 km
Darwin - Prelude 2 days 850 km
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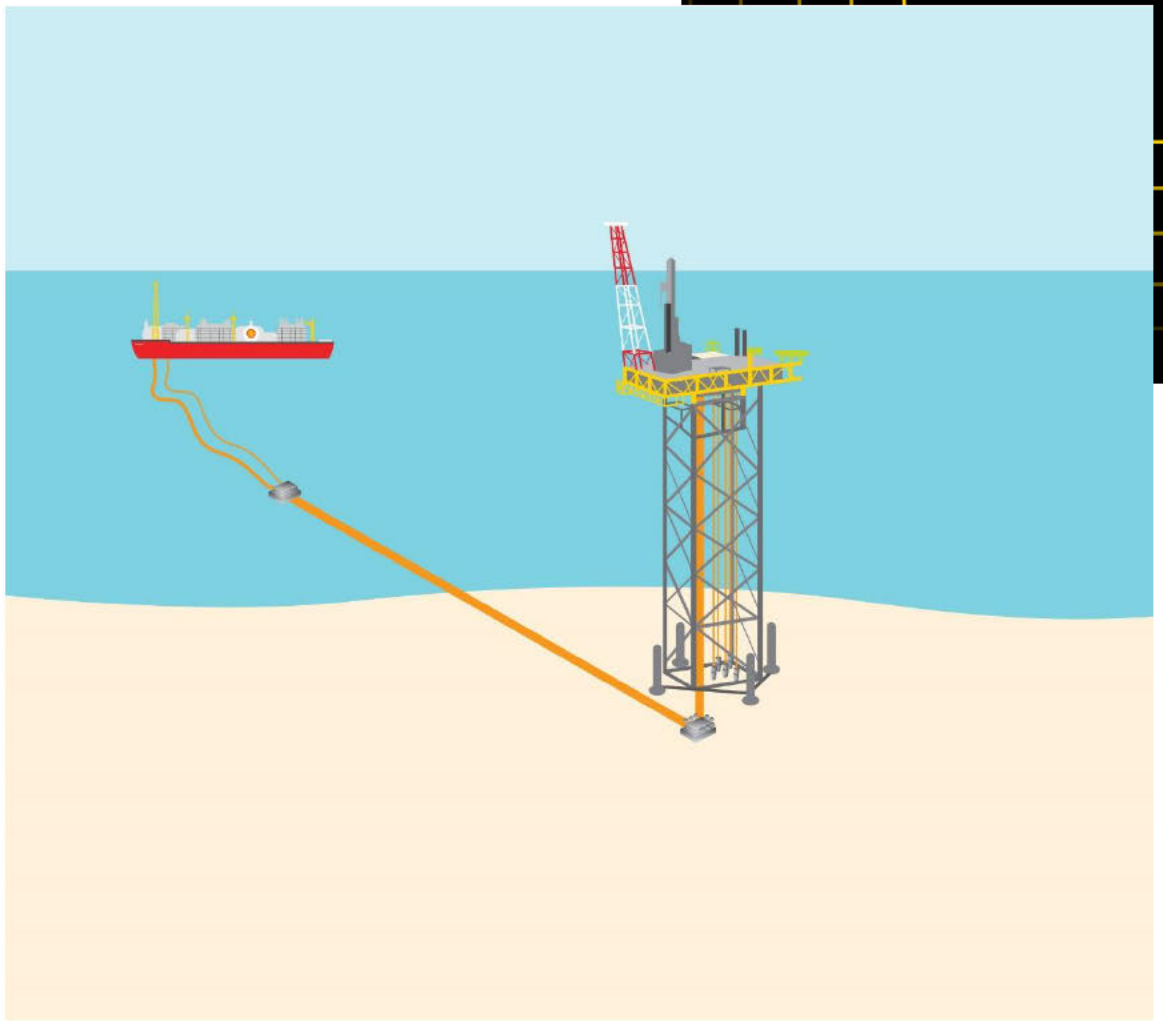
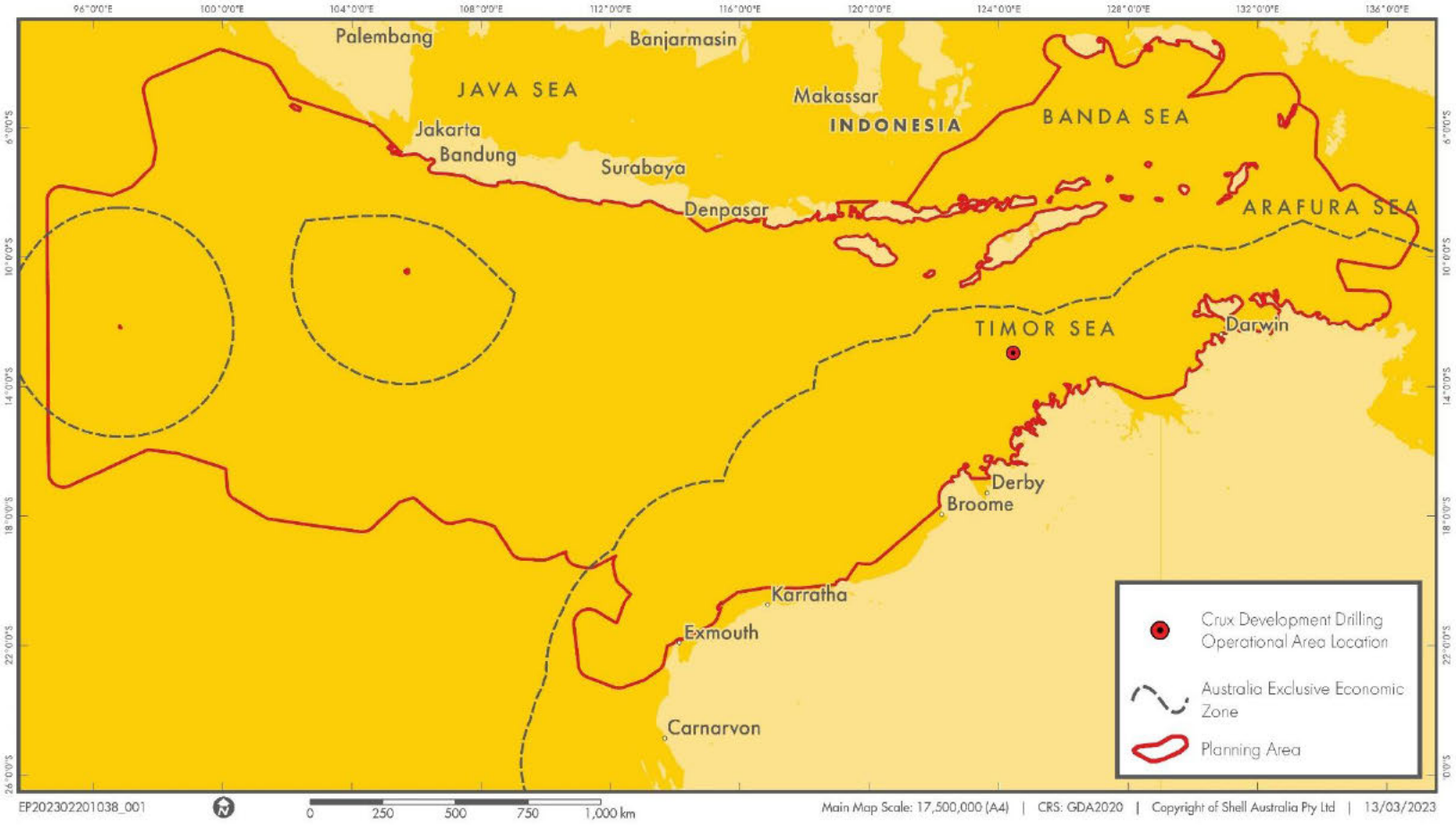
Crux update

- In May 2022, Shell Australia and SGH Energy took final investment decision to approve the development of Crux.
- The project is an important longer term backfill opportunity for the existing Prelude FLNG facilities. The proposed concept is an unmanned platform with minimal facilities, remotely operated from the Prelude FLNG.
- The project aligns with Shell's strategy and forms an important part of Shell's gas portfolio and will help meet the needs of gas users as the energy market transitions to a lower carbon future, noting the expected increasing demand for natural gas, renewables, low and zero carbon technologies, and the criticality of security in energy supply.
- The natural gas from Crux and Prelude will be a key part of how we help move Asian customers from coal to gas as a cleaner burning fuel.



3. Crux Development Drilling Environment Plan



Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Timing:

- Expected Mobile Offshore Drilling Unit Operations – End 2023 - early 2024.
- Expected temporary well suspension period, approximately 2-3 years. Scope completed no later than the end of 2025

4. Activities Related to Crux Development Drilling Environment Plan

ACTIVITY DESCRIPTION

The Crux Drilling Environment Plan includes provision for the installation of guideposts and five deviated production wells via the preinstalled drilling template. The location of the drill center has been selected to optimise well length and reservoir penetration, and for avoidance of any potential subsurface hazards.

- **The guideposts:** ensure that the Crux substructure and topsides are accurately positioned over the drilling template when installed during the subsequent installation campaigns. The guideposts will remain on location at the seabed for the life of the asset. The drilling template and guideposts have an approximate structural footprint of Length 28 m X Width 9 m X Height 10 m
- **The wells:** will be drilled and suspended from a Mobile Offshore Drilling Unit, prior to installation of the Crux Substructure and Topsides. They will be drilled from a single drill center, via the pre-installed drilling template. The wells will be suspended and left in-situ with well completions planned to occur following installation of the Crux platform.
- **Mobile Offshore Drilling Unit:** This will be a semi-submersible Mobile Offshore Drilling Unit – which will be held in position by anchor spread.

The development drilling program will be supported by a range of services including helicopter transfers from mainland Australia, a dedicated installation vessel, four anchor handling, tug and support vessels and remotely operated vehicles undertaking inspection, maintenance and repair activities.

Crux Development Drilling Environment Plan

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse gas emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

Key aspect and control

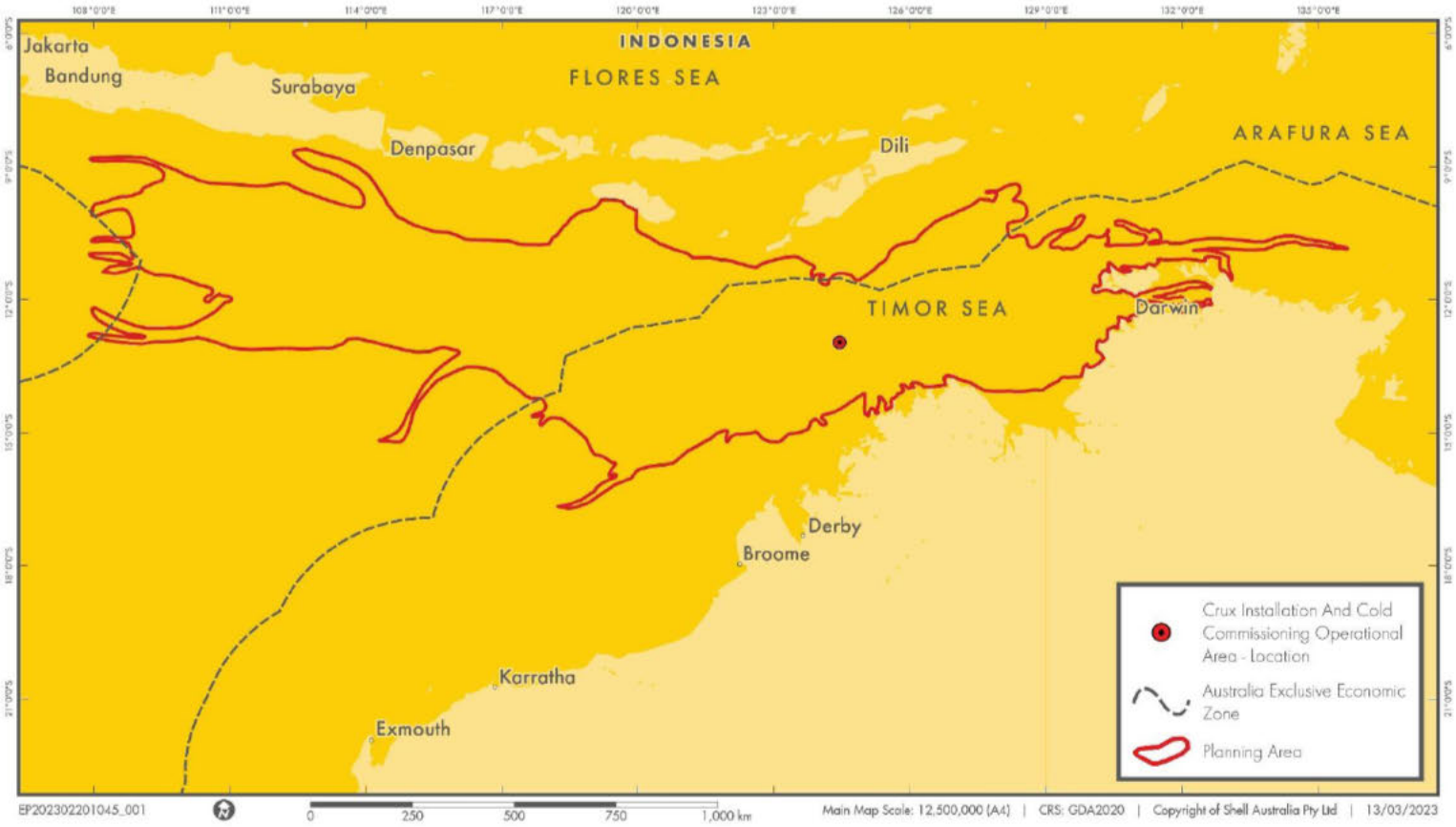
Discharge of liquid effluent (including drilling discharges)

The drilling activity includes discharges of liquids and materials to the marine environment

Key Controls:

- Shell Chemical Management Process:
- Chemicals selected for use in accordance with the Shell Chemical Management Process to minimise potential environmental risks.
- Chemicals that are planned for discharge to sea are substitution warning free and Gold, Silver, D, or E rated through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oil Spill Prevention, Administration and Response (OSPAR) Commission), or have a complete ALARP assessment.

4. Crux Installation and Cold Commissioning Environment Plan



Shell is planning to install the Crux Jacket and Topsides which will be fixed to the seabed.

The facility will commence cold commissioning once installation is complete.

Duration: 360 days

Timing: 1 August 2024 – 31 Dec 2028*

Crux Installation and Cold Commissioning Environment Plan

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
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Noise

Scope include piling campaign which results in under water noise.

Key controls:

Start-up and shutdown procedures which consider approach by sensitive species and actions taken when species come too close.

Environmental Management Unplanned – All Environment Plan

Unplanned	
Emergency Events – Hydrocarbon Spill	▪ Align with relevant International Convention for the Prevention of Pollution from Ships requirements and subsequent regulations ▪ Valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) ▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Offshore Vessel Inspection Database (OVID) process ▪ Australian Hydrographic Office Notice to Mariners ▪ NOPSEMA accepted Environment Plan and Oil Pollution Emergency Plan (OPEP) in place ▪ Relevant Persons consultation process ▪ Vessel Maintenance management system
Introduction of Invasive Marine Species from Vessels	▪ Ballast water exchange operations will comply with the international conventions and associated national regulations. ▪ Biofouling management for vessels in accordance with state, national and international biofouling management guidelines ▪ Biofouling management in compliance with state and commonwealth regulations ▪ Vessels (of appropriate class) will have a valid International Anti-Fouling System Certificate ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area

Q&A

CONTACT US Community Hotline: 1800 059 152

Email: SDA-crux-project@shell.com

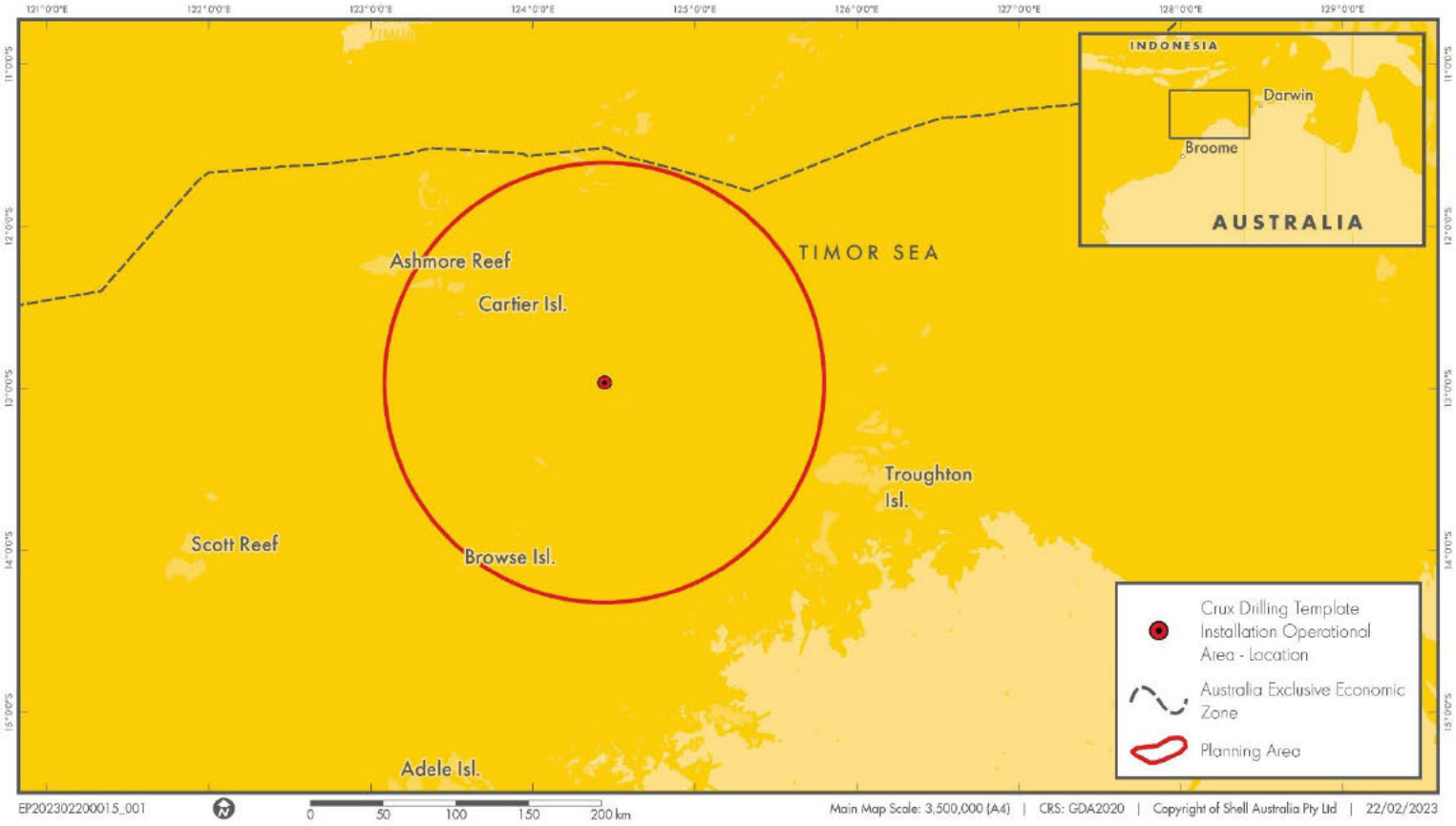
www.shell.com.au/crux

Shell welcomes any feedback on Environment Plan submissions, including requests for further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

Additional Slides

2. Crux Template Installation Environment Plan

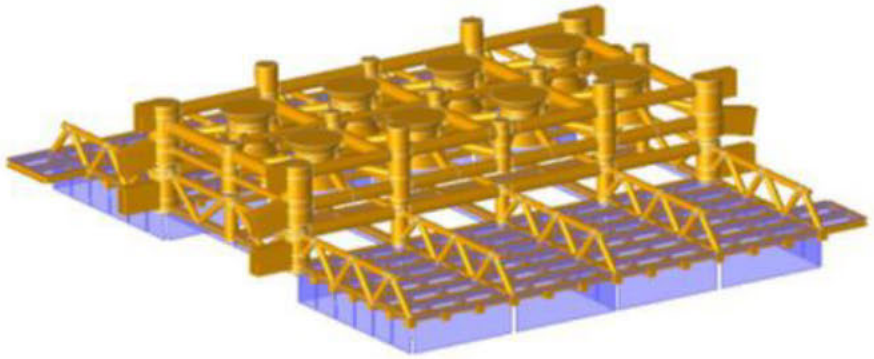
A template which will act as a guide for the drill bit during drilling operations



Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux jacket.

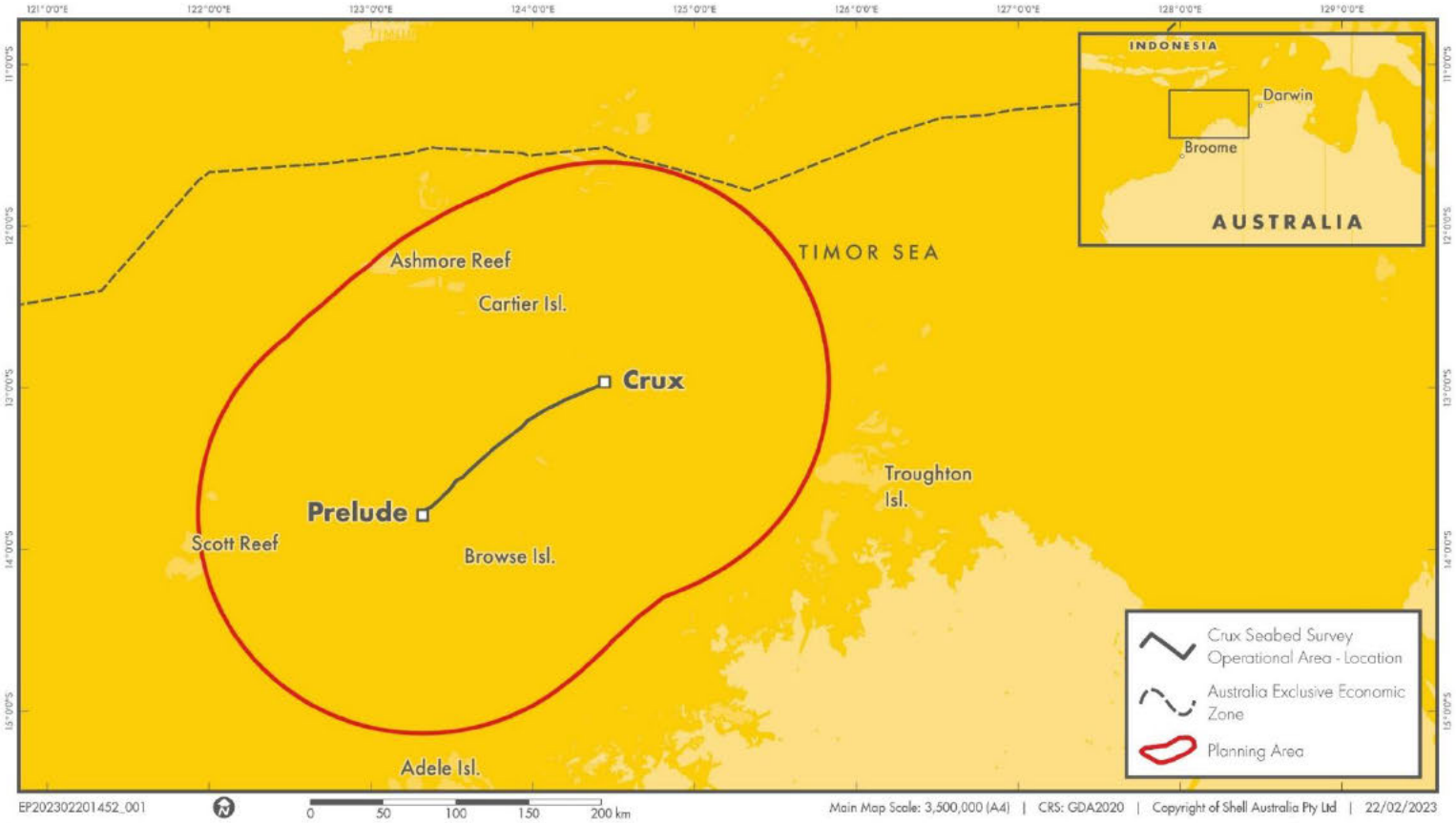
Duration: <7 days

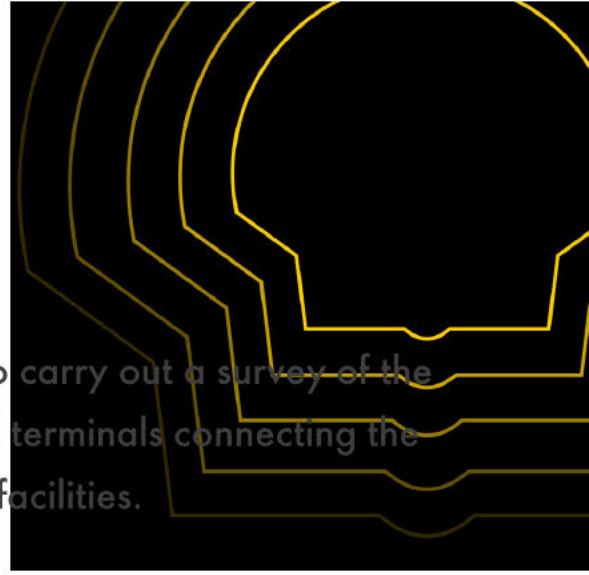
Timing: 1 September 2023 – 1 April 2024*



1. Crux Seabed Survey Environment Plan

Investigating the sub-seabed conditions





Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

A vessel will traverse the pipeline route, towing survey and monitoring equipment.

Duration: <5 days

Timing: 1 May – 31 December 2023*

Appendix A - 5.01 Community Briefing - Broome

Shell in Australia Community Briefing Broome

Agenda

Time	Agenda Item	Presenter
1.00pm	Introduction	Dani Tassone
1.05pm	Welcome to Country	Dianne Appleby
1.15pm	Welcome- why we are hear today, context setting	Bruce Lockyer
1.25pm	Asset and project overview	Bruce Lockyer
1.35-1.50	Environmental Plan Presentation Crux Development Drilling EP Crux Installation and Cold Commissioning EP Additional Environmental Plans: Crux Seabed Survey Crux Template Installation EP	Bruce Lockyer/Nathan Waugh
1.50-2.00pm	Q&A	Bruce Lockyer/Nathan Waugh
2.00pm	Light lunch	All

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respectfully acknowledges the many Traditional Owner groups of the lands and waters on which we operate and pay our respect to the Elders past, present and emerging.

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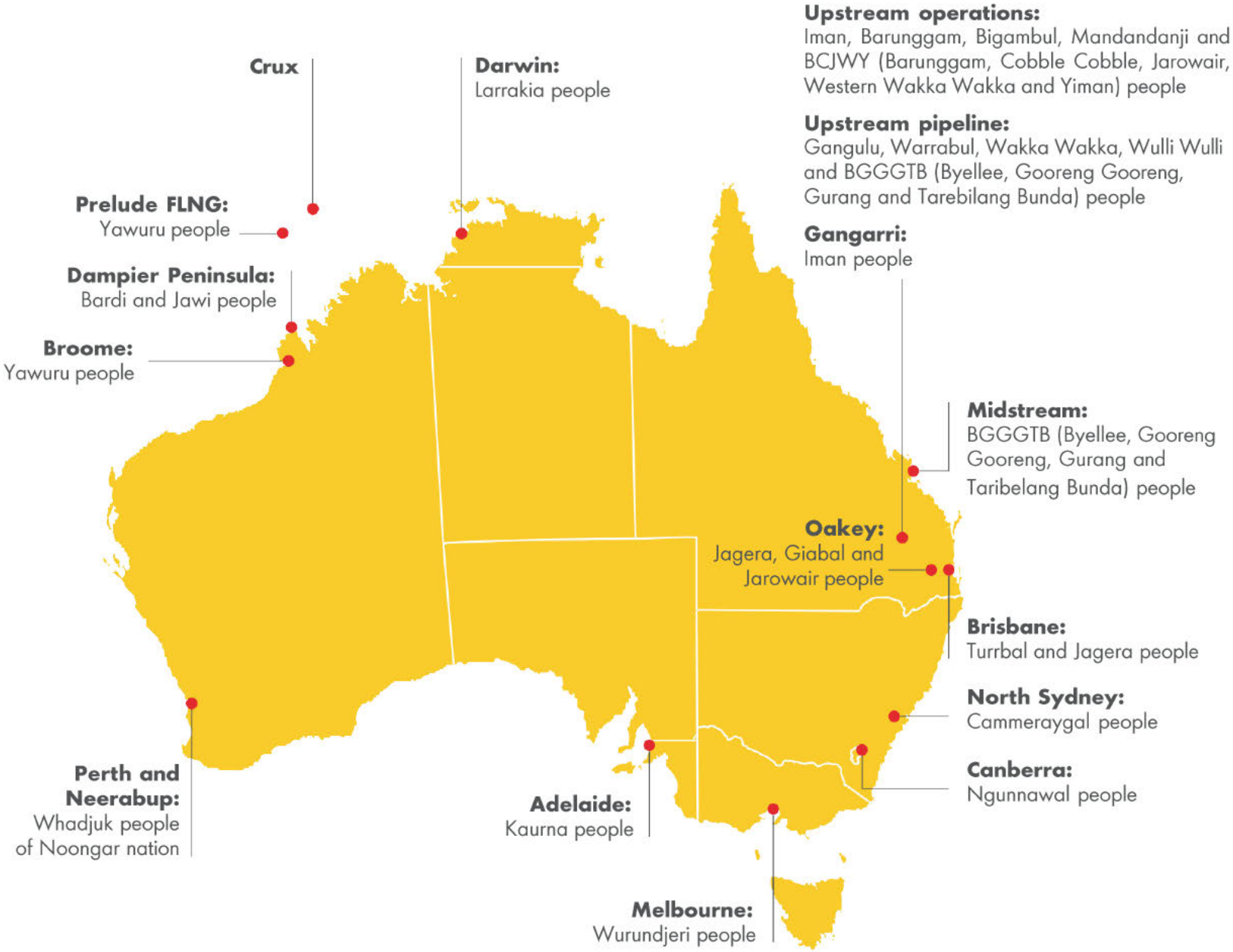

Definitions & cautionary note

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Forward-Looking Statements

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', "milestones", ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this **[report]**, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, judicial, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Shell plc's Form 20-F for the year ended December 31, 2021 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this **[report]** and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 27 April 2023. Neither Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

Shell's net carbon footprint

Also, in this presentation we may refer to Shell's "Net Carbon Footprint" or "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" or "Net Carbon Intensity" are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCF target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with relevant persons whose functions, interests or activities may be affected by the activities we are proposing in relation to the development of the Crux project.

Shell is here to consult on the **Development Drilling Environmental Plan and** Crux Installation and Cold Commissioning Environment Plan

For your awareness we are currently consulting on 2 other Environmental Plans. Broome is not within the planning area of these activities

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan

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Shell Australia's Footprint

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

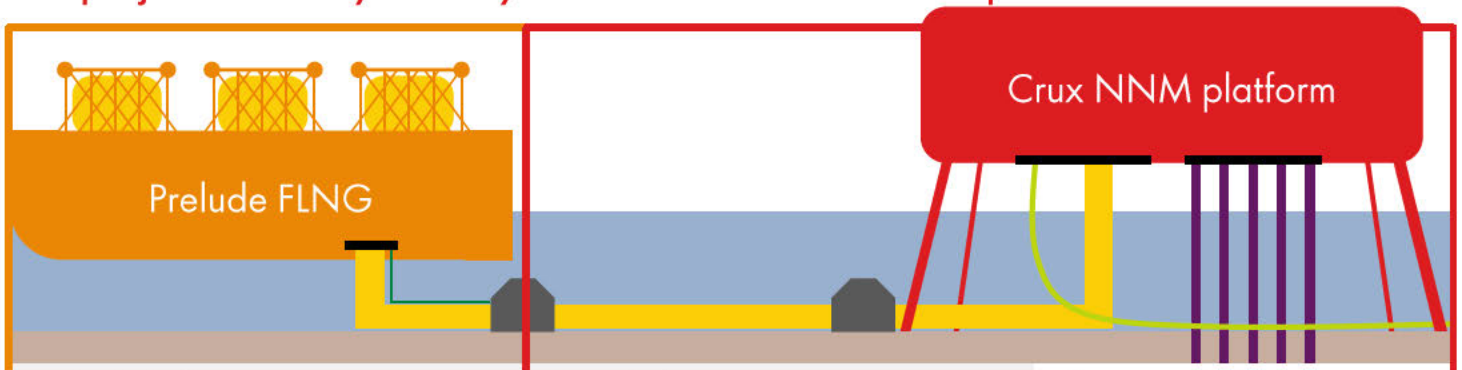
Prelude – Overview

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.
- Crux has a supply base in Broome (utilized for drilling activities)
- The Prelude FLNG facility is operated by Shell Australia in joint venture with Inpex, OPIC and Kogas.
- The Prelude Joint Venture has executed agreements to allow for processing of Crux hydrocarbons, which are expected to commence in 2027.

Prelude and Crux

Crux will leverage Prelude FLNG's existing infrastructure to its fullest extent to maximise capital efficiency and deliverability

Crux project boundary and key infrastructure under development



Prelude infrastructure

- Riser, umbilical, and receiver
- Pipeline termination point and subsea isolation valve

Prelude participants

- 67.5% (Operator)
- INPEX 17.5%
- KOGAS 10%
- CPC Corporation, Taiwan 5%

Crux infrastructure

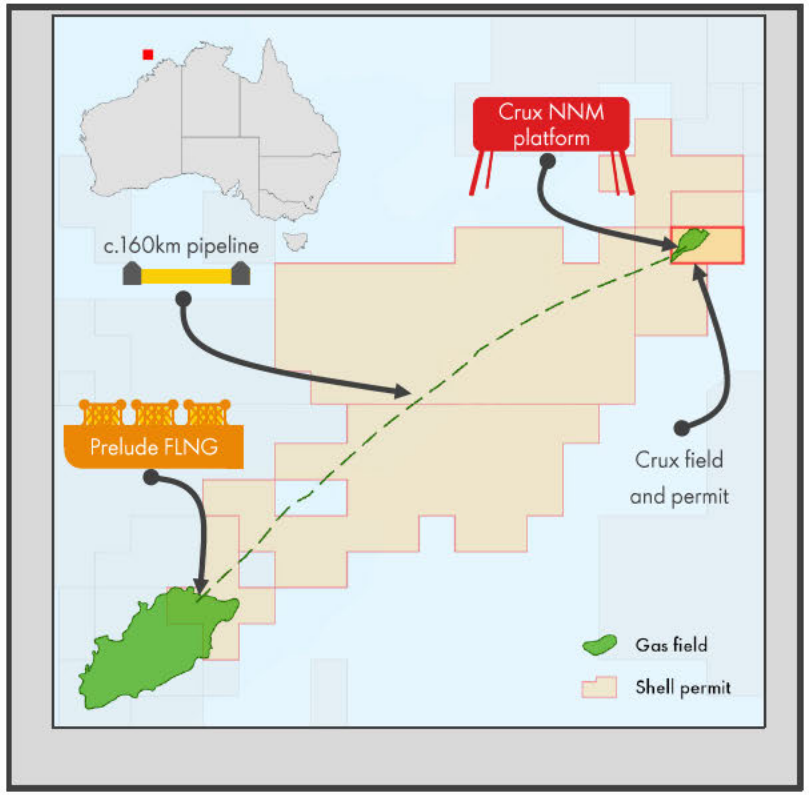
- 5x dry tree wells
- Pipeline termination point and subsea isolation valve
- Riser and fibre optic cable
- c.160km pipeline

Crux participants

- 84.5% (Operator)
- SGH | Energy 15.5%

Crux platform topsides and substructure

Crux field overview



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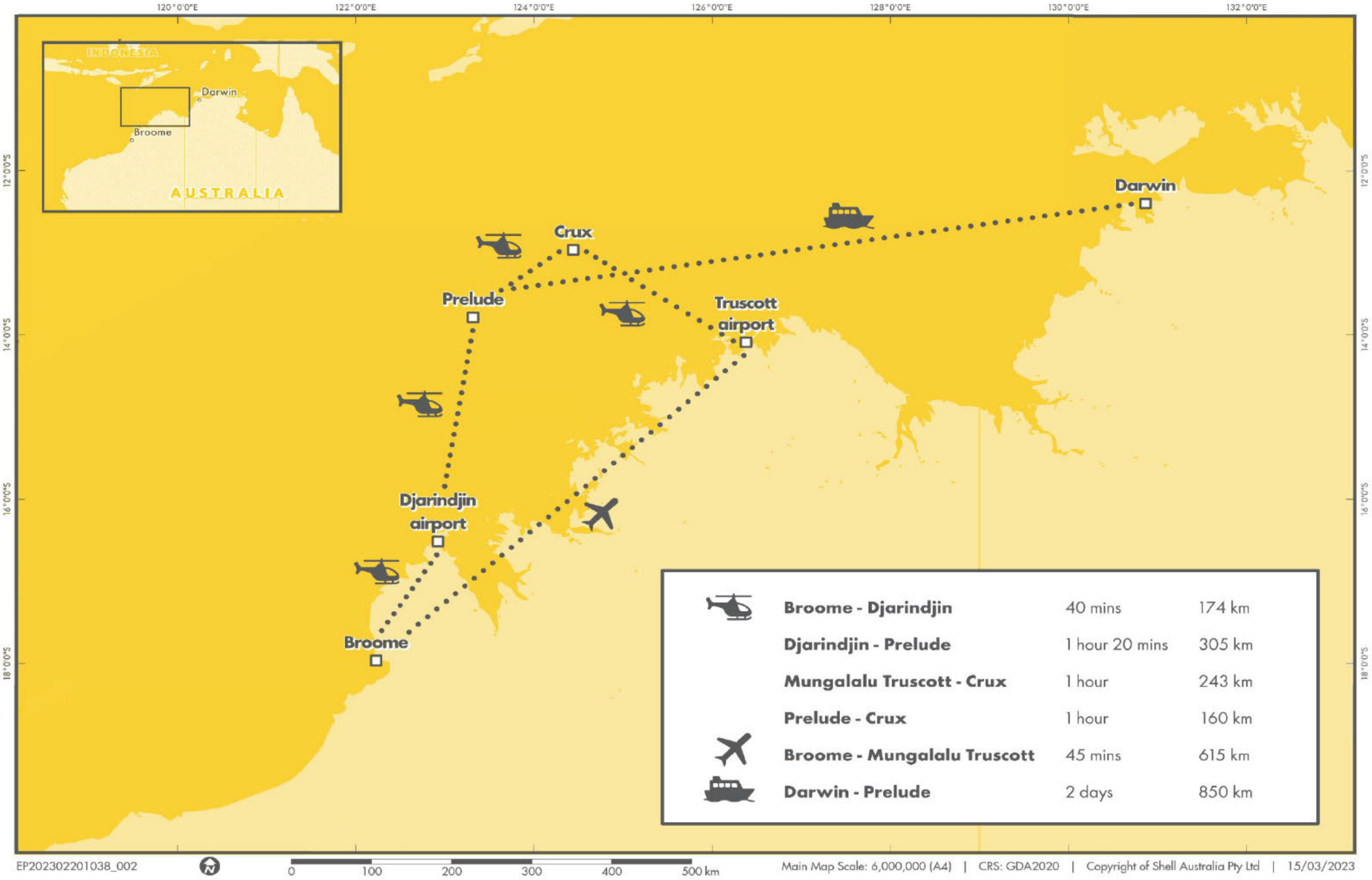
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Prelude
Truscott airport
Djarindjin airport
Broome
Broome - Djarindjin 40 mins 174 km
Djarindjin - Prelude 1 hour 20 mins 305 km
Mungalalu Truscott - Crux 1 hour 243 km
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Darwin - Prelude 2 days 850 km
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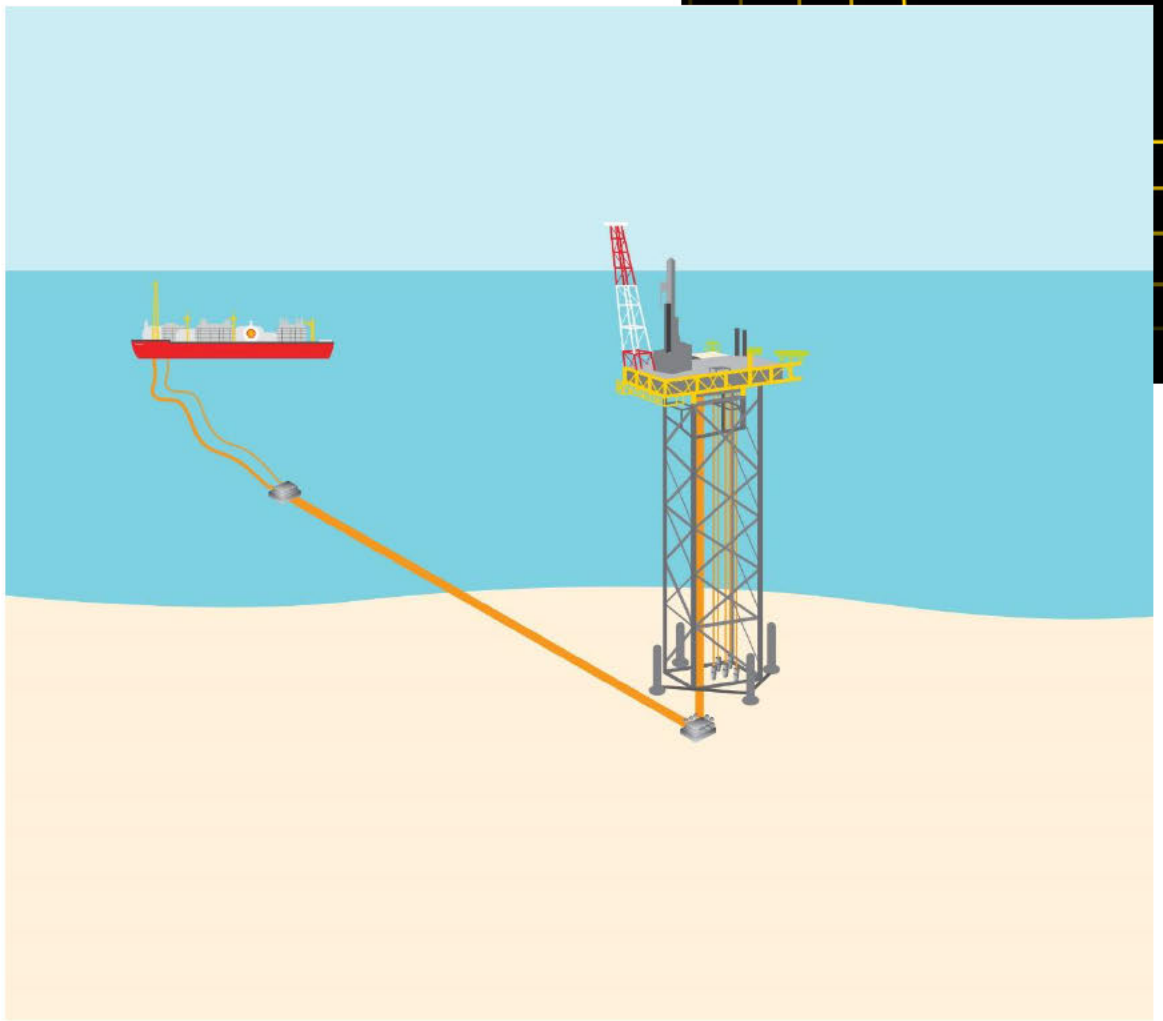
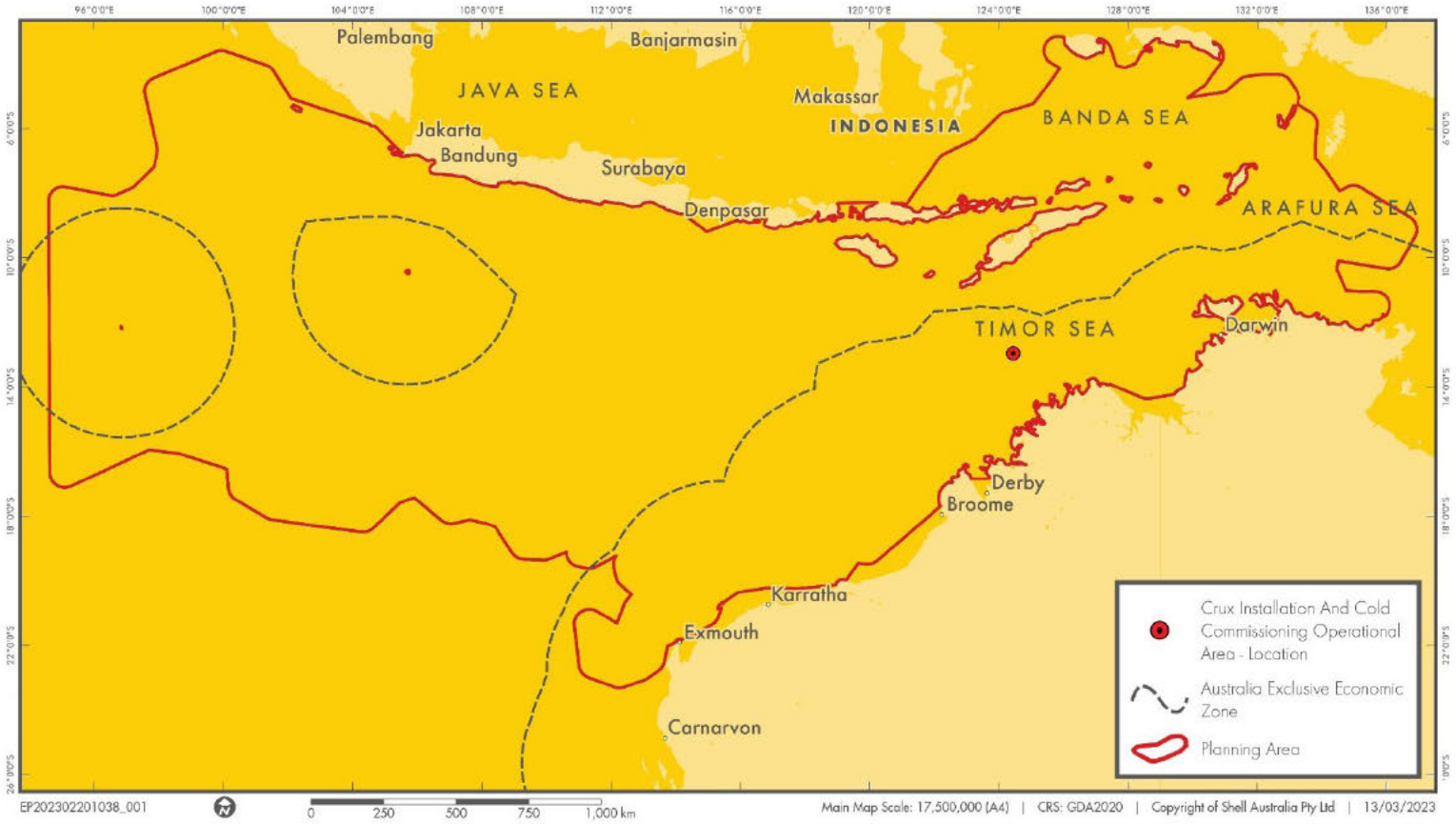
Crux update

- In May 2022, Shell Australia and SGH Energy took final investment decision to approve the development of Crux.
- The project is an important longer term backfill opportunity for the existing Prelude FLNG facilities. The proposed concept is an unmanned platform with minimal facilities, remotely operated from the Prelude FLNG.
- The project aligns with Shell's strategy and forms an important part of Shell's gas portfolio and will help meet the needs of gas users as the energy market transitions to a lower carbon future, noting the expected increasing demand for natural gas, renewables, low and zero carbon technologies, and the criticality of security in energy supply.
- The natural gas from Crux and Prelude will be a key part of how we help move Asian customers from coal to gas as a cleaner burning fuel.



Crux Video to be played

3. Crux Development Drilling Environment Plan



Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Timing:

- Expected Mobile Offshore Drilling Unit Operations – End 2023 - early 2024.
- Expected temporary well suspension period, approximately 2-3 years. Scope completed no later than the end of 2025

4. Activities Related to Crux Development Drilling Environment Plan

ACTIVITY DESCRIPTION

The Crux Drilling Environment Plan includes provision for the installation of guideposts and five deviated production wells via the preinstalled drilling template. The location of the drill center has been selected to optimise well length and reservoir penetration, and for avoidance of any potential subsurface hazards.

- **The guideposts:** ensure that the Crux substructure and topsides are accurately positioned over the drilling template when installed during the subsequent installation campaigns. The guideposts will remain on location at the seabed for the life of the asset. The drilling template and guideposts have an approximate structural footprint of Length 28 m X Width 9 m X Height 10 m
- **The wells:** will be drilled and suspended from a Mobile Offshore Drilling Unit, prior to installation of the Crux Substructure and Topsides. They will be drilled from a single drill center, via the pre-installed drilling template. The wells will be suspended and left in-situ with well completions planned to occur following installation of the Crux platform.
- **Mobile Offshore Drilling Unit:** This will be a semi-submersible Mobile Offshore Drilling Unit – which will be held in position by anchor spread.

The development drilling program will be supported by a range of services including helicopter transfers from mainland Australia, a dedicated installation vessel, four anchor handling, tug and support vessels and remotely operated vehicles undertaking inspection, maintenance and repair activities.

Crux Development Drilling Environment Plan

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse gas emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

Key aspect and control

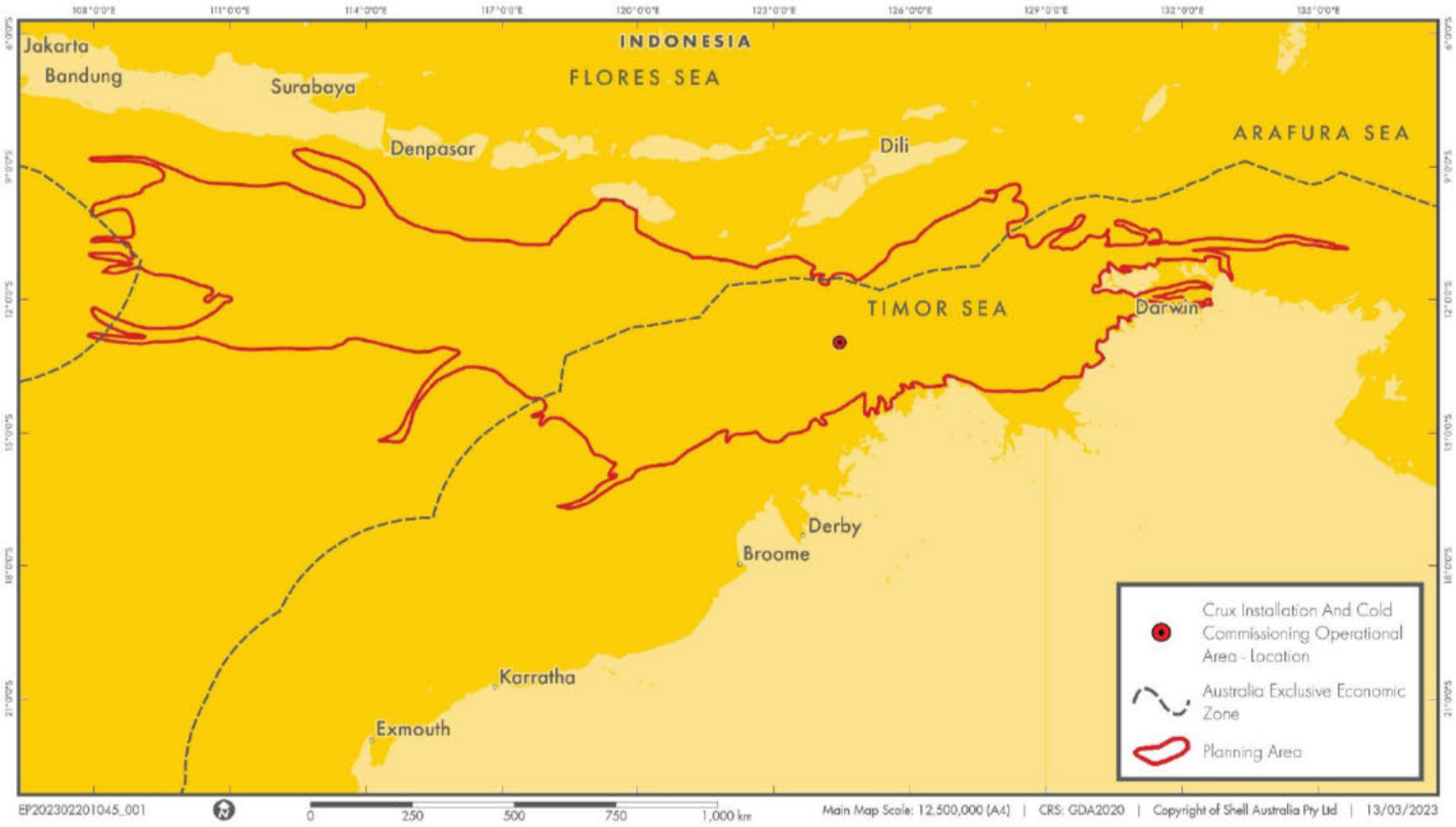
Discharge of liquid effluent (including drilling discharges)

The drilling activity includes discharges of liquids and materials to the marine environment

Key Controls:

- Shell Chemical Management Process:
- Chemicals selected for use in accordance with the Shell Chemical Management Process to minimise potential environmental risks.
- Chemicals that are planned for discharge to sea are substitution warning free and Gold, Silver, D, or E rated through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oil Spill Prevention, Administration and Response (OSPAR) Commission), or have a complete ALARP assessment.

4. Crux Installation and Cold Commissioning Environment Plan



Shell is planning to install the Crux Jacket and Topsides which will be fixed to the seabed.

The facility will commence cold commissioning once installation is complete.

Duration: 360 days

Timing: 1 August 2024 – 31 Dec 2028*

Crux Installation and Cold Commissioning Environment Plan

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
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Noise

Scope include piling campaign which results in under water noise.

Key controls:

Start-up and shutdown procedures which consider approach by sensitive species and actions taken when species come too close.

Environmental Management Unplanned – All Environment Plan

Unplanned	
Emergency Events – Hydrocarbon Spill	▪ Align with relevant International Convention for the Prevention of Pollution from Ships requirements and subsequent regulations ▪ Valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) ▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Offshore Vessel Inspection Database (OVID) process ▪ Australian Hydrographic Office Notice to Mariners ▪ NOPSEMA accepted Environment Plan and Oil Pollution Emergency Plan (OPEP) in place ▪ Relevant Persons consultation process ▪ Vessel Maintenance management system
Introduction of Invasive Marine Species from Vessels	▪ Ballast water exchange operations will comply with the international conventions and associated national regulations. ▪ Biofouling management for vessels in accordance with state, national and international biofouling management guidelines ▪ Biofouling management in compliance with state and commonwealth regulations ▪ Vessels (of appropriate class) will have a valid International Anti-Fouling System Certificate ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area

Q&A

CONTACT US Community Hotline: 1800 059 152

Email: SDA-crux-project@shell.com

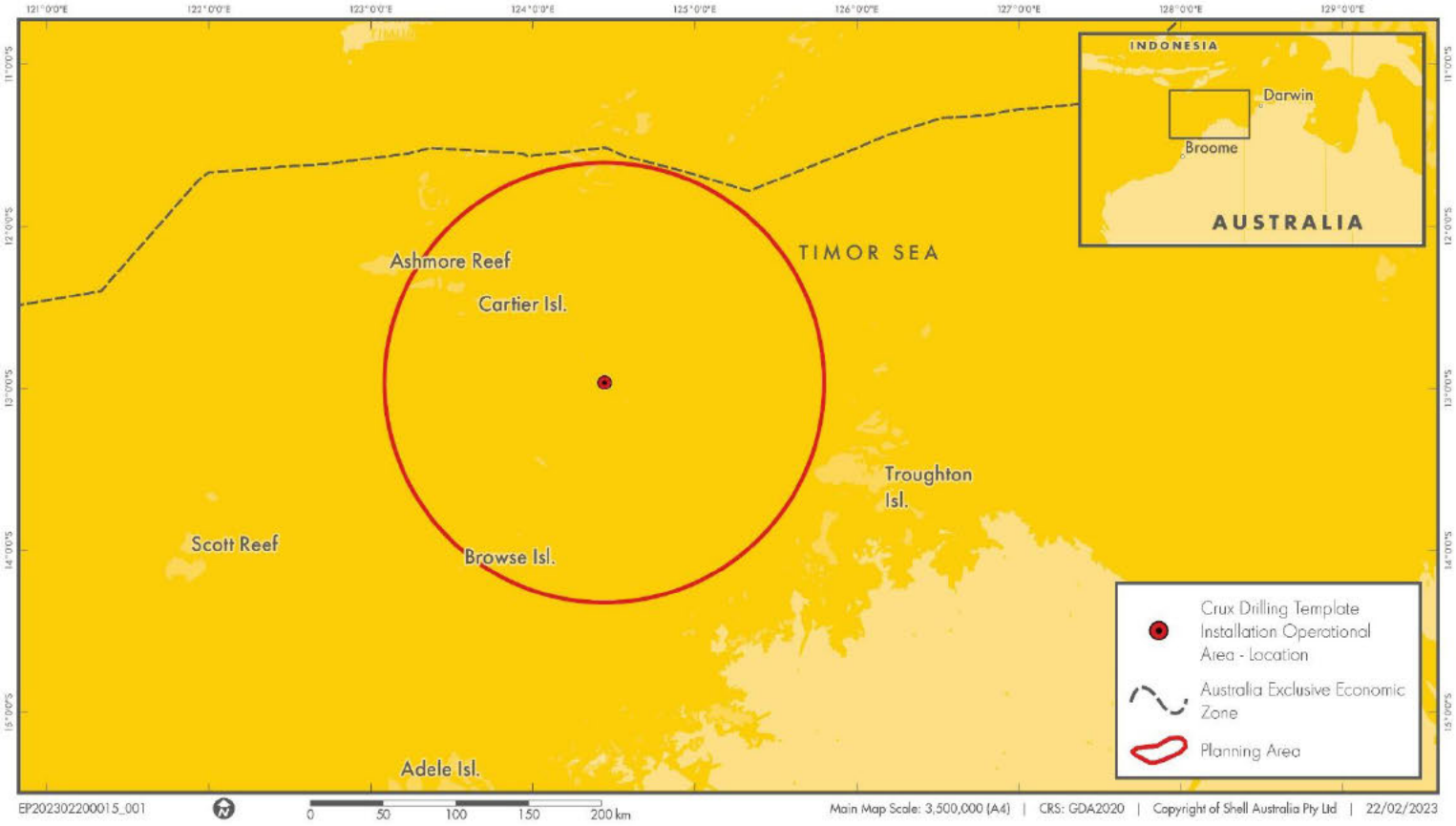
www.shell.com.au/crux

Shell welcomes any feedback on Environment Plan submissions, including requests for further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

Additional Slides

2. Crux Template Installation Environment Plan

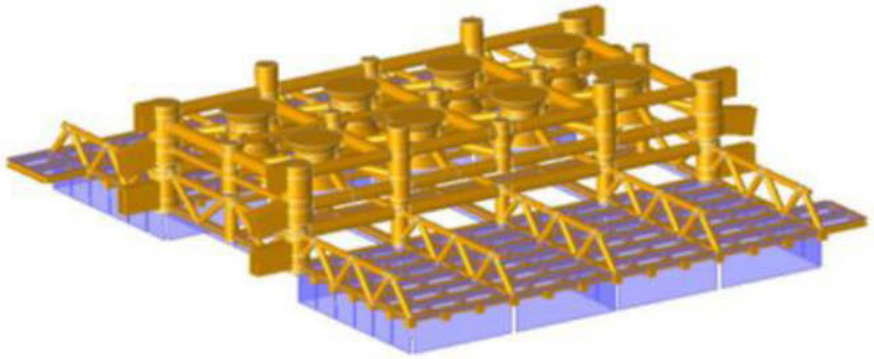
A template which will act as a guide for the drill bit during drilling operations



Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux jacket.

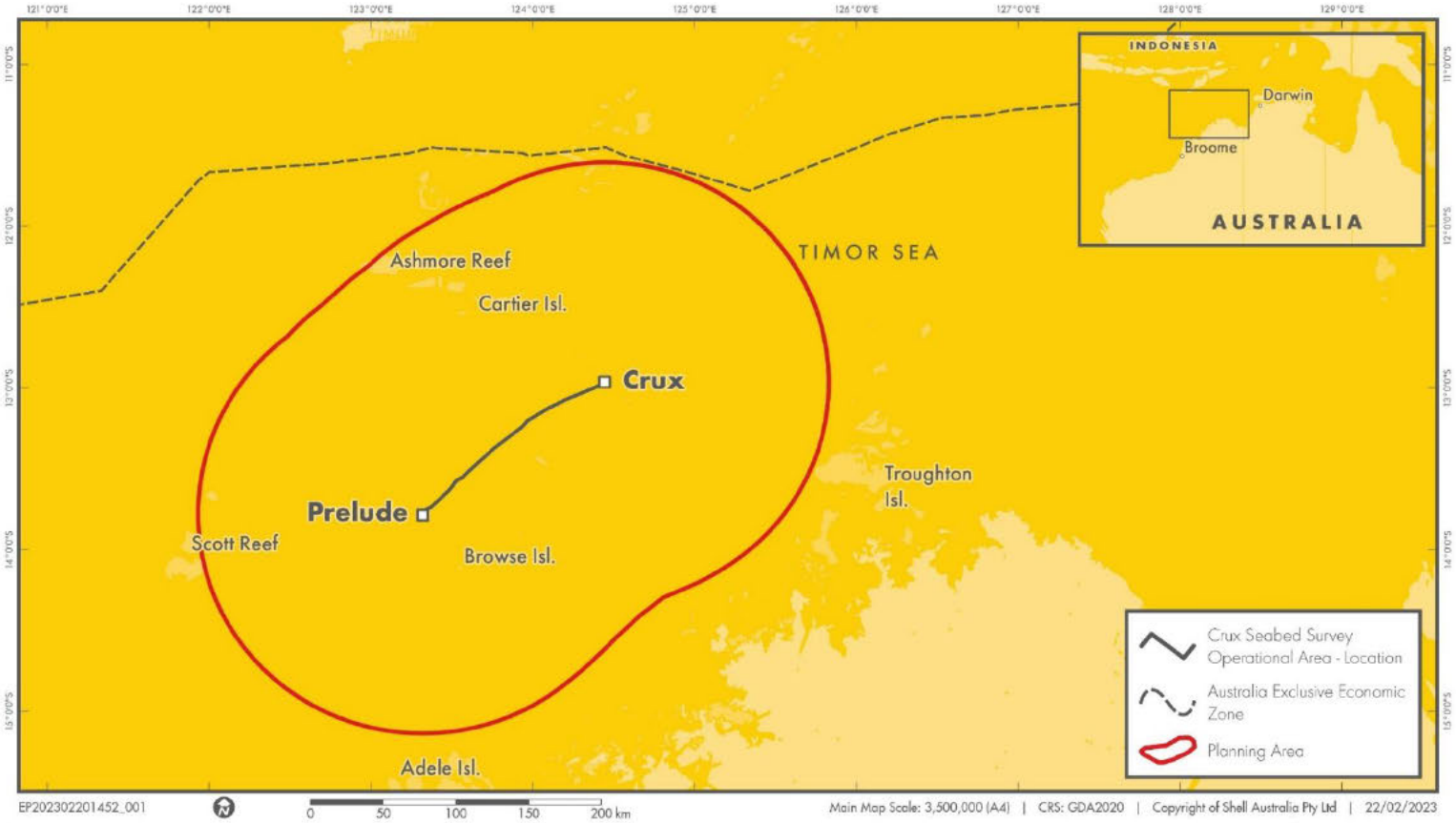
Duration: <7 days

Timing: 1 September 2023 – 1 April 2024*



1. Crux Seabed Survey Environment Plan

Investigating the sub-seabed conditions



Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

A vessel will traverse the pipeline route, towing survey and monitoring equipment.

Duration: <5 days

Timing: 1 May – 31 December 2023*

Appendix A - 5.02 Industry Briefing - Perth

Shell in Australia Industry Briefing

Agenda

Agenda Item	Presenter
Introductions	Nandini Pereira
Acknowledgement of Country & welcome	Brendan Herbst
Purpose of forum	Nandini Pereira
Asset and project overview	Rama Gunturi
Crux Seabed Survey Environment Plan overview	Andy Gowing
Crux Template Installation Environment Plan overview	Andy Gowing
Crux Development Drilling Environment Plan overview	Andy Gowing
Crux Installation and Cold Commissioning Environment Plan overview	Andy Gowing
Q&A	Nandini Pereira

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The companies in which Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell Group" and "Group" are sometimes used for convenience where references are made to Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. "Joint ventures" and "joint operations" are collectively referred to as "joint arrangements". Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

Forward-Looking Statements

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', "milestones", ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this **[report]**, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, judicial, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Shell plc's Form 20-F for the year ended December 31, 2021 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this **[report]** and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 27 April 2023. Neither Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

Shell's net carbon footprint

Also, in this presentation we may refer to Shell's "Net Carbon Footprint" or "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" or "Net Carbon Intensity" are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCF target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

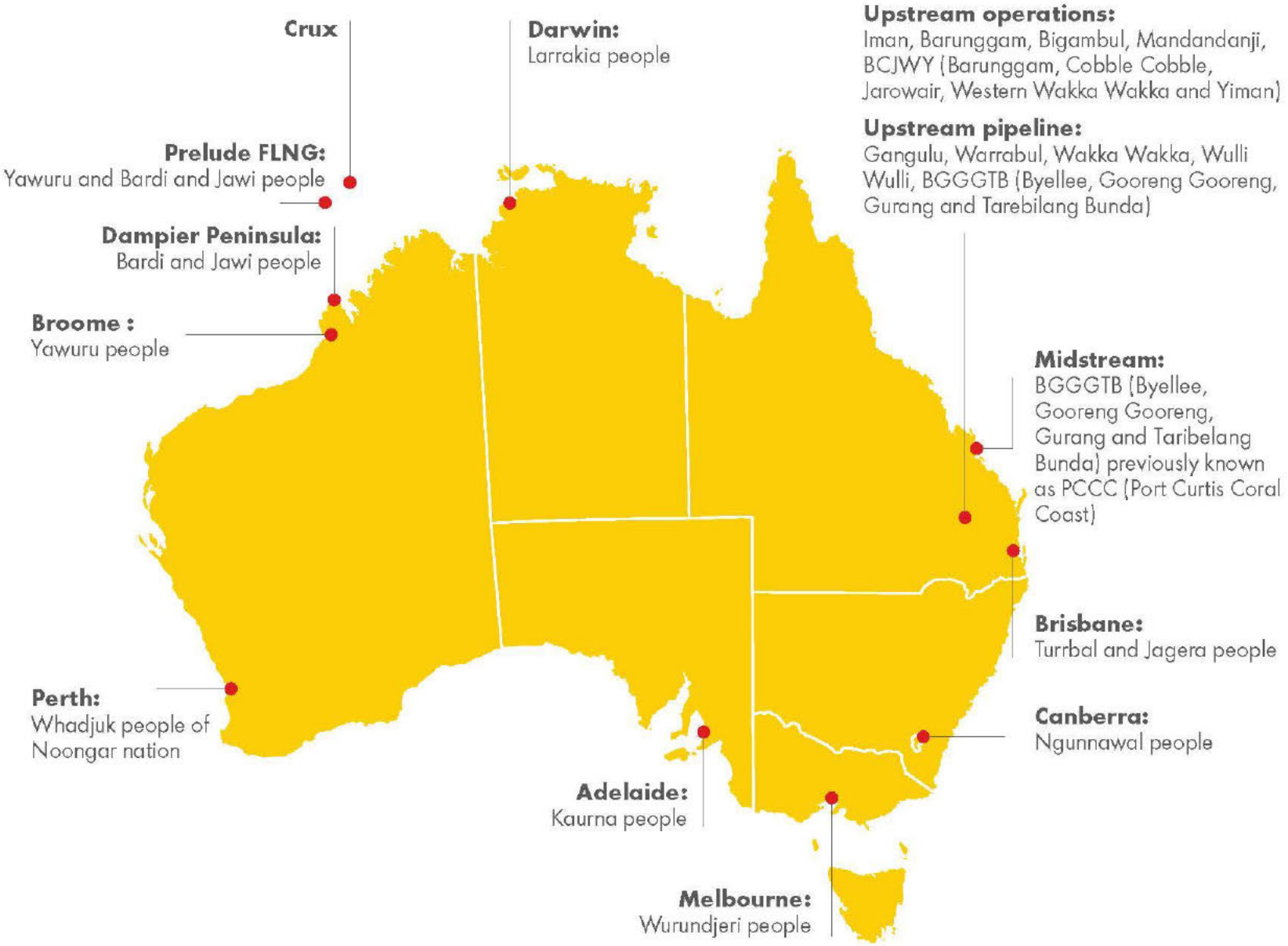
Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available at the SEC website www.sec.gov.

Shell Australia respectfully acknowledges the many Traditional Owner groups of the lands and waters on which we operate and pay our respect to the Elders past, present and emerging.



Shell Australia's Footprint

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with relevant persons who may be impacted by the activities we are proposing in relation to the development of the Crux project.

We are consulting on four Environment Plans:

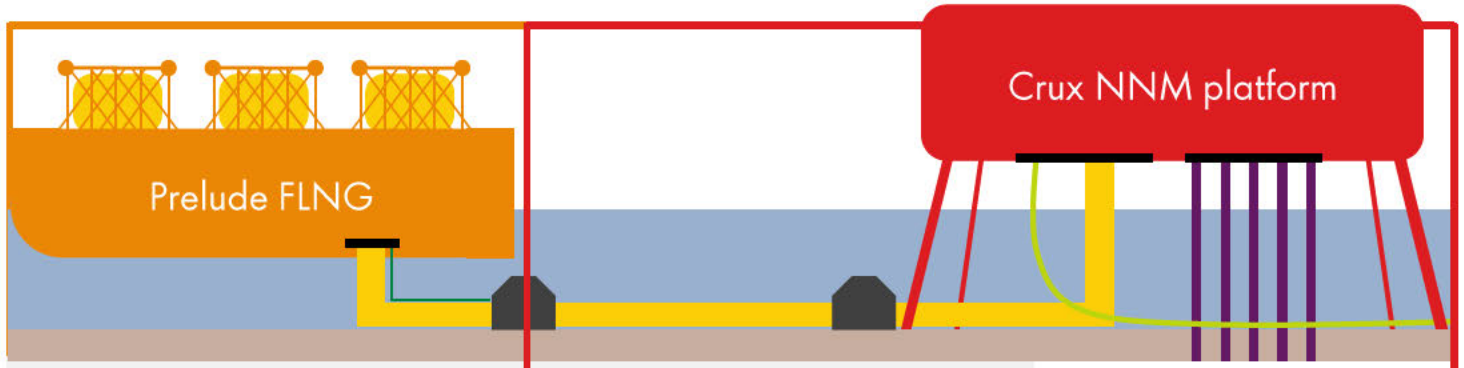
1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan
3. Development Drilling Environment Plan
4. Crux Installation and Cold Commissioning Environment Plan

Prelude – Overview

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.
- The Prelude FLNG facility is operated by Shell Australia in joint venture with INPEX, OPIC and Kogas.
- The Prelude Joint Venture has executed agreements to allow for processing of Crux hydrocarbons, which are expected to commence in 2027.

Prelude and Crux

Crux will leverage Prelude FLNG's existing infrastructure to its fullest extent to maximise capital efficiency & deliverability



Prelude infrastructure

- Riser, umbilical, and receiver
- Pipeline termination point and subsea isolation valve

Prelude participants

- 67.5% (Operator)
- INPEX 17.5%
- KOGAS 10%
- CPC Corporation, Taiwan 5%

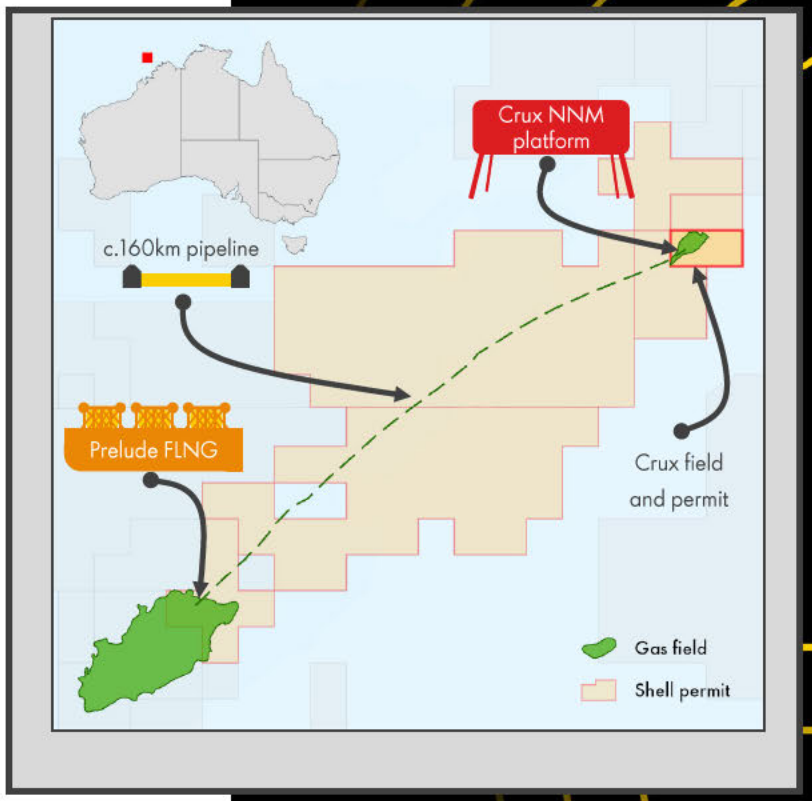
Crux infrastructure

- 5x dry tree wells
- Pipeline termination point and subsea isolation valve
- Riser and fibre optic cable
- c.160km pipeline

Crux participants

- SGH | Energy 84.5% (Operator)
- 15.5%

Crux platform topsides and substructure



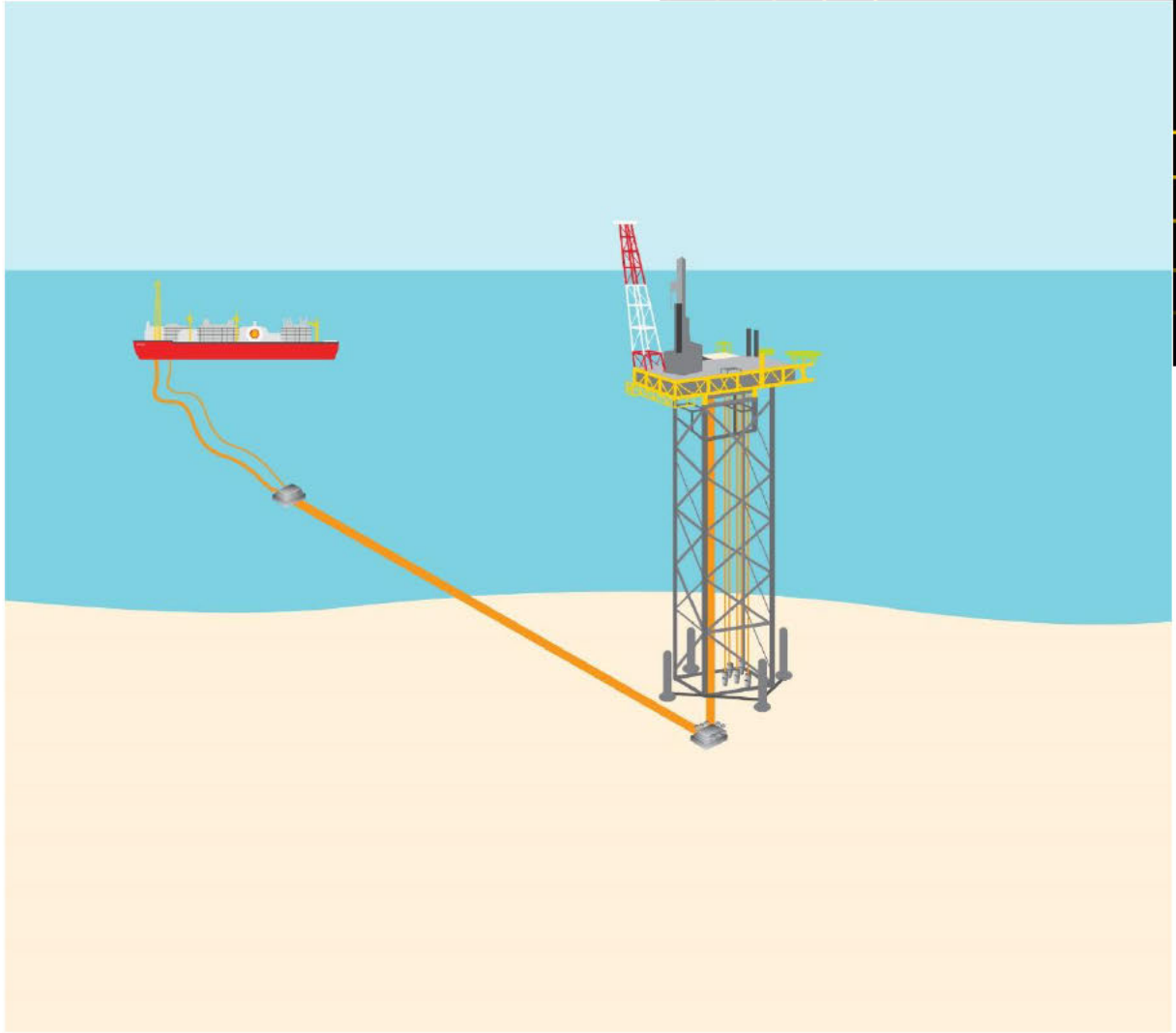
Crux update

- In May 2022, Shell Australia and SGH Energy took final investment decision to approve the development of Crux.

- The project is an important longer term backfill opportunity for the existing Prelude FLNG facilities. The proposed concept is an unmanned platform with minimal facilities, remotely operated from the Prelude FLNG.

- The project aligns with Shell's strategy and forms an important part of Shell's gas portfolio and will help meet the needs of gas users as the energy market transitions to a lower carbon future, noting the expected increasing demand for natural gas, renewables, low and zero carbon technologies, and the criticality of security in energy supply.

- The natural gas from Crux and Prelude will be a key part of how we help move Asian customers from coal to gas as a cleaner burning fuel.



Crux Environment Plans

Each EP describes controls to mitigate both the planned impacts and unplanned risks to as low and reasonably practicable

Planned impacts

Includes activities that result in physical impact to the environment:

- Disturbances to the seabed
- Drilling Fluid Discharges
- Noise generated from construction activities.

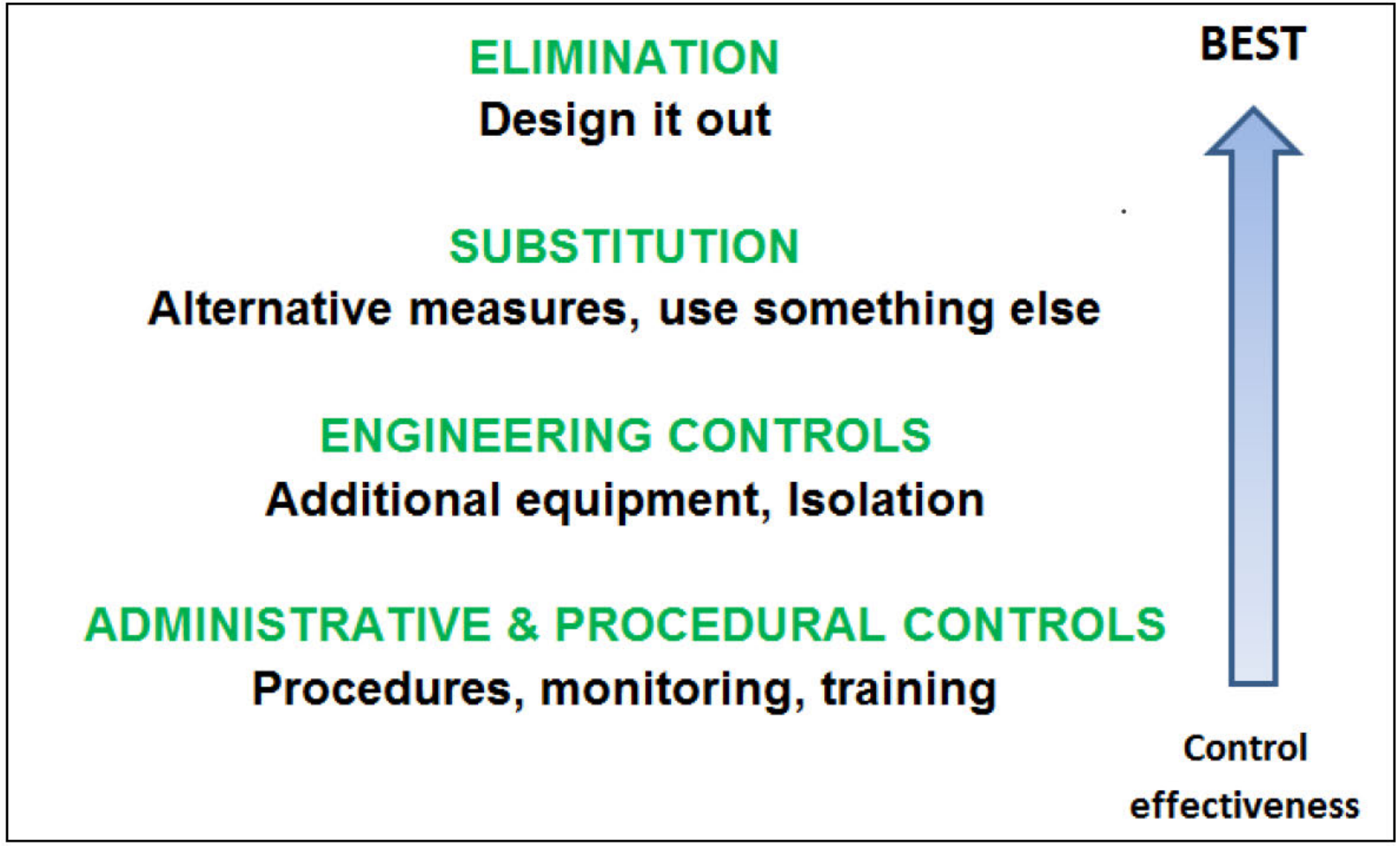
Unplanned risks

Includes events that may occur as a result of an incident:

- Release of diesel as a result of a vessel collision.
- Release of hydrocarbons as a result of loss of well control.

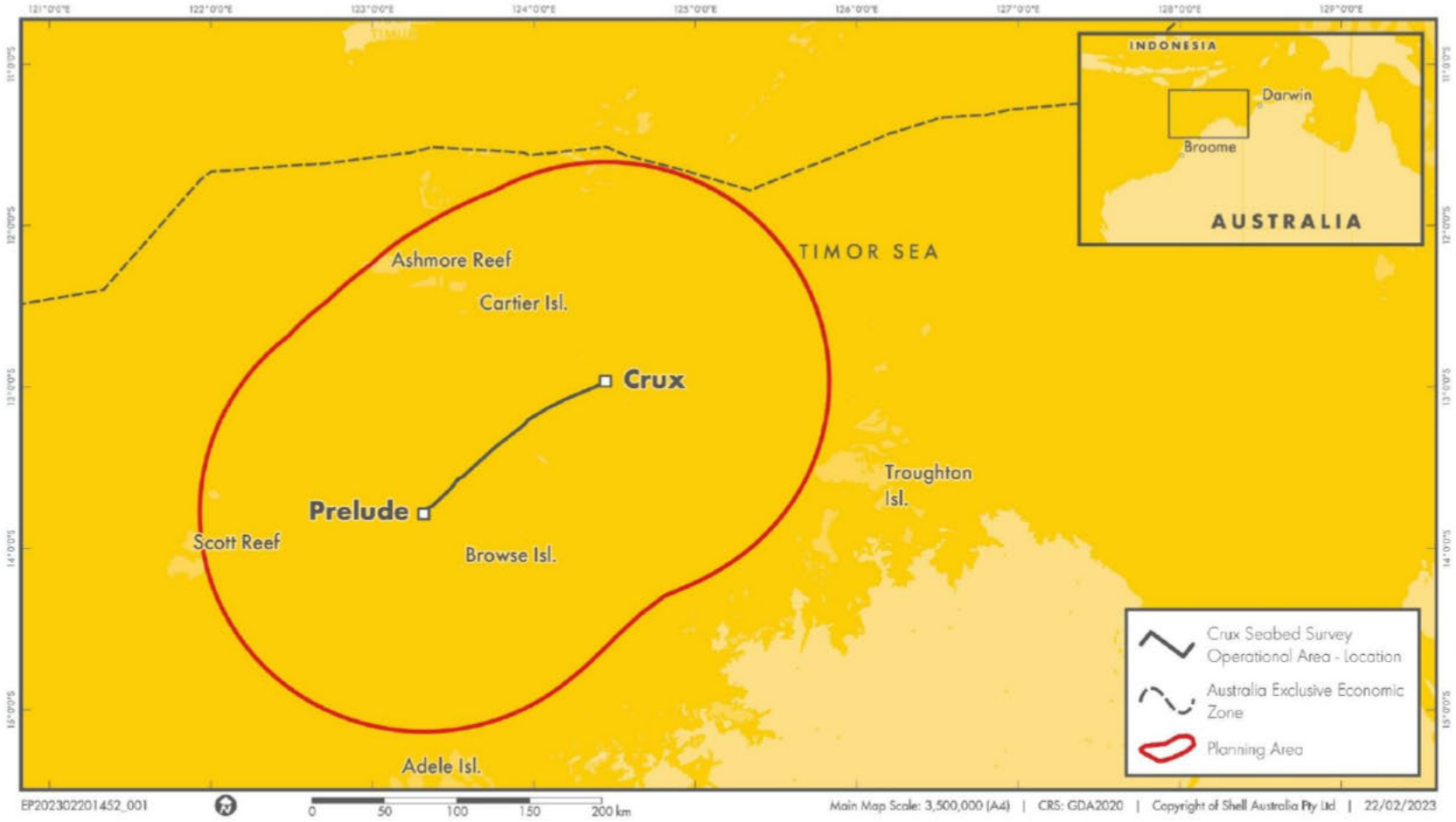
Crux Environment Plans

Shell applies a hierarchy of control process to establish controls which mitigate environmental impacts and risk.



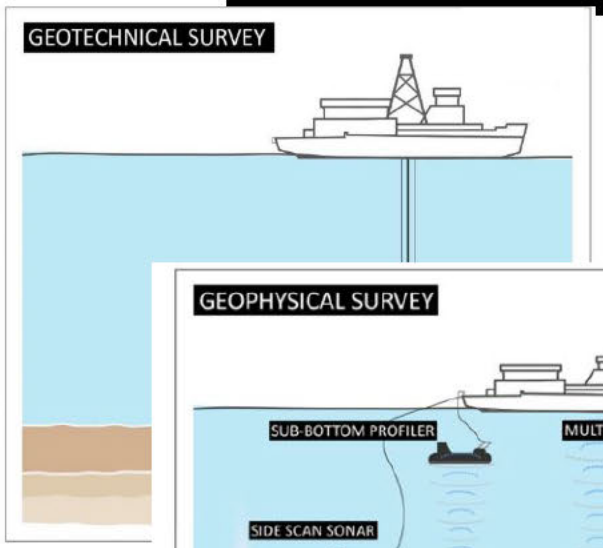
1. Crux seabed survey environment plan

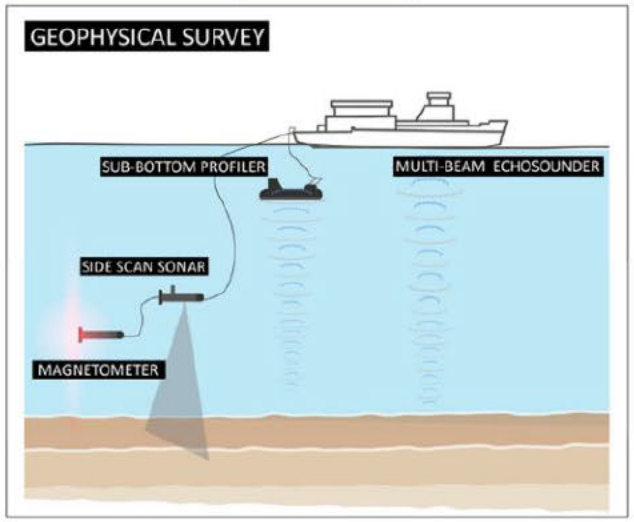
To carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.



Duration: <5 days

Timing: 1 May – 31 December 2023*





Dates for the commencement of activities and duration are subject to schedule change

1. Crux seabed survey environment plan
Key aspects and controls

Key aspect: Noise

The geophysical survey equipment emits impulsive noise which can affect marine fauna if in proximity.

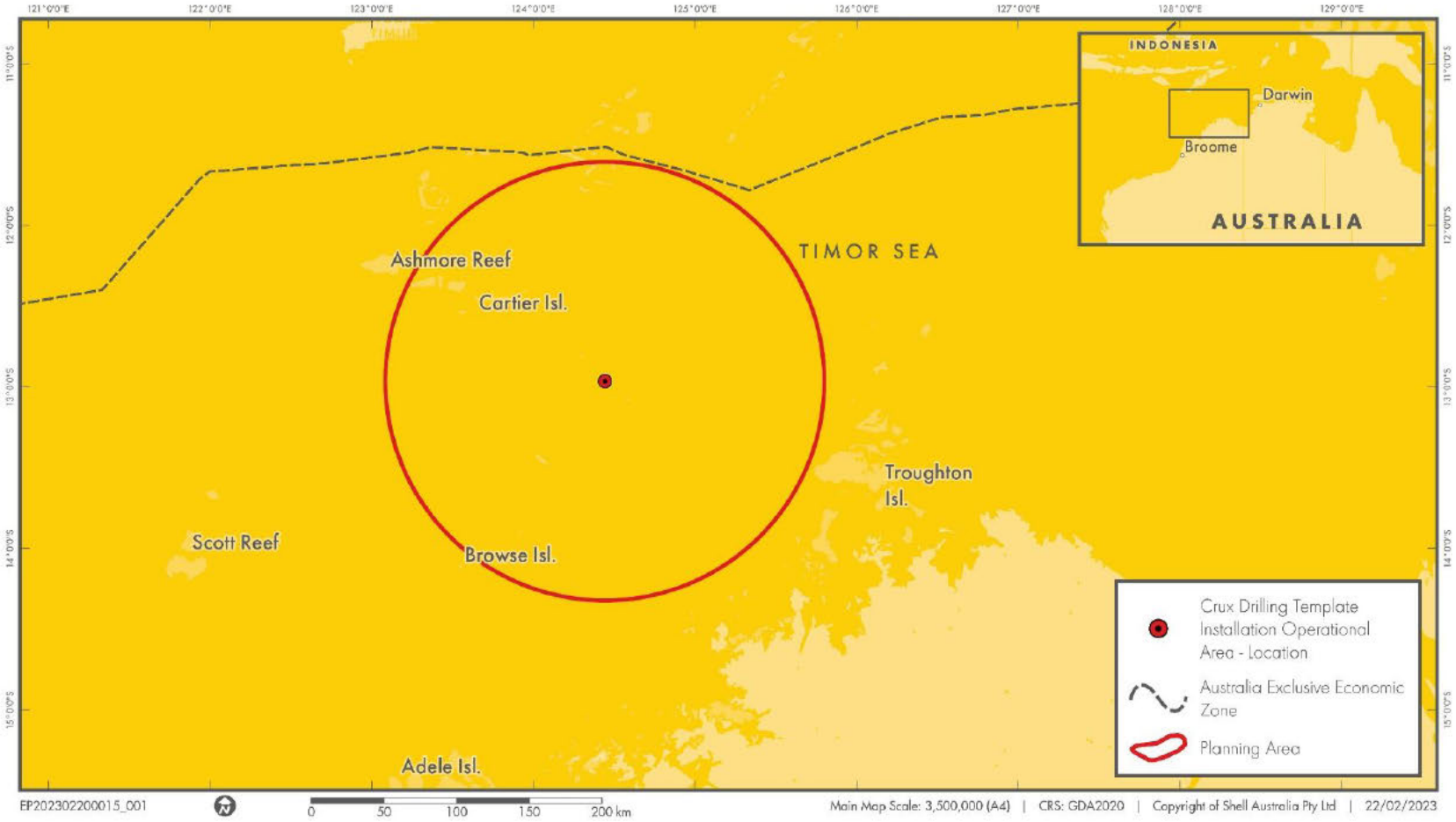
Proposed controls: Observations

- Pre-start visual observations out to 3 km for 30 minutes.
- If a whale or turtle is observed during the pre- start observations, delay start up for 30 minutes.
- If no whales or turtles are observed, activate acoustic equipment.

Aspect	Proposed control
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of Liquid Effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric Emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse Gas Emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
Waste Management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

2. Crux template installation environment plan

to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux jacket.

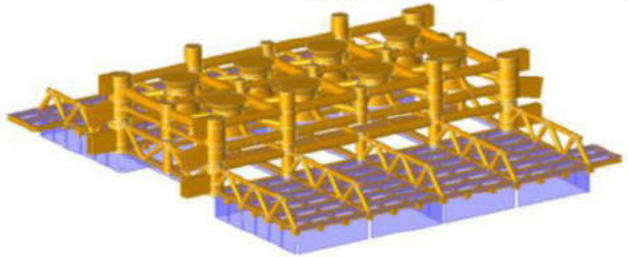


Duration: <7 days

Timing: 1 September 2023 – 1 April 2024*

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2.

It weights 200 tonnes



*Dates for the commencement of activities and duration are subject to schedule change

2. Crux template installation environment plan

Key aspects and controls

Key aspect: Physical Presence

The drilling template will be left on the seabed for the life of Crux.

Proposed controls:

- AHS is given notification in advance to enable a 'Notice to Mariners' to be issued prior to petroleum activities occurring within the operational area
- Relevant persons consultation – other marine users will be made aware of the location of the drilling template via Shells consultation process.

Aspect	Proposed Controls
Planned	
Physical presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
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Discharge of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
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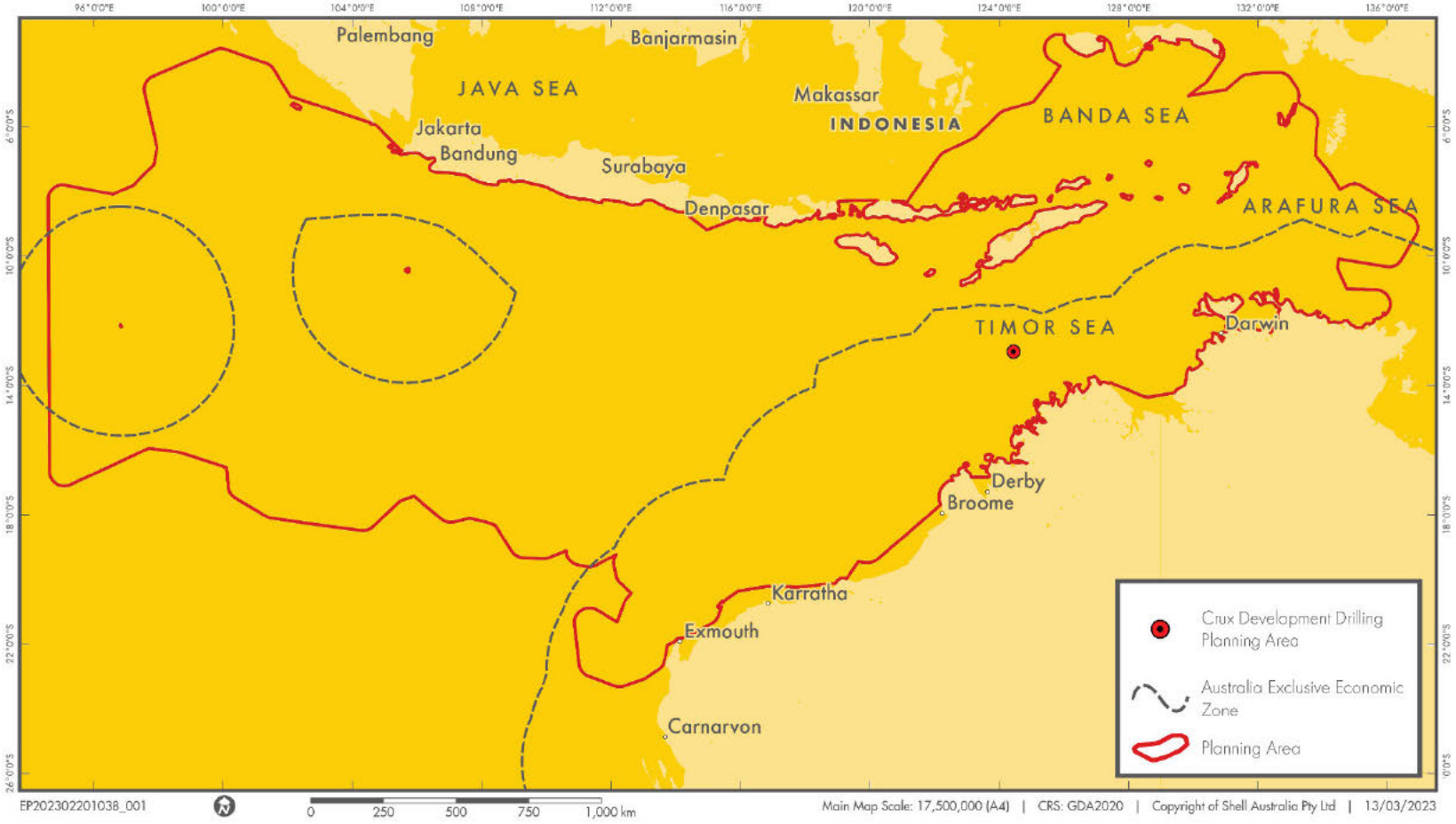
Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

3. Crux development drilling environment plan

Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.



Timing:

- Expected Mobile Offshore Drilling Unit Operations – End 2023 - early 2024.
- Expected temporary well suspension period, approximately 2-3 years. Scope completed no later than the end of 2025*

Dates for the commencement of activities and duration are subject to schedule change

3. Crux development drilling environment plan

Key aspects and controls

Key aspect: Discharge of liquid effluent (including drilling discharges)

The drilling activity includes discharges of liquids and materials to the marine environment.

Proposed Controls:

- Shell Chemical Management Process:
  - Chemicals selected for use in accordance with the Shell Chemical Management Process to minimise potential environmental risks.
  - Chemicals that are planned for discharge to sea are substitution warning free and Gold, Silver, D, or E rated through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oil Spill Prevention, Administration and Response (OSPAR) Commission), or have a complete ALARP assessment.

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
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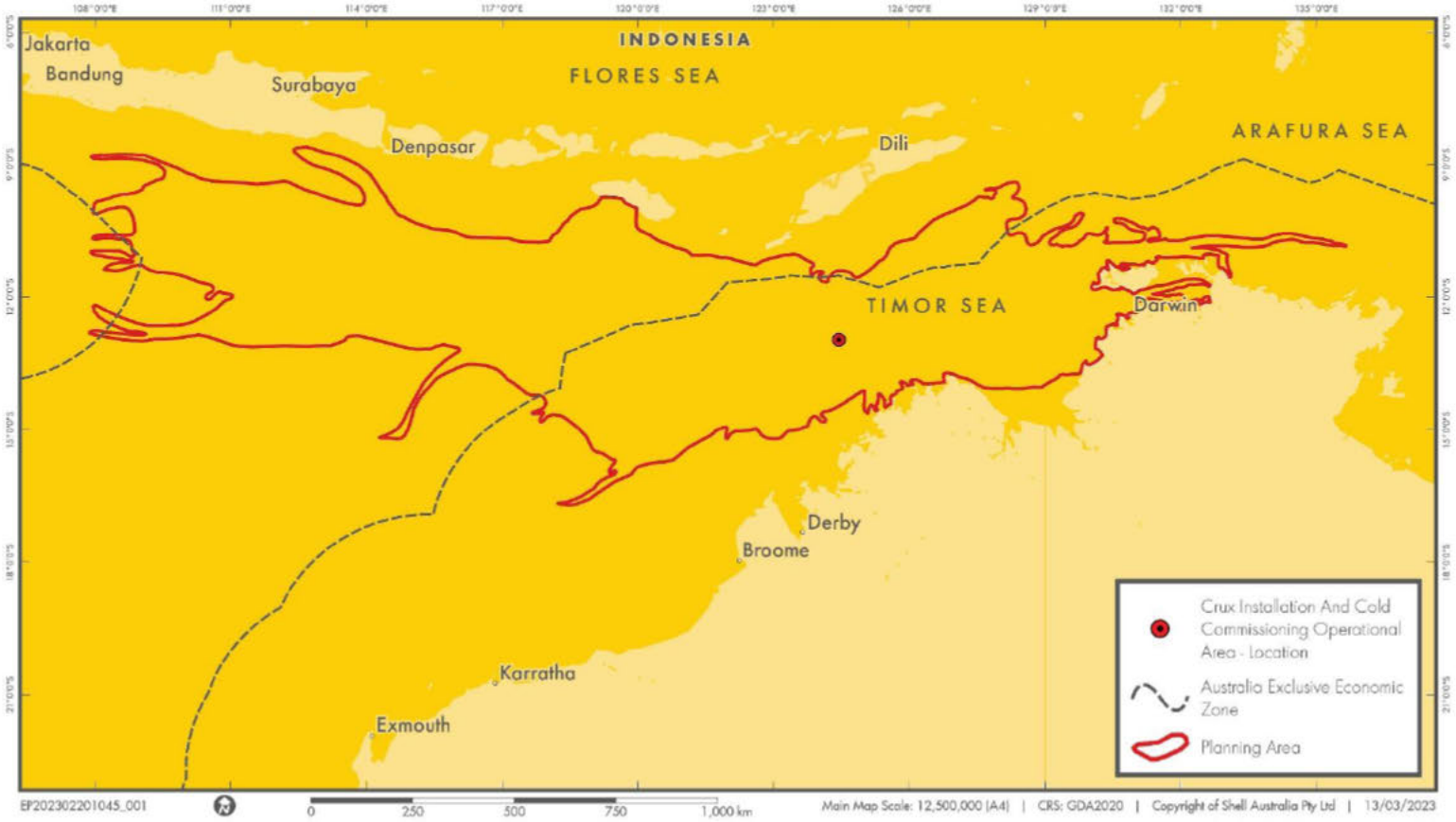
4. Crux installation and cold commissioning environment plan



Shell is planning to install the Crux Jacket and Topsides which will be fixed to the seabed.

The facility will commence cold commissioning once installation is complete.

Duration: 360 days

Timing: 1 August 2024 – 31 Dec 2026*

**Dates for the commencement of activities and duration are subject to schedule change*

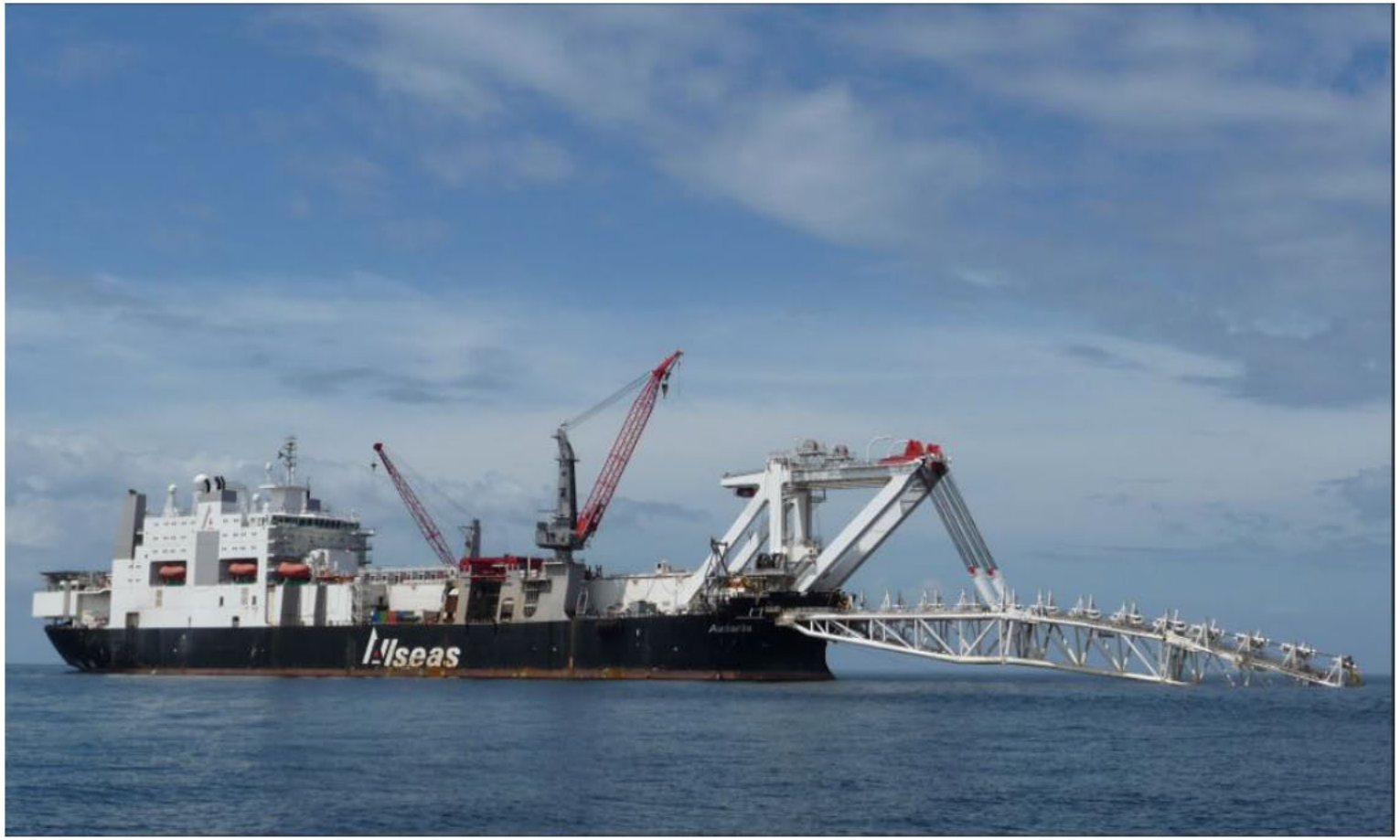
4. Crux installation and cold commissioning environment plan

Key activities

Installation of 26-inch export pipeline (~165 km long) from Prelude to Crux

Vessel operations

- Pre- and post-lay geophysical surveys
- Pipeline hydrotest, preservation and associated discharges



4. Crux installation and cold commissioning environment plan

Key activities

Substructure Installation

Construction Vessel

DLV2000

Support Vessels

Pile Transport barge, Tugs, Supply Vessel

Jacket Transport & Launch

Transported on Launch Barge + approximately 3 Tugs

Activity includes pile driving and pile drilling

4. Crux installation and cold commissioning environment plan

Key activities

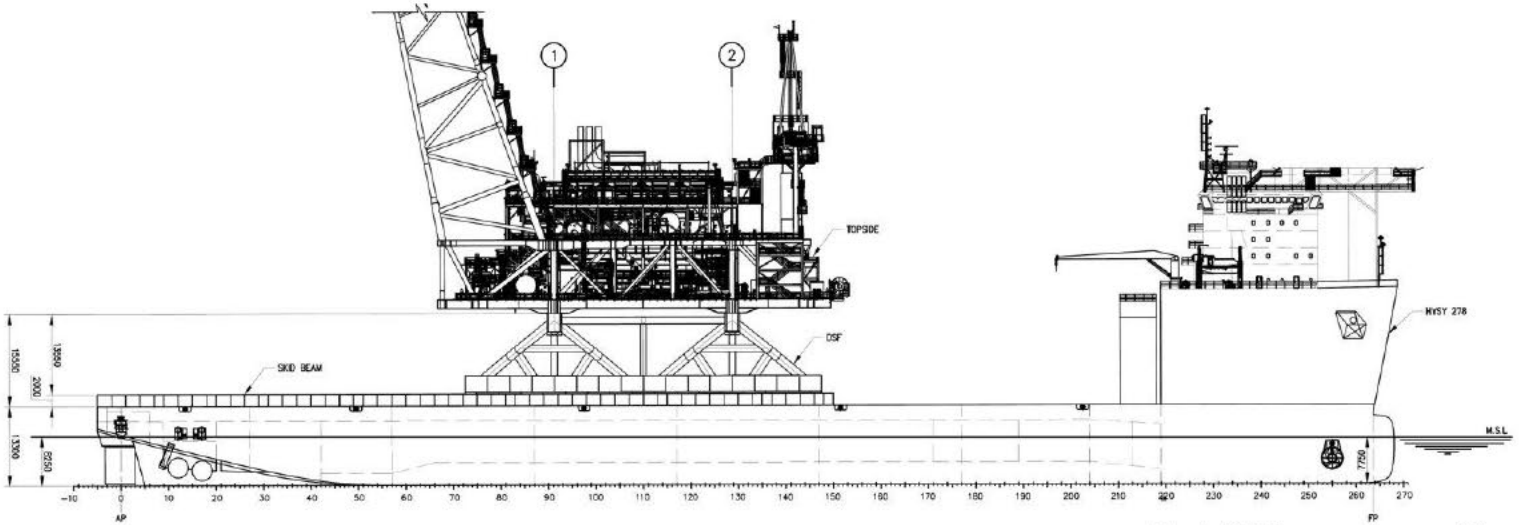
Topsides Installation

Float Over Installation Vessel

HYSY 278 (or similar)

Support Vessels

Tugs/Supply Vessel



4. Crux installation and cold commissioning environment plan

Key aspects and controls

Key aspect: Noise

Scope include multiple vessel operations and a piling campaign which results in underwater noise.

Proposed controls:

- During piling operations, start-up and shutdown procedures will be adopted which consider approach by sensitive species and actions taken when species approach.
- Vessel interactions with threatened and migratory species to follow the of EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06). In particular:
- Support vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf.
- If the whale, dolphin, turtle or whale shark shows signs of being distressed, support vessels will immediately withdraw from the caution zone at a constant speed of less than 6 knots.

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
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Atmospheric emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse gas emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
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Crux environment plan – unplanned events

Unplanned	
Emergency Events – Hydrocarbon Spill	▪ Align with relevant requirements from the International Convention for the Prevention of Pollution from Ships and subsequent regulations ▪ Valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) ▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Offshore Vessel Inspection Database (OVID) process ▪ Australian Hydrographic Office Notice to Mariners ▪ NOPSEMA accepted Environment Plan and Oil Pollution Emergency Plan (OPEP) in place ▪ Relevant Persons consultation process ▪ Vessel Maintenance management system
Introduction of Invasive Marine Species from Vessels	▪ Ballast water exchange operations will comply with the international conventions and associated national regulations. ▪ Biofouling management for vessels in accordance with state, national and international biofouling management guidelines ▪ Biofouling management in compliance with state and commonwealth regulations ▪ Vessels (of appropriate class) will have a valid International Anti-Fouling System Certificate ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area

Q&A

CONTACT US Community Hotline: 1800 059 152

Email: SDA-crux-project@shell.com

www.shell.com.au/crux

Shell welcomes any feedback on Environment Plan submissions, including requests for further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

Appendix A - 6.00 Crux Animation Video

Crux Animation

https://creativehub.shell.com/m/61f586aae5cb405e/original/Crux-Stakeholder-Engagement-2023-05-10.mp4

Appendix A - 6.01 Crux Animation Transcript

The Crux Project is located 190km off the north-west coast of Western Australia, in waters of around 165m deep. It will provide continued supply of gas to the existing Prelude Floating Liquefied Natural Gas (FLNG) facility, approximately 160km southwest of the Crux field. The Crux Project forms an important part of Shell Australia's natural gas portfolio, and is being progressed with our joint venture partner, SGH Energy.

The project features a Not Normally Manned platform with five production wells, minimal processing facilities and utility systems. The platform will be operated remotely from the existing Prelude FLNG facility, requiring only periodic maintenance visits, significantly reducing the operational safety exposure to staff. A 26" export pipeline will connect the Crux Project to Prelude along the seabed approximately 160km long away. The pipeline route is relatively straight, and there are no seabed obstructions. The Prelude Floating LNG facility is 488mm long and 74m wide and is designed to remain moored in the field for at least 25 years. The facility extracts, liquefies, and stores natural gas at sea, before it is transferred and shipped to customers.

Development of Crux begins with drilling of the five wells. A subsea template structure provides a guide for the drill bit, with eight slots to allow for contingency. The wells will be drilled by a Mobile Offshore Drilling Unit, then suspended ready for completion after the platform and substructure have been installed.

The 26" rigid, concrete-clad export pipeline will be laid by a specialised pipelay vessel along a seabed corridor in water depths from 170m - 280m. A pipeline termination structure will be installed at each end, allowing for tie-in operations to be completed afterwards. The substructure will be brought to site, then landed over the guideposts on the drilling template. 12 anchor piles will be driven through the foundation to hold it in place. The topside facility will then be brought in and lowered onto the substructure. Subsea tie-in activities will then connect the platform to the export pipeline and to Prelude FLNG.

All systems will then be commissioned and safety-tested before production begins. At peak capacity the Crux Project is expected to provide approximately 2.9 million tonnes per annum of natural gas.

Before Shell commences substantial work on major projects or existing facilities, the regulatory, environmental, and social impacts are assessed, alongside commercial and technical considerations. As part of the Crux development, Shell will be preparing environmental approvals for submission to NOPSEMA. These Environmental plans outline the potential impacts and risks of an activity and how they will be managed.

Shell is consulting with relevant community members who have functions, interests or activities that may be affected, which is an important part of these approvals.

For more information on these plans please visit shell.com.au/crux

Shell has been operating in Australia since 1901. In this time, the needs of our customers and the nation have changed. Today, Shell Australia has an integrated energy solutions portfolio which includes gas production and liquefaction businesses, and Shell has been investing in renewable power and energy solutions to create a low- and zero-carbon energy business in Australia.

The Crux Project is a key part of Shell's current and future energy goals, helping to meet the growing demand for LNG. It aligns with Shell's "Powering Progress" strategy by helping customers switch to liquefied natural gas (LNG) as an alternative to more carbon intensive forms of fuel such as coal. Natural gas emits around half the greenhouse gas than coal does when used to generate electricity and less than one-tenth of the air pollutants.

To Whom It May Concern,

Shell Australia would like to invite you to attend our upcoming forums in April and May 2023, to talk about Shell Australia's Crux project. **Due to the easter public holidays, registrations to our upcoming forums have been extended.** The location of the Shell forums will be subject to a majority vote by the conference participants invited to the Shell forums.

If you are interested in attending our Shell forums, please ensure you complete the attached registration form **by Friday 14th April, at 5pm (AWST)** and email your form to SDA-crux-project@shell.com. Shell will provide travel and accommodation support for your representative to attend.

The options we have provided in the attached registration form will also ensure all forum participants have an opportunity to tell us how, where and when they want to be consulted.

This event will be restricted to a maximum of 120 Indigenous people and organisations, due to venue capacity.

The forums will be held on the following dates:

Forum 1
Date: Wednesday 19 April 2023
Time: 8:15am Arrival (For an 8:30am start)
Location: Subject to majority vote
About this Forum: Forum 1 is an introduction to our Shell leaders who will provide an update on Shell's National Indigenous Affairs, Prelude and Crux projects and environmental approvals related to the Crux project which will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Forum 2
Date: Wednesday 10 May 2023
Time: 8:15am Arrival (For an 8:30am start)
Location: Subject to majority vote
About this Forum: Forum 2 will provide all attendees with the opportunity to provide feedback and raise any concerns that your community has raised in response to Shell's forum 1 on the Crux project. The sessions in forum 2 will be in smaller groups, that will include a Shell leader, and an environmental or cultural heritage expert, to listen to your concerns and answer questions.

If you have any other enquiries not identified in the attached registration form, please email SDA-crux-project@shell.com.

Yours faithfully,
[info redacted]

Appendix A – 7.00 Indigenous relevant persons consultation material

Appendix A - 7.01 Initial email invitation – March/April

REGISTRATION INSTRUCTIONS

Shell Australia is extending invitations to relevant persons and organisations, to attend our upcoming forums on 19 April and 10 May 2023 to talk to us about our Crux Project.

You have an opportunity to nominate one person to represent your Organization, Native Title Determination Group, Native Title Holders, Native Title Claimants, or Individual/s Family Groups, at the Shell forums.

- All Shell forum participants will be provided with travel and accommodation support.
- All Shell forum participants will have an opportunity to vote on the location of the forum.
- Due to the venue capacity, the forums will be restricted to a maximum of 120 participants.
- To register for the Shell forums, please complete this form by Friday 7th April 2023, 5pm (AWST) and return your form to SDA-crux-project@shell.com.

Appendix A - 7.02 Survey issued for Indigenous Forums (attached to email)

NOMINATE YOUR REPRESENTATIVE
Please provide contact details for your nominated representative.

1. PERSONAL DETAILS
p Click here to enter text
PHONE OR MOBILE: Click here to enter your number
EMAIL: Click here to enter your email address
ADDRESS: Click here to your address
STATE: Click here to enter a State
POSTCODE: Click here to enter your postcode

2. ORGANISATION (only complete this section if it applies to you)
ORGANISATION NAME: Click here to enter your organisation name
POSITION: Click here to enter position details

3. NATIVE TITLE GROUP/NATIVE TITLE HOLDERS/NATIVE TITLE CLAIMANTS
If relevant, please tell us which native title group, native title holders, or native title claimant, which you will be representing at the Shell forums? Click here to enter your response

4. PLEASE TELL US HOW AND WHERE YOU WOULD LIKE FORUM 1 AND FORUM 2 DELIVERED, BY TICKING AN OPTION BELOW.

FORUM 1 (19 APRIL) OPTIONS
☐ **Option 1** PERTH WA (Shell will provide your nominated representative with travel and accommodation support to attend a forum in Perth)

☐ **Option 2** BROOME WA (Shell will only provide travel/accommodation support to participants not living in Broome WA)

☐ **Option 3** Drop-in Session in Broome ➥ Broome Civic Centre, Monday 27 April

☐ **Option 4** Not available for several months due to cultural commitments

☐ **Option 5** Not available but interested in providing feedback at forum 2 in May.

FORUM 2 (10 MAY) OPTIONS
☐ **Option 1** BROOME WA (Shell will only provide travel/accommodation support to participants not living in Broome WA)

☐ **Option 2** Not available for several months due to cultural commitments

☐ **Option 3** Not available in May but interested in providing feedback at a later date. (Please email SDA-crux-project@shell.com when you're ready to provide feedback)

5. CATERING ➥ DIETARY REQUIREMENTS
For catering purposes, please tell us if you have any special dietary requirements or food allergies? Click here to enter your dietary requirements

6. CONTACT US
Shell Australia welcomes any other suggestions, or feedback on how and where you would like to be consulted.
Click here to enter your response.

7. OTHER OPTIONS
If you didn't select an option from one of the forum locations that we provided to you in Section 4, then as an alternative, you can also select from one of the options below:

☐ **Option 1** On-Country Consultation (Please note this will include Shell leadership and Indigenous Affairs, Environmental and Cultural Heritage experts)
☐ **Option 2** Not interested

8. FILMING CONSENT
We are intending to film the presentations delivered by our Shell leaders at forum 1. The film will be emailed to all nominated representatives who attended the forum to share with your organization, community, or extended family groups.

You may appear in this film, so we are requesting your consent, noting:

The breakout sessions planned for forum 1, will not be filmed.

The filming of forum 1 will not be used for any online media, YouTube, LinkedIn, Facebook, Twitter or Instagram promotions.

☐ I provide consent to be filmed.
☐ I prefer not to be filmed and would like to be seated out of view of the Camera Operator.

Appendix A - 7.03 Presentation – Indigenous Forum 1 in Perth

Shell Australia – Indigenous Forum

Wednesday 19 April 2023

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Definitions & cautionary note

Cautionary Note

The companies in which Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell Group" and "Group" are sometimes used for convenience where references are made to Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. "Joint ventures" and "joint operations" are collectively referred to as "joint arrangements". Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

Forward-Looking Statements

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', "milestones", ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this **[report]**, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, judicial, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Shell plc's Form 20-F for the year ended December 31, 2021 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this **[report]** and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 27 April 2023. Neither Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

Shell's net carbon footprint

Also, in this presentation we may refer to Shell's "Net Carbon Footprint" or "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" or "Net Carbon Intensity" are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCF target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available from the SEC website www.sec.gov.

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Shell Australia's Footprint

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with relevant persons who may be impacted by the activities we are proposing in relation to the development of the Crux project.

We are consulting on four Environment Plans:

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan
3. Development Drilling Environment Plan
4. Crux Installation and Cold Commissioning Environment Plan

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Prelude – Overview

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.
- The Prelude FLNG facility is operated by Shell Australia in joint venture with Inpex, OPIC and Kogas.
- The Prelude Joint Venture has executed agreements to allow for processing of Crux hydrocarbons, which are expected to commence in 2027.

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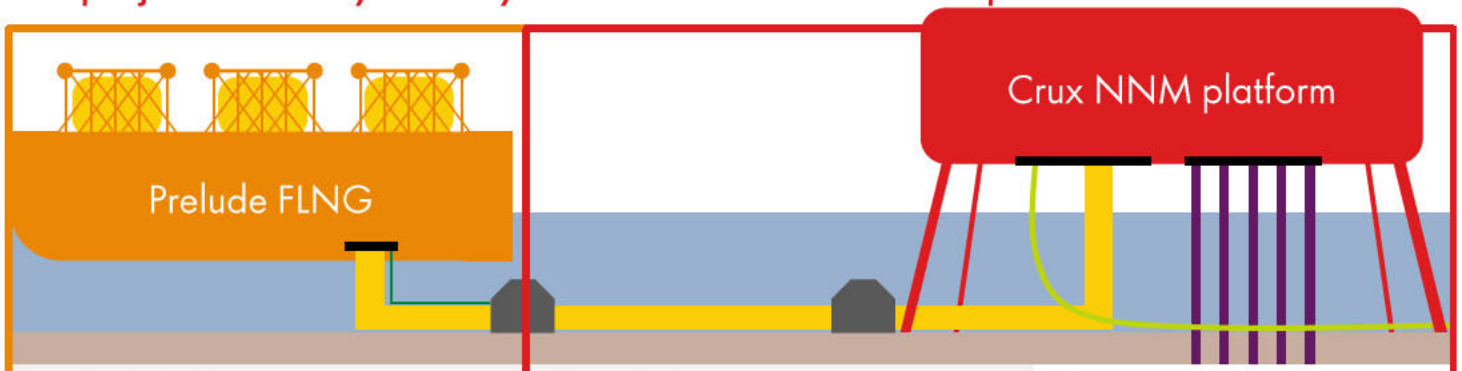
Prelude and Crux

Crux will leverage Prelude FLNG's existing infrastructure to its fullest extent to maximise capital efficiency and deliverability

Crux project boundary and key infrastructure under development



Prelude infrastructure

- Riser, umbilical, and receiver
- Pipeline termination point and subsea isolation valve

Prelude participants

- 67.5% (Operator)
- INPEX 17.5%
- KOGAS 10%
- CPC Corporation, Taiwan 5%

Crux infrastructure

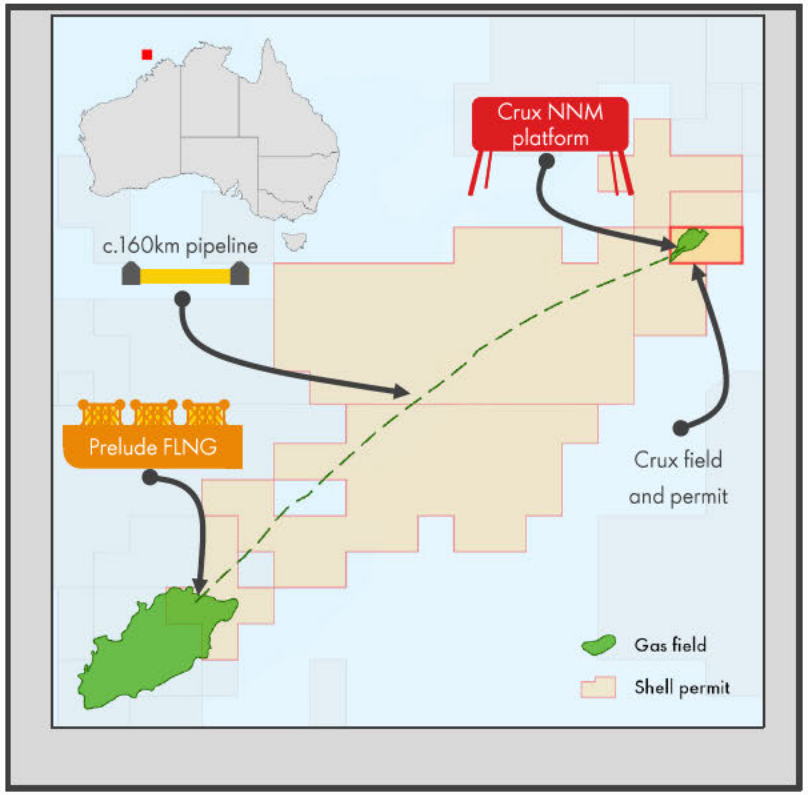
- 5x dry tree wells
- Pipeline termination point and subsea isolation valve
- Riser and fibre optic cable
- c.160km pipeline

Crux participants

- SGH | Energy
- 84.5% (Operator)
- 15.5%

Crux platform topsides and substructure

Crux field overview



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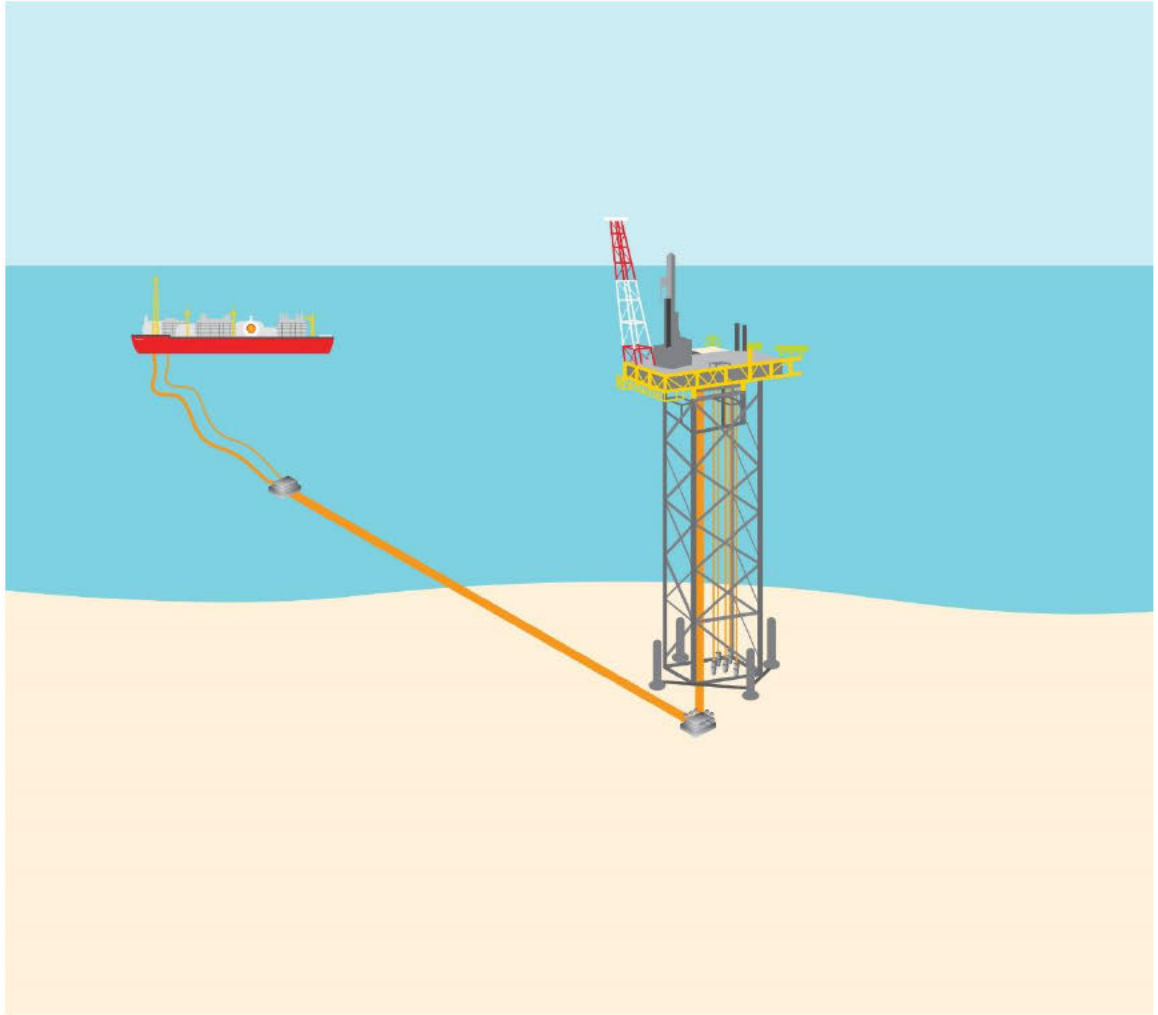
Crux update

- In May 2022, Shell Australia and SGH Energy took final investment decision to approve the development of Crux.
- The project is an important longer term backfill opportunity for the existing Prelude FLNG facilities. The proposed concept is an unmanned platform with minimal facilities, remotely operated from the Prelude FLNG.
- The project aligns with Shell's strategy and forms an important part of Shell's gas portfolio and will help meet the needs of gas users as the energy market transitions to a lower carbon future, noting the expected increasing demand for natural gas, renewables, low and zero carbon technologies, and the criticality of security in energy supply.
- The natural gas from Crux and Prelude will be a key part of how we help move Asian customers from coal to gas as a cleaner burning fuel.



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4. Crux Installation and Cold Commissioning Environment Plan

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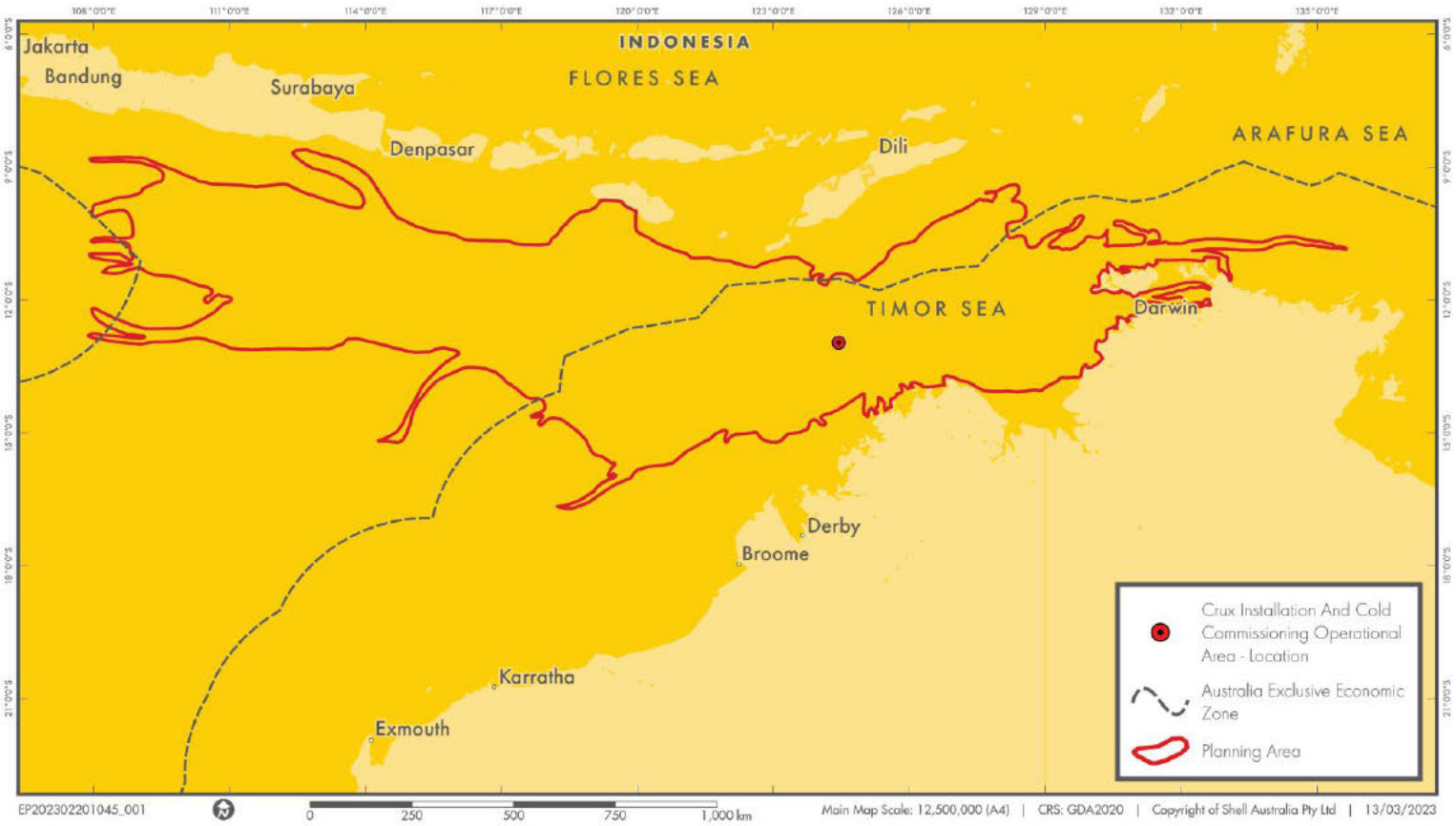
Crux Environment Plans

To help frame how Shell describes impacts and risk EPs can be broken into planned impacts and unplanned risks/potential impacts.



Planned impacts include activities that result in physical impact to the environment, i.e:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area.

Unplanned risks include events that may occur as a result of an incident i.e:

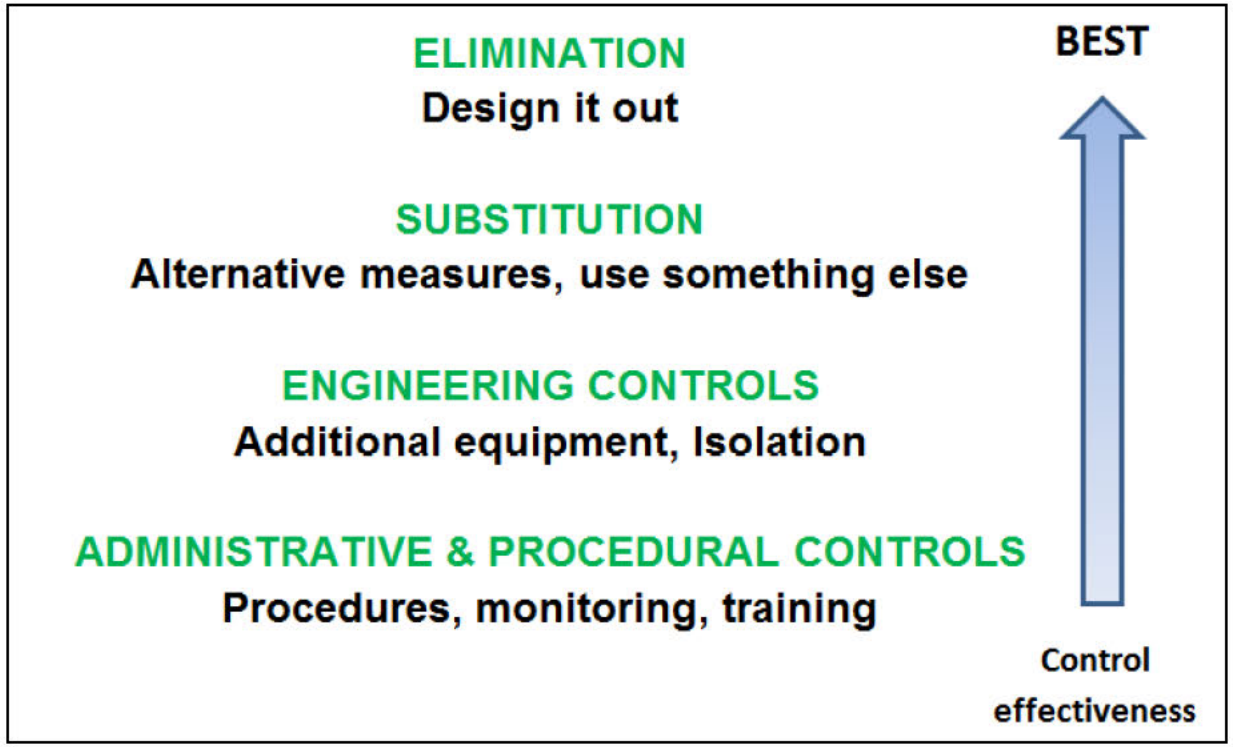
- Release of Diesel as a result of a vessel collision.
- Release of hydrocarbons as a result of loss of well control.

These unplanned events are very rear however are necessary to described to ensure adequate controls are adopted – these unplanned events define the **Planning Area**.

Each EP describes the controls that are adopted to mitigate both the planned impacts and unplanned risks to as low and reasonably practicable.

Crux Environment Plans

Hierarchy of controls – Impact/Risk reduction.



Shell applies a hierarchy of control process to establish controls which mitigate environmental impacts and risk.

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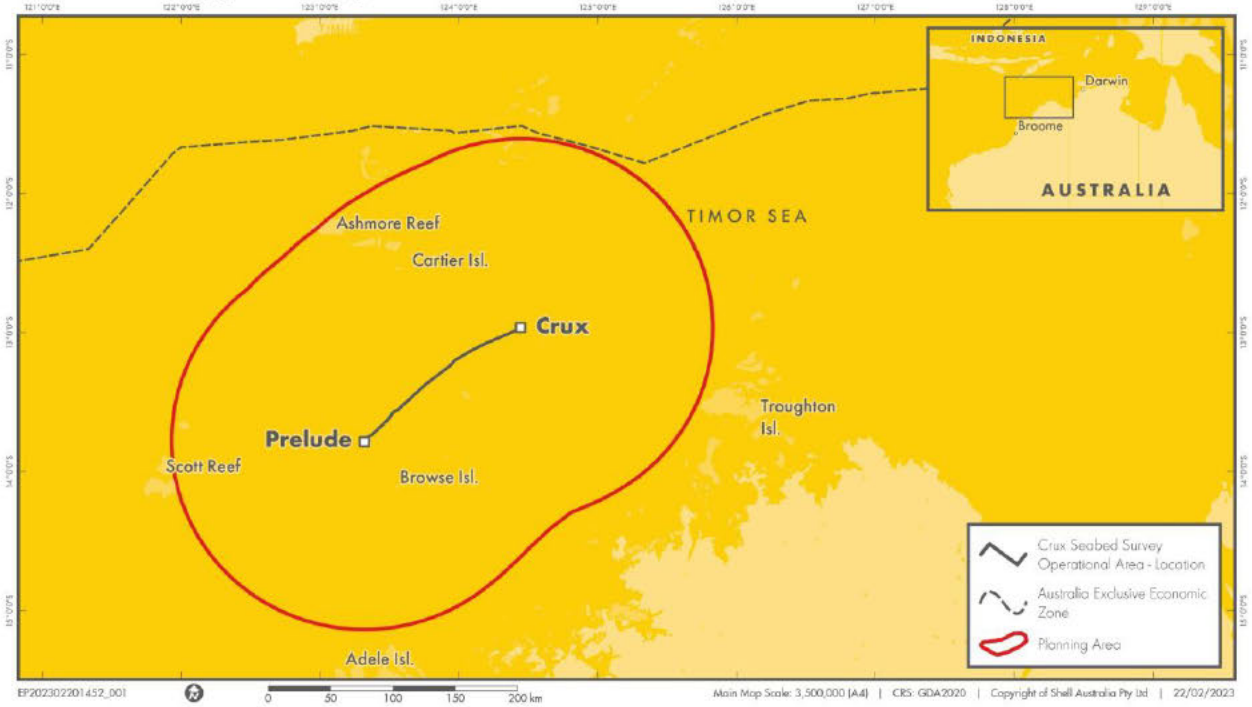
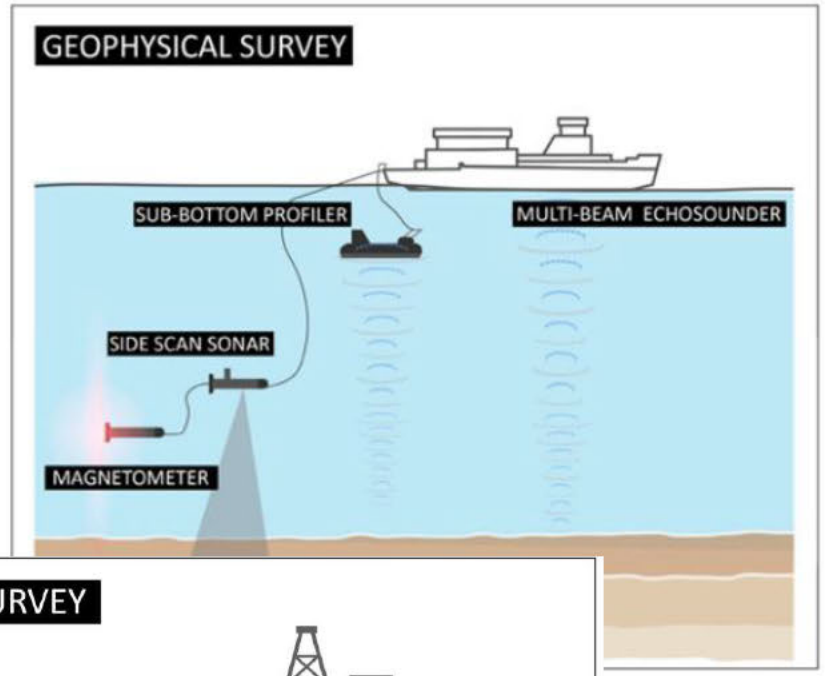
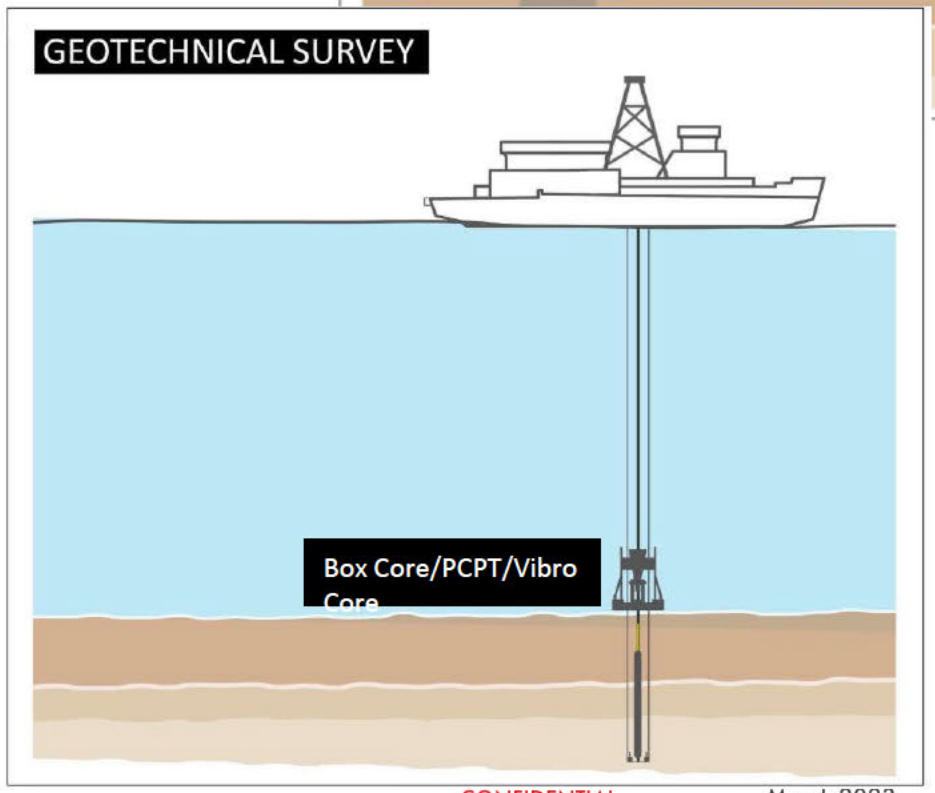
1. Crux Seabed Survey Environment Plan

Investigating the seabed and sub-seabed conditions







Activity: Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

A vessel will traverse the pipeline route, towing survey equipment and deploying coring equipment.

Duration: <5 days

Timing: 1 May – 31 December 2023*

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1.(cont.) Crux Seabed Survey Environment Plan

Investigating the seabed and sub-seabed conditions

Aspect	Proposed control
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of Liquid Effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric Emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse Gas Emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
Waste Management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

Key aspect and control:

Noise

The geophysical survey equipment emits impulsive noise which can affect marine fauna if in proximity.

Key control: Pre Start-Up Visual Observations

- Pre-start visual observations out to 3 km for 30 minutes.
- If a whale or turtle is observed during the pre- start observations, delay start up for 30 minutes.
- If no whales or turtles are observed, activate acoustic equipment (soft start is not possible on the MBES, SSS or SBP, nor is it possible for the shallow seismic source

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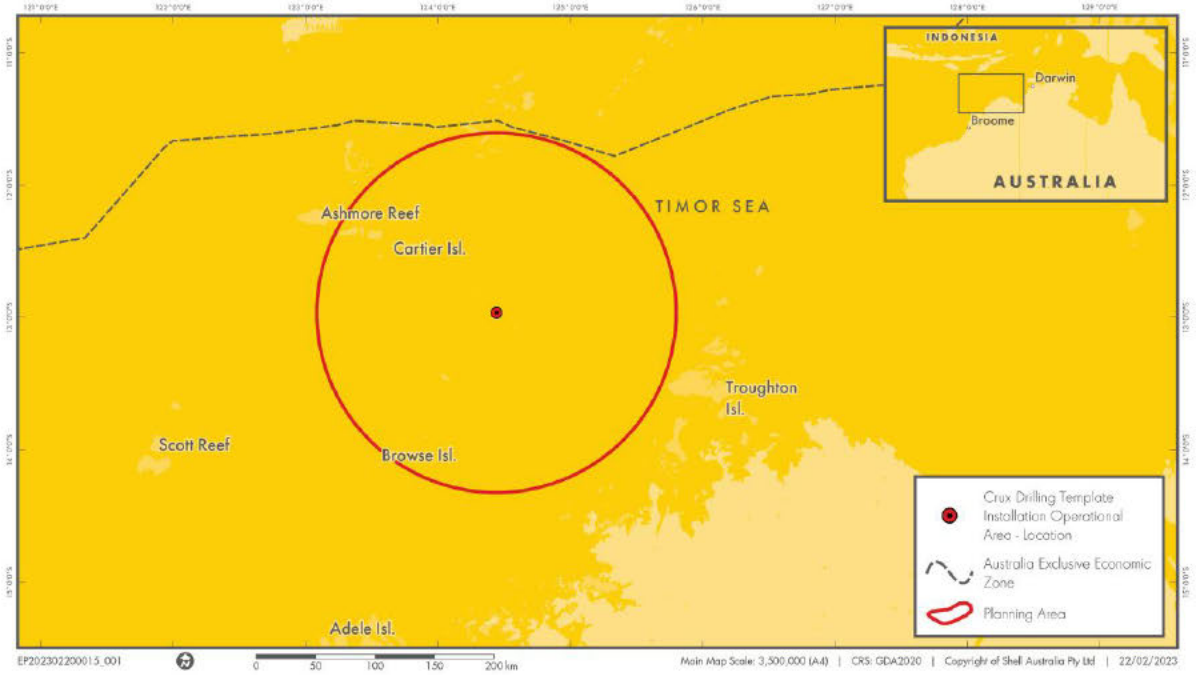
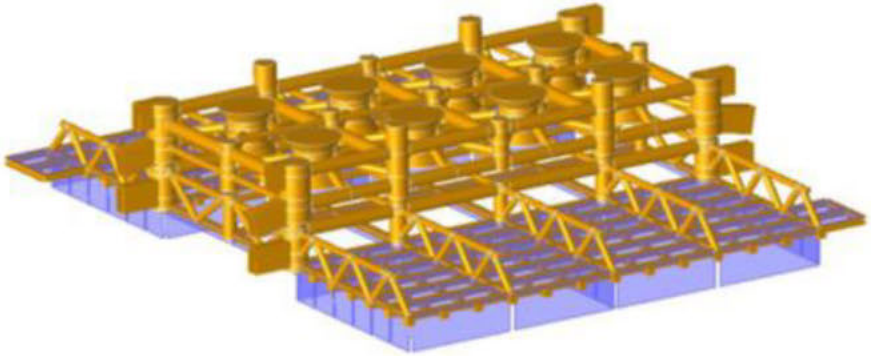
2. Crux Drilling Template Installation Environment Plan

A template which will act as a guide for the drill bit during drilling operations



Activity: Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux jacket.

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2. It weights 200 tonnes



Duration: <7 days **Timing:** 1 September 2023 – 1 April 2024*

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2.(cont.) Crux Drilling Template Installation Environment Plan

A template which will act as a guide for the drill bit during drilling operations

Aspect	Proposed Controls
Planned	
Physical presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
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Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

Key aspect and control

Physical Presence

The drilling template will be left on the seabed for the life of Crux.

Key Controls:

- AHS is given notification in advance to enable a 'Notice to Mariners' to be issued prior to petroleum activities occurring within the operational area
- Relevant Persons consultation – Other marine users will be made aware of the location of the drilling template via Shells consultation process.

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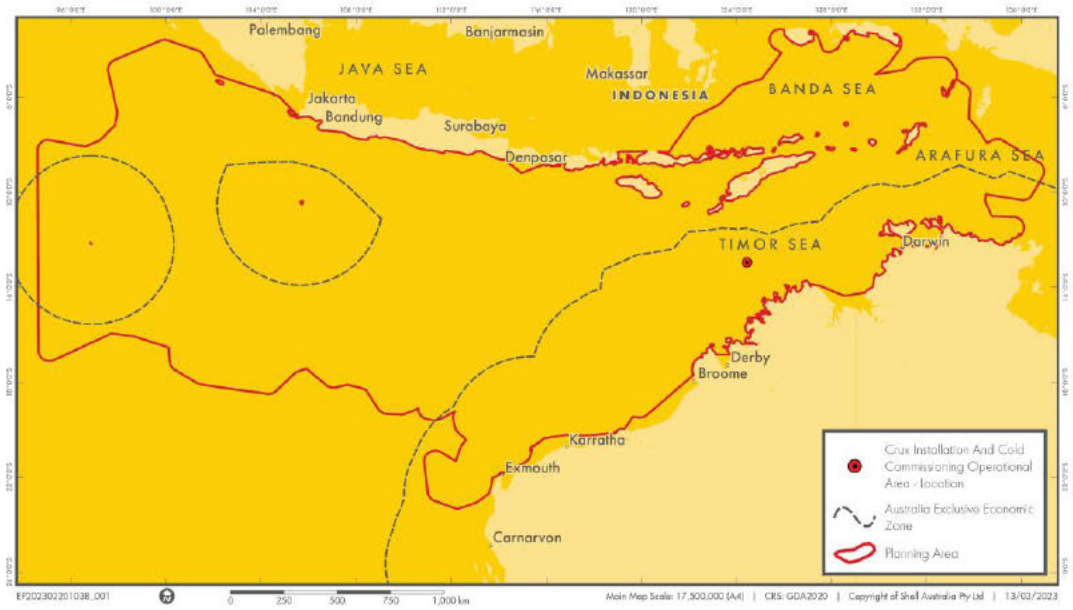
3. Crux Development Drilling Environment Plan



Activity: Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Timing:

- Expected Mobile Offshore Drilling Unit Operations start date – end 2023 - early 2024.
- Duration: approximately 10 months, with 10 months contingency.
- Expected temporary well suspension period, approximately 2-3 years.

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3. (cont.) Crux Development Drilling Environment Plan

Aspect	Proposed Controls
Planned	
Physical Presence, vessel movements and seabed disturbance	▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ Environmental Protection and Biodiversity Conservation Regulations (2000) (EPBC Regulations), Part 8.1 – Interacting with cetaceans ▪ Australian Hydrographic Office Notice to Mariners
Lighting	▪ External lighting on vessels minimised to that required for navigation, safety of deck operations and security considerations
Noise	▪ Apply EPBC policy statement 2.1 – Part B (seismic survey guidelines) to geophysical survey activities as applicable to the scope. This is planned to be applied using trained crew members. ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area ▪ EPBC Regulations Part 8.1 – Interacting with cetaceans ▪ Marine fauna observations
Discharge of liquid effluent	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations ▪ Chemical Management Process for chemical assessment and selection
Atmospheric emissions	▪ Comply with relevant requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and associated regulations. ▪ Relevant vessels to have a valid International Air Pollution Prevention Certificate ▪ Use of low sulphur fuel when possible
Greenhouse gas emissions	▪ Comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Comply with the National Greenhouse and Energy Reporting Act (2007) and National Greenhouse and Energy Reporting Regulations (2008)
Waste management	▪ Discharge of waste from vessels will comply with relevant International Convention for the Prevention of Pollution from Ships (MARPOL) requirements and associated regulations ▪ Waste management procedures ▪ Waste tracking process ▪ The management and disposal of any quarantine risk material will be in accordance with state and commonwealth regulations

Key aspect and control

Discharge of liquid effluent (including drilling discharges)

The drilling activity includes discharges of liquids and materials to the marine environment

Key Controls:

- Shell Chemical Management Process:
- Chemicals selected for use in accordance with the Shell Chemical Management Process to minimise potential environmental risks.
- Chemicals that are planned for discharge to sea are substitution warning free and Gold, Silver, D, or E rated through the Offshore Chemical Notification Scheme (OCNS), or are considered to Pose Little or No Risk to the Environment (PLONOR) (listed by the Oil Spill Prevention, Administration and Response (OSPAR) Commission), or have a complete ALARP assessment.

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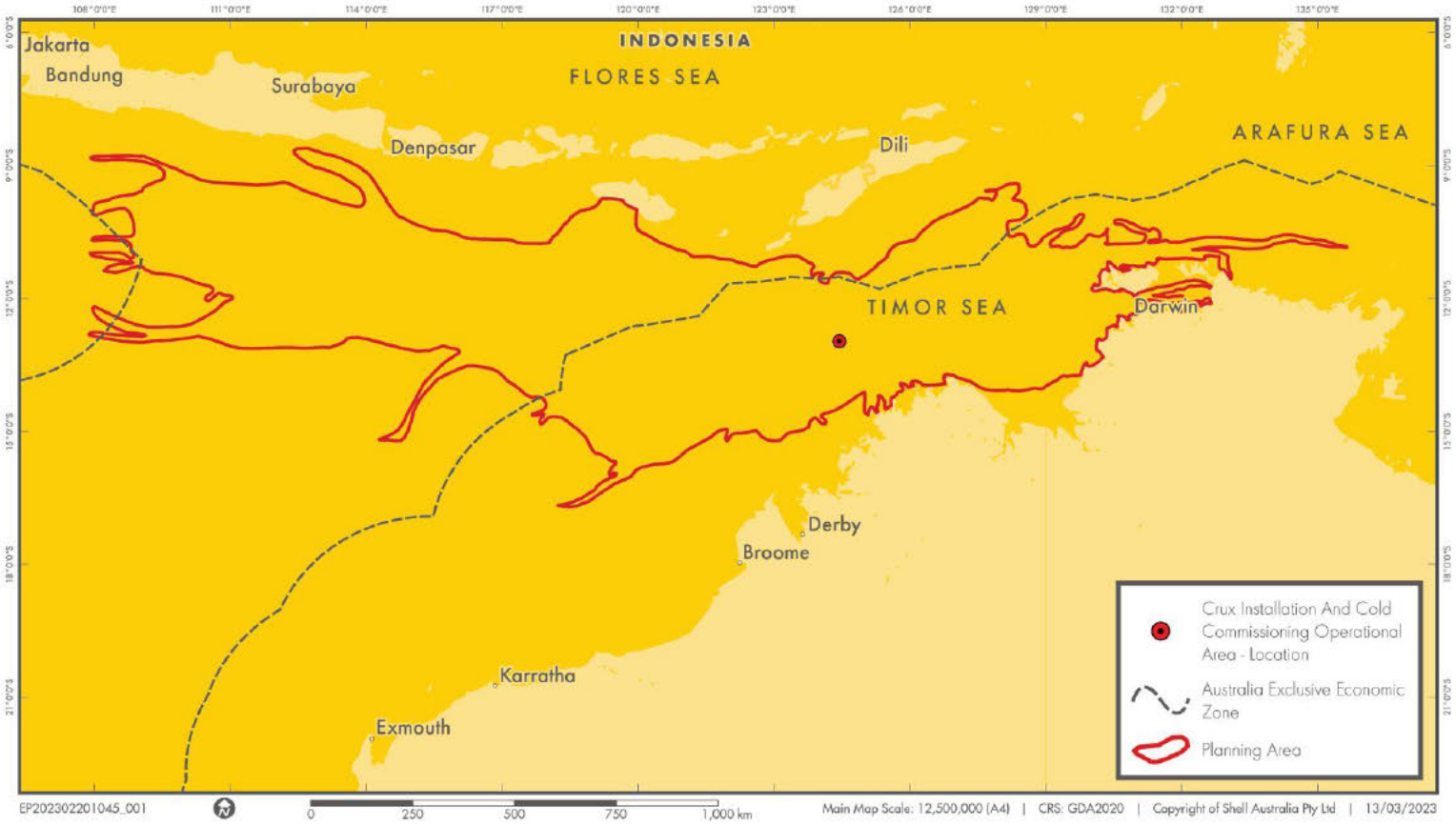
4. Crux Installation and Cold Commissioning Environment Plan



Shell is planning to install the Crux pipeline, substructure and Topsides.

The facility will commence cold commissioning once installation is complete.

Duration: Mid 2024 – Dec 2026
Timing: start mid 2024, pending regulatory approvals.

Dates for the commencement of activities and duration are subject to schedule change

4. (cont.) Crux Installation and Cold Commissioning Environment Plan

Key activities

Crux pipelay

Installation of 26-inch export pipeline (~165 km long) from Prelude to Crux

Vessel operations

Pre- and post-lay geophysical surveys

Pipeline hydrotest, preservation and associated discharges

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4. (cont.) Crux Installation and Cold Commissioning Environment Plan

Key activities

Substructure Installation

Construction Vessel

DLV2000

Support Vessels

Pile Transport barge, Tugs, Supply Vessel

Jacket Transport & Launch

Transported on Launch Barge + approximately 3 Tugs

Activity includes pile driving and pile drilling

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4. (cont.) Crux Installation and Cold Commissioning Environment Plan

Key activities

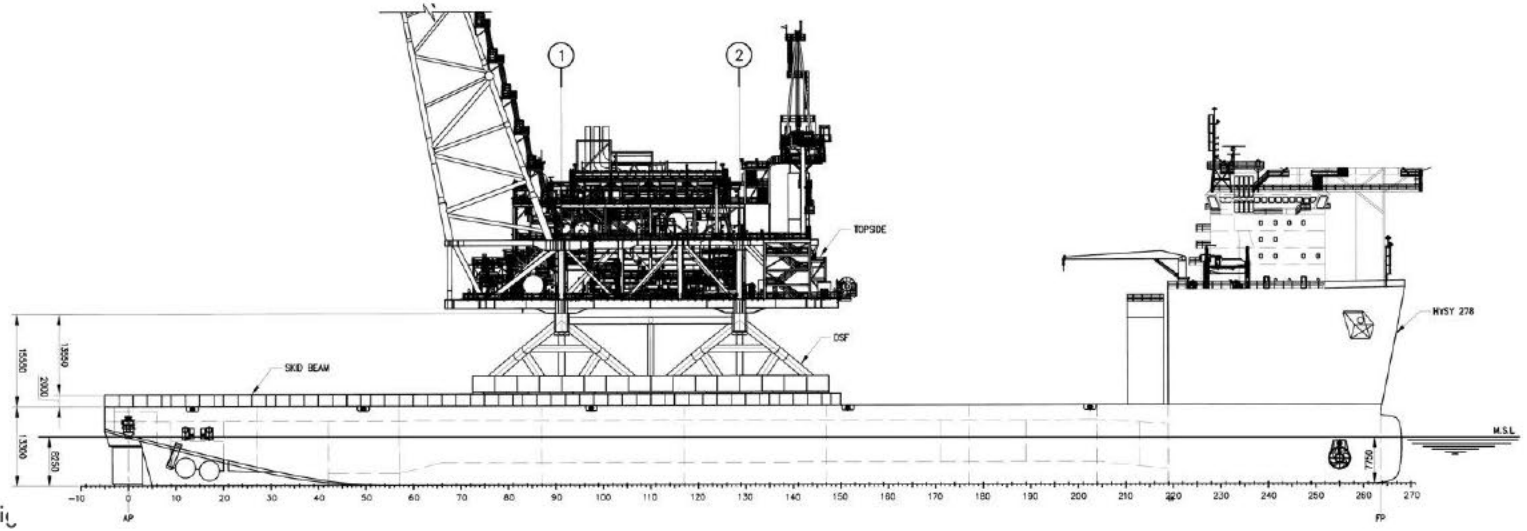
Topsides Installation

Float Over Installation Vessel

HYSY 278 (or similar)

Support Vessels

Tugs/Supply Vessel



4. (cont.) Crux Installation and Cold Commissioning Environment Plan

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Noise

Scope include multiple vessel operations and a piling campaign which results in underwater noise.

Key controls:

During piling operations, start-up and shutdown procedures will be adopted which consider approach by sensitive species and actions taken when species approach.

Vessel interactions with threatened and migratory species to follow the of EPBC Regulations 2000 – Part 8 Division 8.1 (Regulations 8.05 and 8.06). In particular:

Support vessels will not deliberately approach closer than 50 m to a dolphin, turtle or whale shark; 100 m for an adult whale; 300 m for a whale calf; and 150 m for a dolphin calf.

If the whale, dolphin, turtle or whale shark shows signs of being distressed, support vessels will immediately withdraw from the caution zone at a constant speed of less than 6 knots.

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Crux Environment Plan – Unplanned Events

Unplanned	
Emergency Events – Hydrocarbon Spill	▪ Align with relevant requirements from the International Convention for the Prevention of Pollution from Ships and subsequent regulations ▪ Valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) ▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Offshore Vessel Inspection Database (OVID) process ▪ Australian Hydrographic Office Notice to Mariners ▪ NOPSEMA accepted Environment Plan and Oil Pollution Emergency Plan (OPEP) in place ▪ Relevant Persons consultation process ▪ Vessel Maintenance management system
Introduction of Invasive Marine Species from Vessels	▪ Ballast water exchange operations will comply with the international conventions and associated national regulations. ▪ Biofouling management for vessels in accordance with state, national and international biofouling management guidelines ▪ Biofouling management in compliance with state and commonwealth regulations ▪ Vessels (of appropriate class) will have a valid International Anti-Fouling System Certificate ▪ Maintenance of a minimum 1 km buffer from shoals and the Operational Area

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Crux Environment Plans – Additional Information

Additional information is available on the **Shell Crux Website**:

Factsheets on each individual Environment Plan.
Drafts of the Environment Plans, as they become available.

www.shell.com.au/crux

Independent technical environmental assistance:

Shell has engaged several local Environmental Consultancies to provide support to Traditional Owners in the interpretation, guidance and fundamentals of the Crux Environment Plans.
Groups or individuals are encouraged to use these resources directly.
Introductions – Consultants

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Q&A

CONTACT US Community Hotline: 1800 059 152 Email: SDA-crux-project@shell.com **www.shell.com.au/crux**

Shell welcomes any feedback on Environment Plan submissions, including requests for further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

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Appendix A - 7.04 Presentation – Indigenous Forum 2 in Broome

SHELL CRUX PROJECT
Broome meeting

Welcome & Housekeeping

Exits
Toilets
Facilitators

Acknowledgement of Country

Shell acknowledges Yawuru people as the Traditional Custodians of the land and sea country in and around Broome, since the time before time, and the importance of their connection to land, sea and community.

We pay our respect to Elders past, present and emerging and extend that respect to all Aboriginal and Torres Strait Islander people today.

This is Yawuru Country

WHY ARE WE HERE TODAY?

Overview of why we are here / the day agenda

There will be a bit of info today – no pressure to comment today (but can if you have any questions or comments).

- Desired outcome is that you all walk away understanding who Shell is and our Crux Project.
- How Shell is going to deliver the Crux Project
- How the Crux Project might affect you and your people
- To let Shell know of any concerns you may have about the project that you would like us to take into consideration (today) or at the very least take away what you might need to know to discuss with your community.

Things to cover today

- Who is Shell?
- What is Crux?
- What are the main components of Crux?
  - Seabed survey
  - Drilling template
  - Drilling development
  - Commissioning

- Crux Environmental Plans
- Cultural heritage, marine systems, coastlines, TO access to country – what is Shell doing?

- Options for meeting with Shell – forums, on-Country, use of the Panel, direct and one-on-one.
- Independent Panel – Andrew, Sam, Richard.

Shell Australia – Crux Project Forum
Bruce Lockyer

Wednesday 10 May 2023

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Definitions & cautionary note

Cautionary Note

The companies in which Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell Group" and "Group" are sometimes used for convenience where references are made to Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. "Joint ventures" and "joint operations" are collectively referred to as "joint arrangements". Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

Forward-Looking Statements

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", ''anticipate'', ''believe'', ''could'', ''estimate'', ''expect'', ''goals'', ''intend'', ''may'', "milestones", ''objectives'', ''outlook'', ''plan'', ''probably'', ''project'', ''risks'', "schedule", ''seek'', ''should'', ''target'', ''will'' and similar terms and phrases. There are a number of factors that could affect the future operations of Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this [report], including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, judicial, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Shell plc's Form 20-F for the year ended December 31, 2021 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this [report] and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 27 April 2023. Neither Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

Shell's net carbon footprint

Also, in this presentation we may refer to Shell's "Net Carbon Footprint" or "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" or "Net Carbon Intensity" are for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Footprint (NCF) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCF target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as [cash capital expenditure] and [divestments]. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

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Shell Australia's Footprint

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with relevant persons who may be impacted by the activities we are proposing in relation to the development of the Crux project.

We are consulting on four Environment Plans:

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan
3. Development Drilling Environment Plan
4. Crux Installation and Cold Commissioning Environment Plan

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Prelude – Overview

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.
- The Prelude FLNG facility is operated by Shell Australia in joint venture with Inpex, OPIC and Kogas.
- The Prelude Joint Venture has executed agreements to allow for processing of Crux hydrocarbons, which are expected to commence in 2027.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 1.3 mtpa LPG, 1.3mtpa condensate

Water depths:
250m

Status:
In operation

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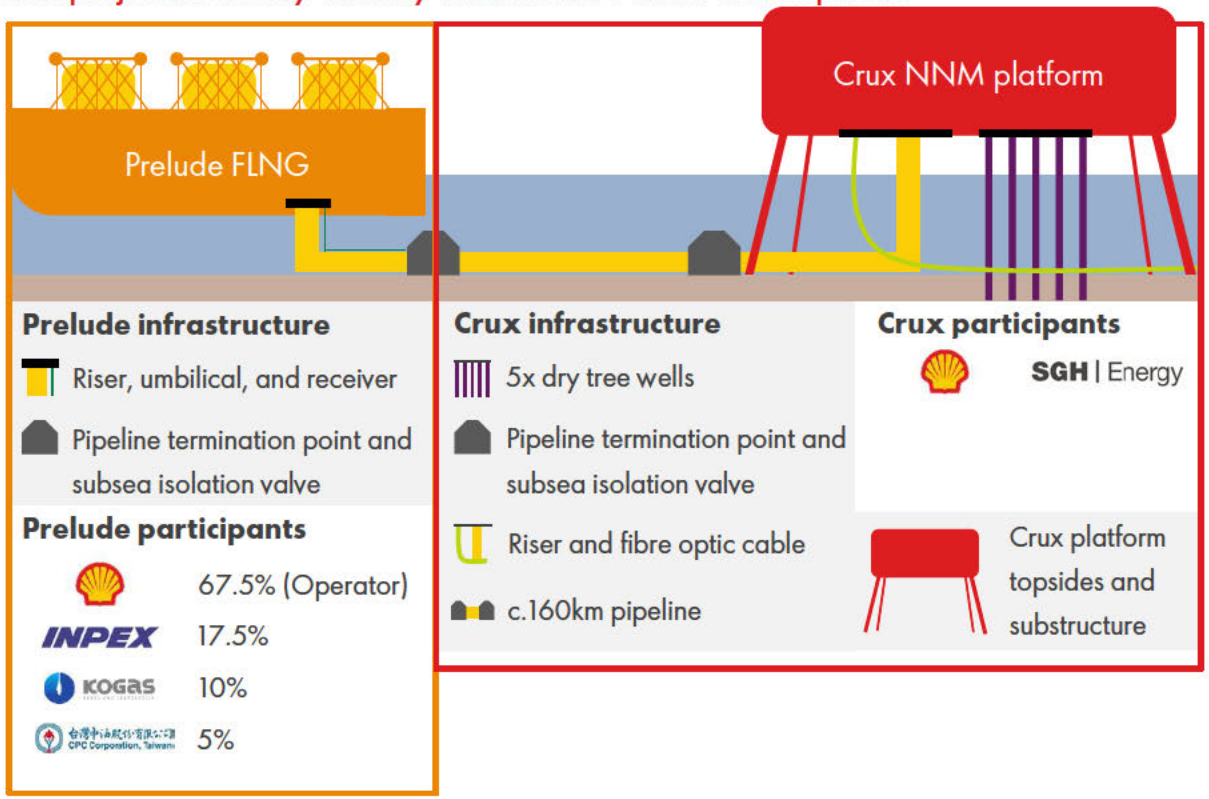
Prelude and Crux

Crux will use Prelude FLNG's existing infrastructure to enable maximum efficiency and production

Crux project boundary and key infrastructure under development



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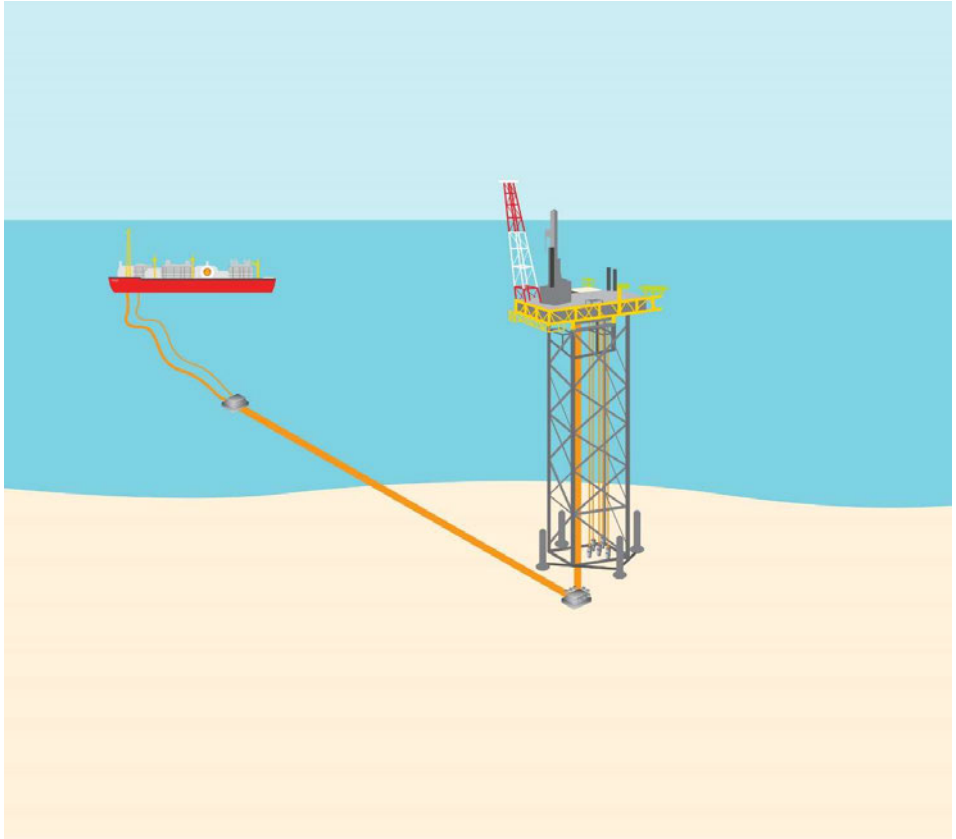
Crux update

- In May 2022, Shell Australia and SGH Energy took final investment decision to approve the development of Crux.
- The project is an important long term extension to the existing Prelude FLNG facilities. The proposed concept is an unmanned platform with minimal facilities, remotely operated from the Prelude FLNG.
- The project aligns with Shell's strategy and forms an important part of Shell's gas portfolio and will help meet the needs of gas users as the energy market transitions to a lower carbon future.
- The natural gas from Crux and Prelude will be a key part of how we help move Asian customers from coal to gas as a cleaner burning fuel.



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Why are we here today?

As part of the Environment Plan approvals process, Shell is undertaking consultation with people who may be impacted by the proposed activities in relation to the development of the Crux project. ca0

There are four Environment Plans:

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan
3. Development Drilling Environment Plan
4. Crux Installation and Cold Commissioning Environment Plan

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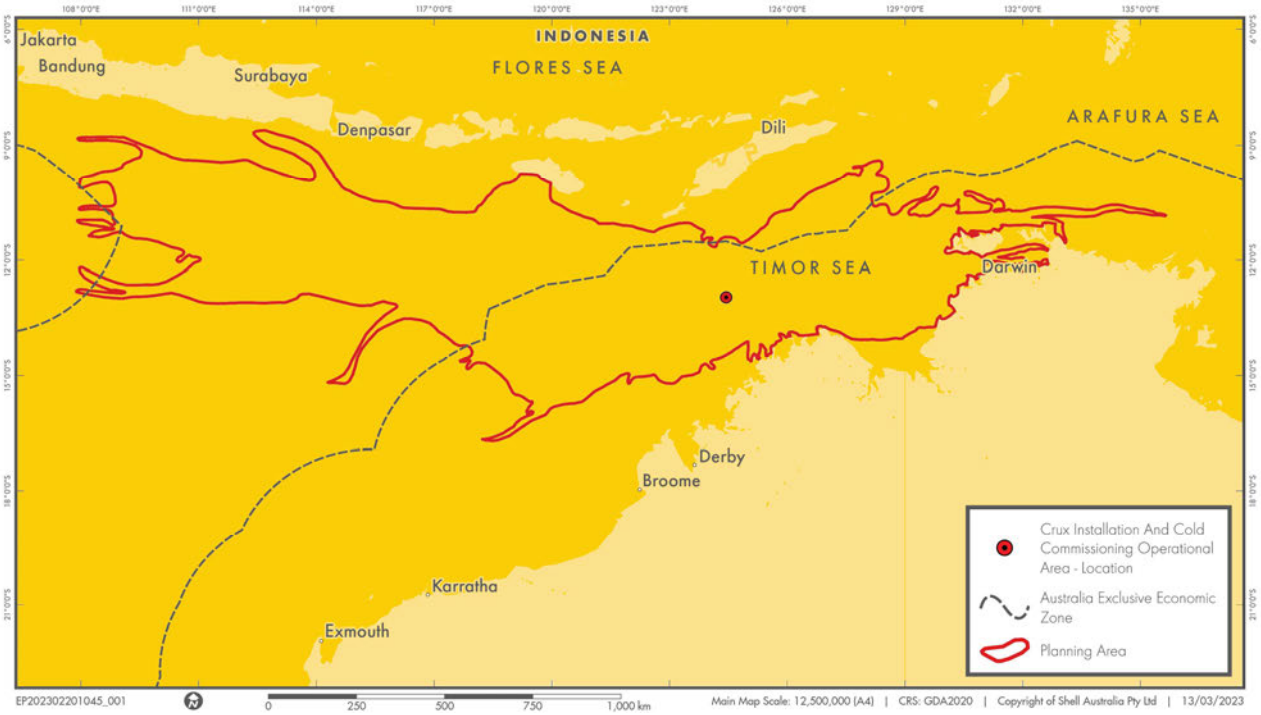
Crux Environment Plans

These describe the impacts and risks, both planned and unplanned that may occur



Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area.

Unplanned risks include events that may occur as a result of an incident i.e:

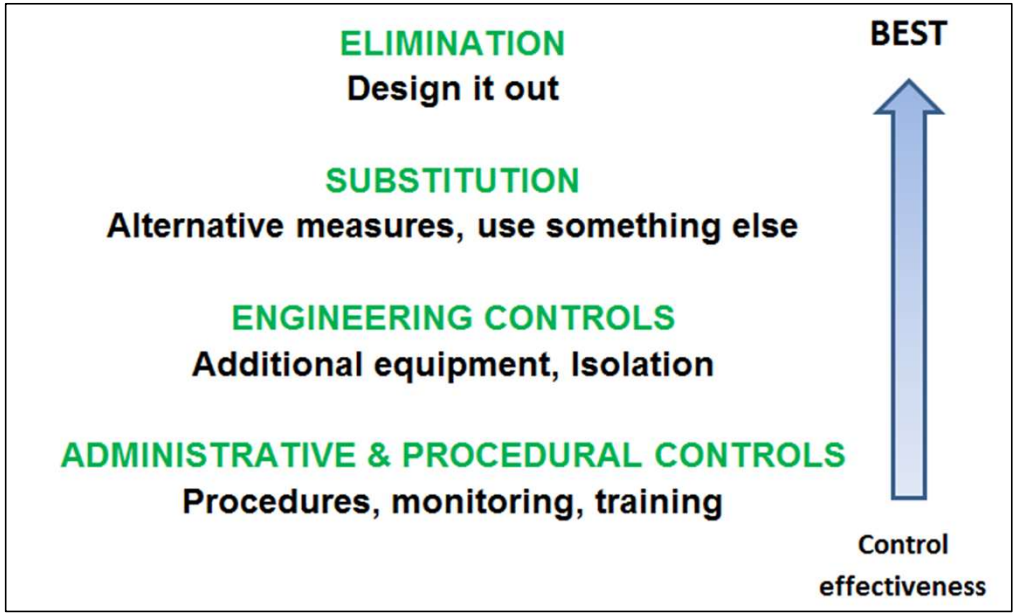
- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.

These unplanned events are very rare however are necessary to described to ensure adequate controls are adopted – these unplanned events define the **Planning Area**.

Each EP describes the controls that are adopted to mitigate both the planned impacts and unplanned risks to as low and reasonably practicable.

Crux Environment Plans

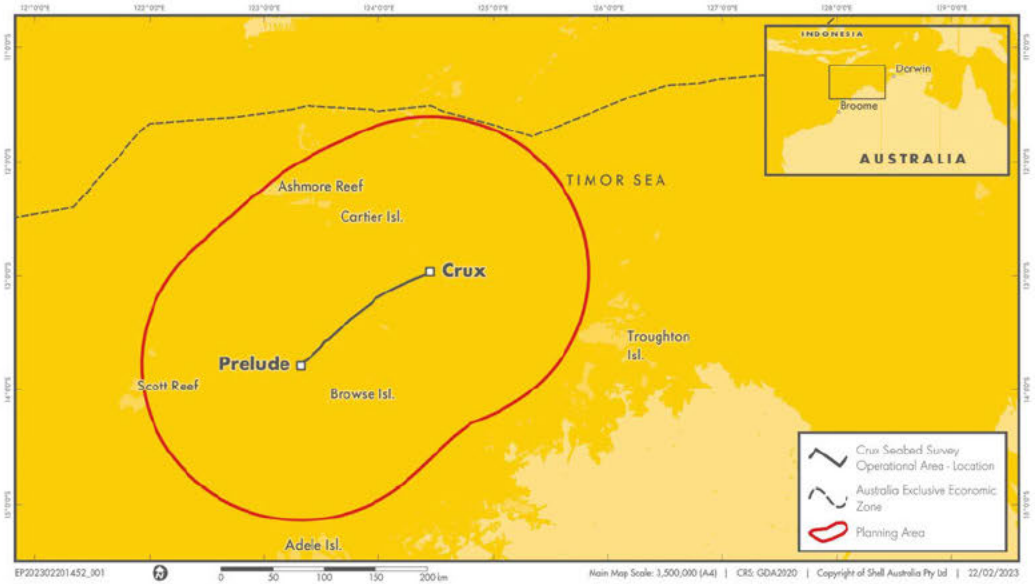
how we reduce risks

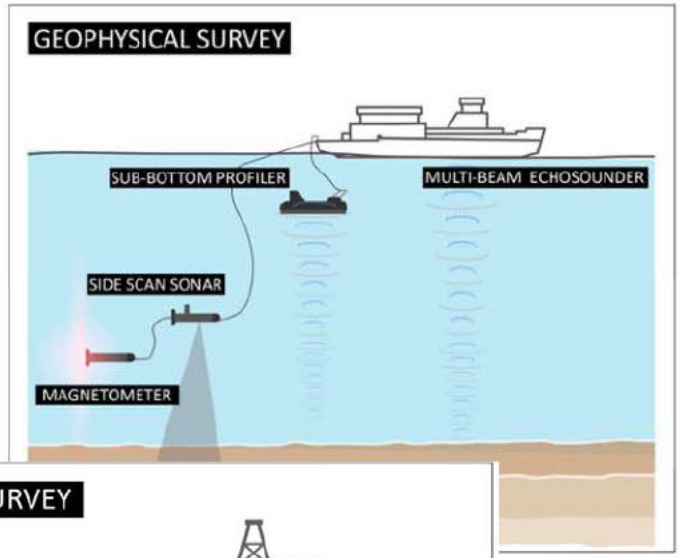


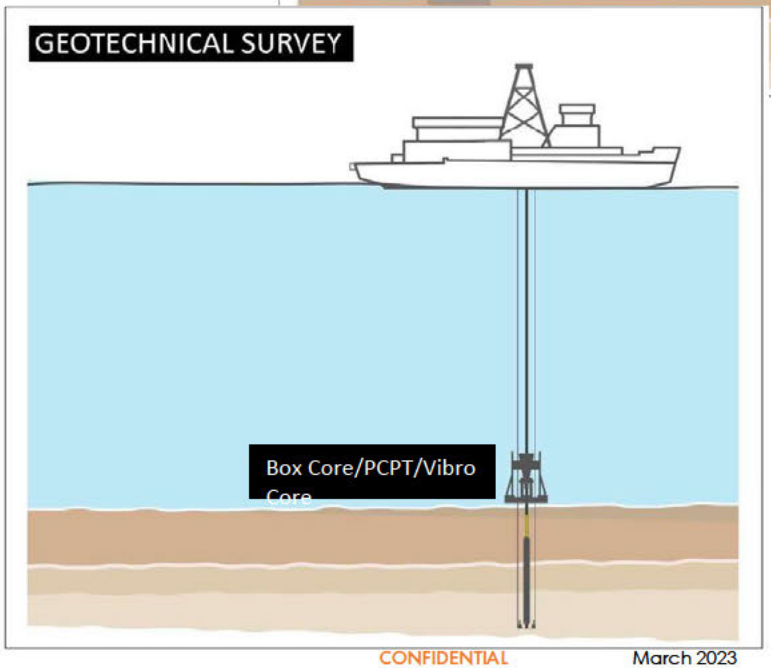
Shell applies a hierarchy of control process to establish controls which mitigate environmental impacts and risk.

1. Crux Seabed Survey Environment Plan

Investigating the seabed and sub-seabed conditions







Activity: Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

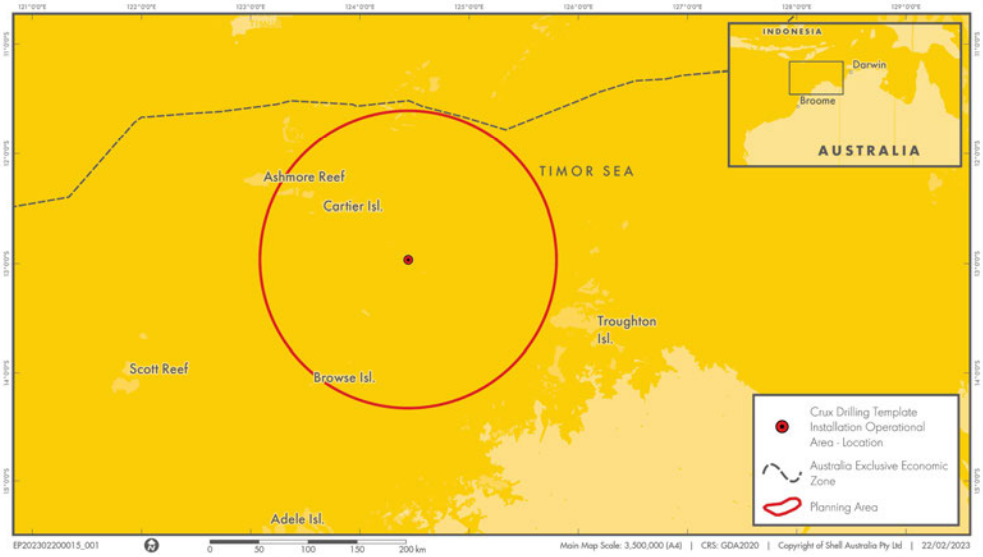
A vessel will traverse the pipeline route, towing survey equipment and deploying coring equipment.

Duration: <5 days

Timing: 1 May – 31 December 2023*

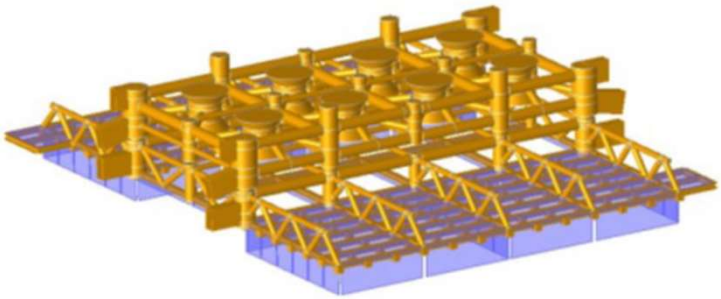
2. Crux Drilling Template Installation Environment Plan

A template which will act as a guide for the drill bit during drilling operations



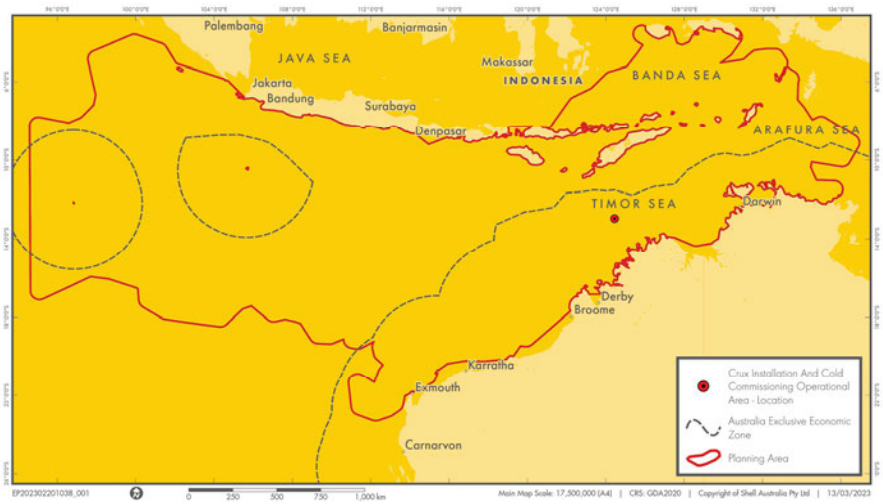
Activity: Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux jacket.

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2. It weights 200 tonnes



Duration: <7 days **Timing:** 1 September 2023 – 1 April 2024*

3. Crux Development Drilling Environment Plan

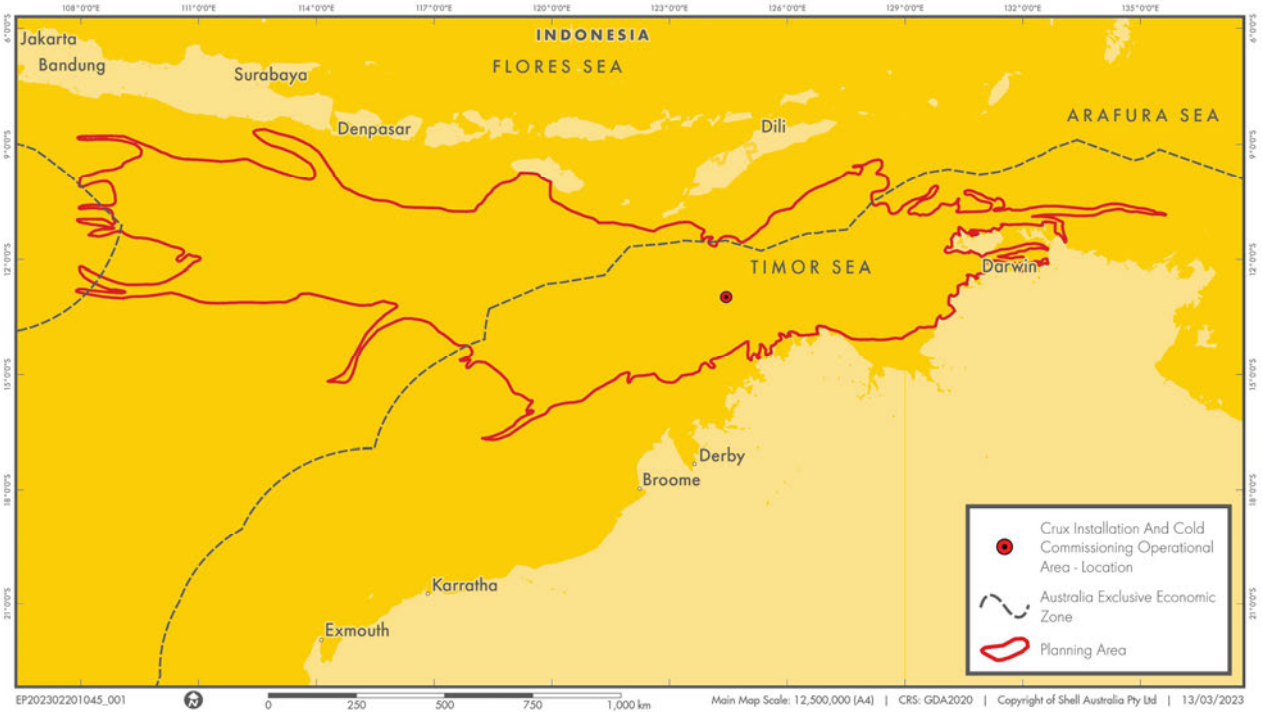


Activity: Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Timing:

- Expected Mobile Offshore Drilling Unit Operations start date – end 2023 - early 2024.
- Duration: approximately 10 months, with 10 months contingency.
- Expected temporary well suspension period, approximately 2-3 years.

4. Crux Installation and Cold Commissioning Environment Plan



Shell is planning to install the Crux pipeline, substructure and Topsides.

The facility will commence cold commissioning once installation is complete.

Duration: Mid 2024 – Dec 2026
Timing: start mid 2024, pending regulatory approvals.

Dates for the commencement of activities and duration are subject to schedule change

4. (cont.) Crux Installation and Cold Commissioning Environment Plan
Key activities

Crux pipelay

- Installation of 26-inch export pipeline (~165 km long) from Prelude to Crux
- Vessel operations
- Pre- and post-lay geophysical surveys
- Pipeline hydrotest, preservation and associated discharges

Crux Environment Plan – Unplanned Events

Unplanned	
Emergency Events – Hydrocarbon Spill	▪ Align with relevant requirements from the International Convention for the Prevention of Pollution from Ships and subsequent regulations ▪ Valid Shipboard Oil Pollution Emergency Plan or Shipboard Marine Pollution Emergency Plan (as appropriate for vessel classification) ▪ Implementation of national and international regulations and conventions for collision prevention, safety and navigation at sea ▪ Offshore Vessel Inspection Database (OVID) process ▪ Australian Hydrographic Office Notice to Mariners ▪ NOPSEMA accepted Environment Plan and Oil Pollution Emergency Plan (OPEP) in place ▪ Relevant Persons consultation process ▪ Vessel Maintenance management system
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Crux Environment Plans – Additional Information

Additional information is available on the **Shell Crux Website**:

www.shell.com.au/crux

Independent technical environmental assistance:

- There is an independent panel, who you can go to with questions, concerns and complaints. Its anonymous, unless you want it not to be. These consultants don't work for Shell and will comment freely on their project, give their opinion and help answer your questions.

Q&A

CONTACT US Community Hotline: 1800 059 152 Email: SDA-crux-project@shell.com **www.shell.com.au/crux**

Shell welcomes any feedback on Environment Plan submissions, including requests for further information. If you have functions, interests or activities that may be affected by any of our projects, Shell Australia invites you to get in touch.

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Indigenous Consultation

Additional information

Jaimie Henderson
Corporate Relations Lead

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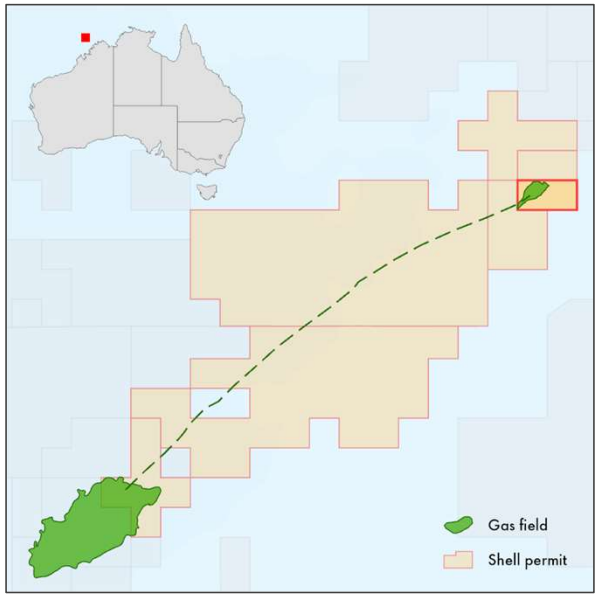
Crux Operations

Investigating the likelihood of tangible underwater archaeology

Crux field overview



What we know

- Database searched have been undertaken through the WA and NT government systems for registered sites. While many intersect with the larger planning areas, there are no sites currently registered within the operational area.
- Crux operational footprint is below the historical seabed levels (below 130m sea level) meaning that there is a very high unlikelihood that there is any tangible cultural heritage – the area was never above sea levels when human occupation existed.
- Further work is in the process of being commissioned from a mapping perspective on what tangible underwater cultural heritage could remain intact.

What we don't know

- Any concerns for particular areas and sites that may exist for each relevant person
- Perceived effectiveness of our current management methods

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Options for Engagement

- Understand a lot of proponents have been reaching out desiring consultation
- Shell want to make it as easy as possible for our Indigenous relevant persons to engage
- There are a variety of options available for which to hear about the project and be consulted – this forum is but one option.
- Once you've had time to consider information there are many options for next steps:
  - Community drop-in centres,
  - Traditional methods (phone, emails, video calls)
  - On-Country visits

We are happy to work with each group's individual preference so please let us know.

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Environmental Panel

A panel of subject matter experts has been established and Indigenous relevant persons will be provided access to the panel, with the costs incurred by Shell.

Information is sometimes specialized and Shell wants to ensure that each person or group is comfortable and confident in their understanding of the more technical components.

The panel:

- is comprised predominantly of businesses and specialists who are independent of Shell although there is some who have previously worked for Shell
- Costs to be covered by Shell
- Selection of what panel member to be used is at the discretion of the client (you)
- You will be the panel's clients – Shell will not see any of the information shared, or advice sought between the panel and the client, only the amount of hours worked and to which party the avice was provided for acquittal purposes.

Our aim is that the information provided by the panels will ensure that our Indigenous relevant persons have access to all the relevant information to provide feedback on our Crux EP**.**

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Shell Crux Project Forum 1

- Meeting the Independent Environmental Panel Experts

About Us

- Xodous
- MCC Environmental
- S2Services
- RPS

How can we help

Q&A's

Q&A

Appendix A - 7.05 Presentation – Indigenous Forum 3 in Darwin

SHELL CRUX PROJECT
Darwin
31 May 2023

This is Larrakia Country

Shell acknowledges the Larrakia people people as the Traditional Custodians of the land and sea country, since the time before time, and the importance of their connection to land, sea and community.

We pay our respect to Elders past, present and emerging and extend that respect to all Aboriginal and Torres Strait Islander people today.

Brief summary

- Who is Shell?
- What is the Crux Project, and how might it affect the environment?
  - Seabed survey
  - Drilling template
  - Drilling development
  - Installation and Commissioning

The Shell Crux Environmental Plans

- What Shell is doing to protect cultural heritage, marine systems, coastlines, TO access to country

- Options after today
- Ongoing consultation and the Independent Panel

Who is Shell?

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

What is Prelude?

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 0.4mtpa LPG 1.3mtpa condensate

Water depths:
250m

Status:
In operation

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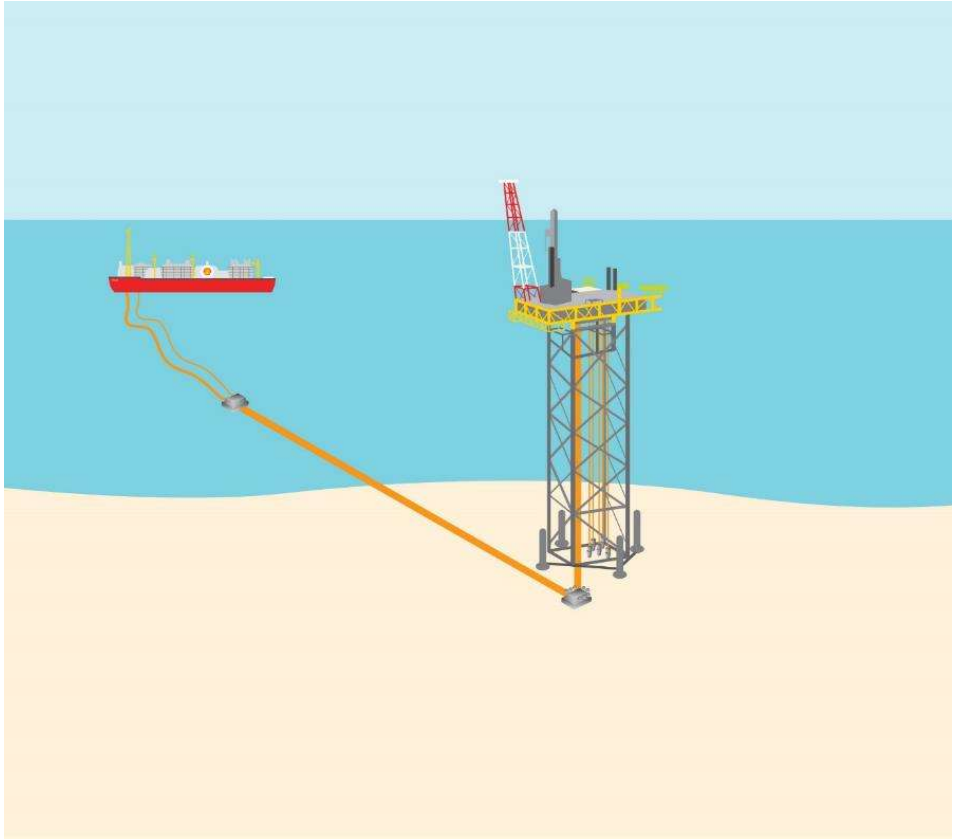
What is Crux?

- In May 2022, Shell Australia and SGH decided to go ahead with Crux.
- The project is a long term extension to the existing Prelude FLNG facilities.
- Crux consists of a platform (which is not normally manned), above 5 gas wells. The gas is delivered via a pipeline to Shell's Prelude project, which is moored some 165 Km away, and processed onboard.
- The project is part of Shell's strategy to help meet the needs of gas users as the energy market moves to a lower carbon future.



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The environmental plans

There are four Environment Plans for Crux that describe what Shell will do to protect the environment.

These must be submitted to, and approved by NOPSEMA. This consultation is a key part of that process. NOPSEMA has a key role in the approvals process and has the power to approve and reject environmental plans. They also have the power to ensure Shell implements all the requirements of the Environmental Plans, and can enforce these by law.

1. Seabed Survey Environment Plan
2. Drilling Template Environment Plan
3. **Development Drilling Environment Plan**
4. **Crux Installation and Cold Commissioning Environment Plan**

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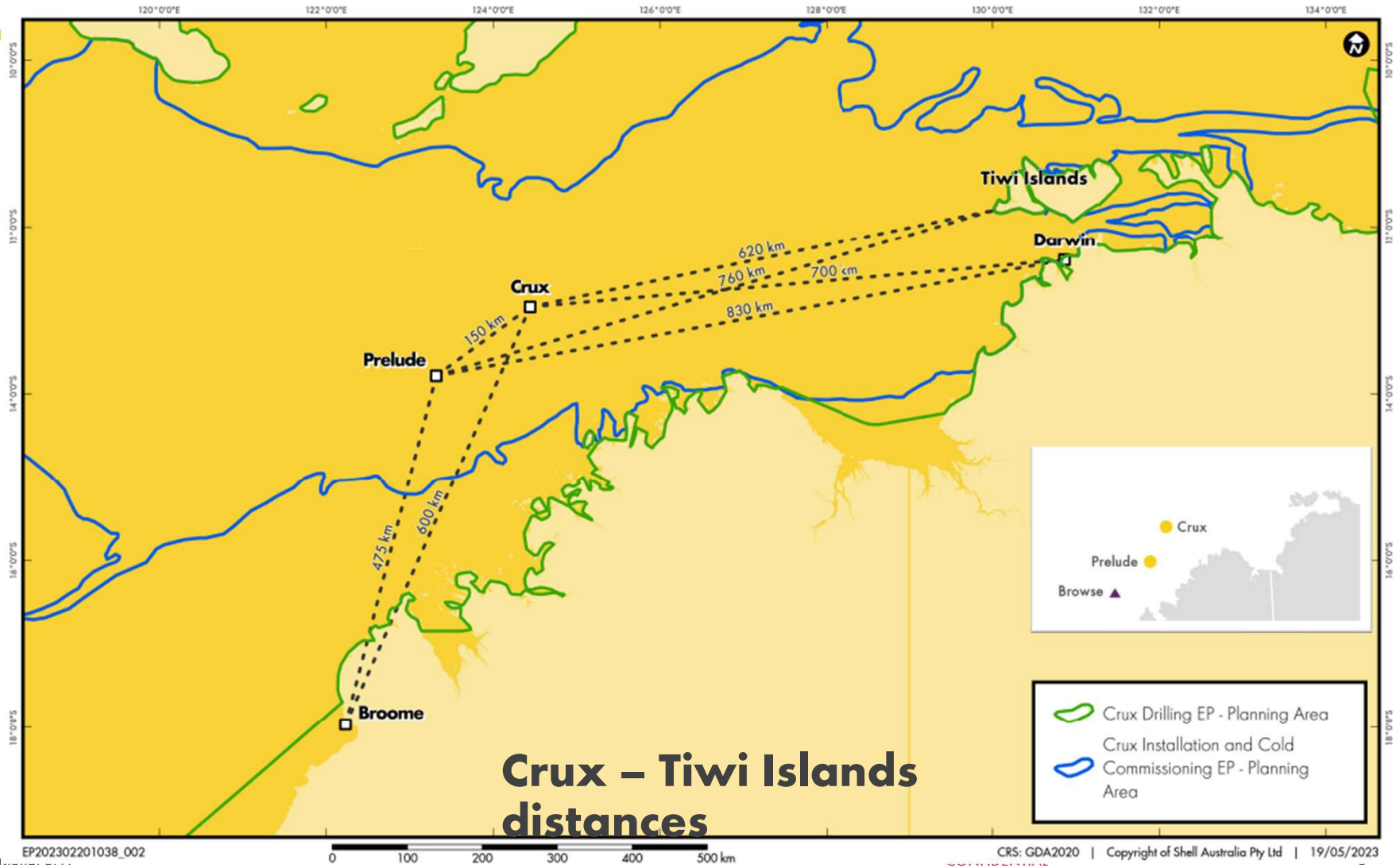

Crux – Tiwi Islands distances

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Crux Environment Plans

These describe the impacts and risks, both planned and unplanned that may occur

Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.
- These planned impacts will occur within close proximity to the operational area.

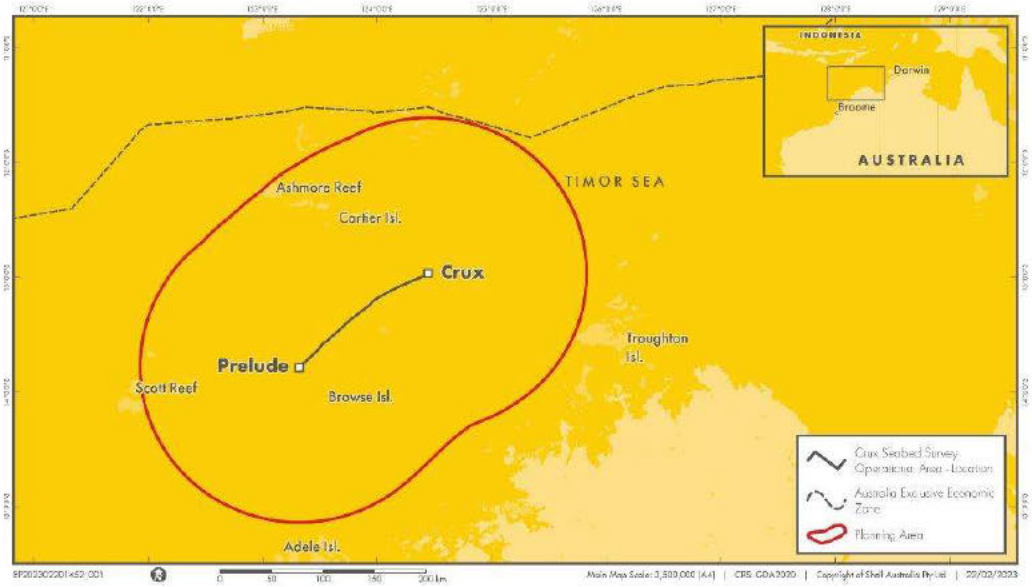
Unplanned risks are accidents. These could include:

- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.
- Introduction of invasive species from the vessels that will be entering Australian waters.

Such accidents are very rare however, Shell has to be prepared for them, to ensure they have adequate controls. Potential accidents are what define the whole of the **Planning Area**.

Each Environmental Plan describes how Shell plans to minimize planned impacts and keep unplanned risks to as low and reasonably practicable.

1. Crux Seabed Survey Environment Plan -
Looking at the seabed and sub-seabed conditions



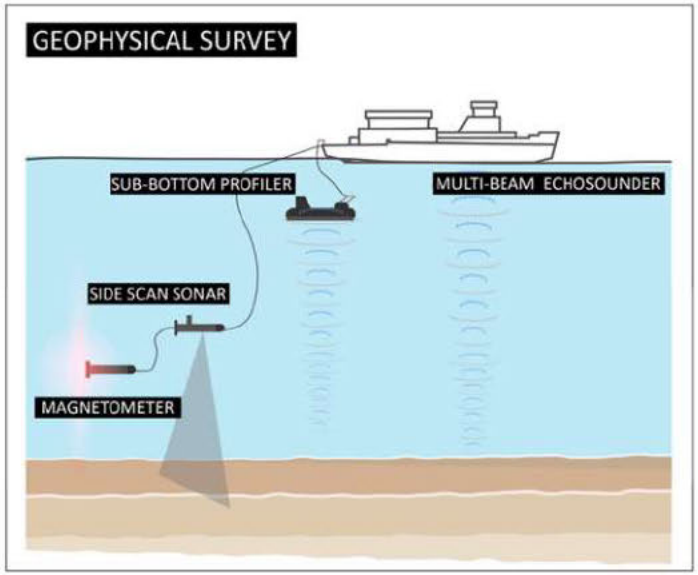
Activity: Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

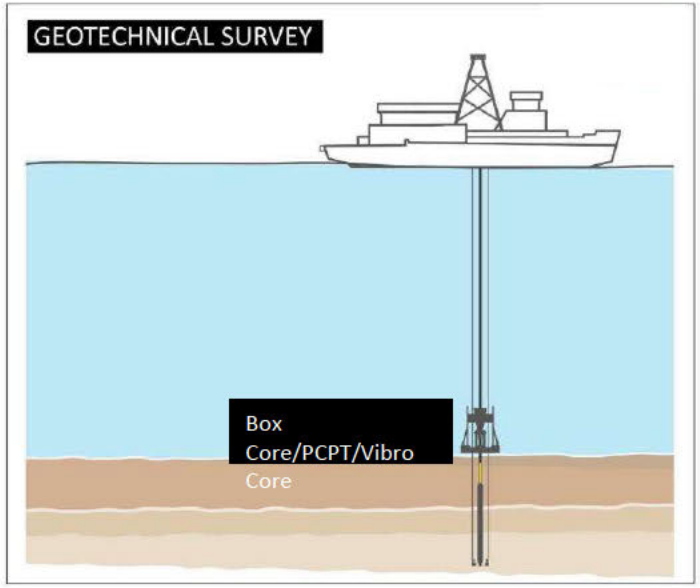
A vessel will traverse the pipeline route, towing survey equipment and deploying coring equipment.

Duration: <5 days

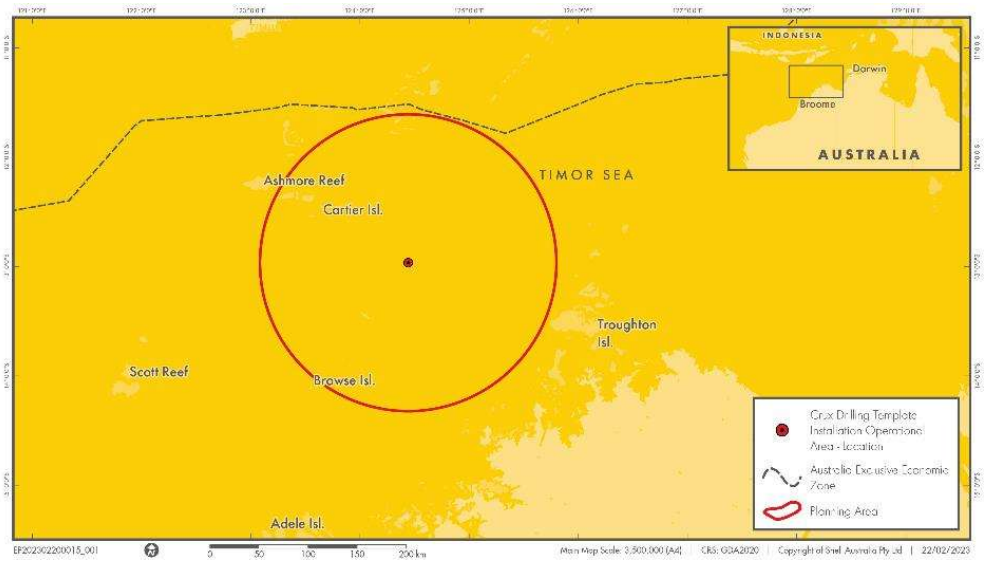
Timing: 1 July – 31 December 2023*

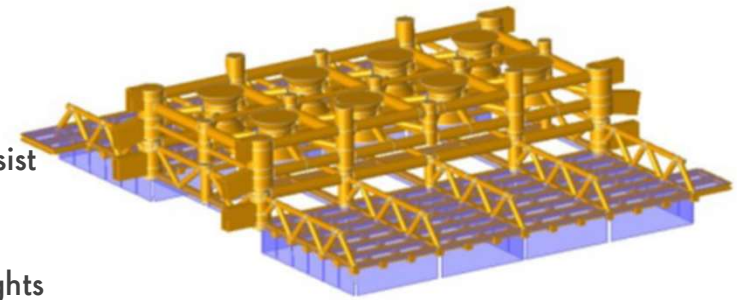
Key points





2. Crux Drilling Template Installation Environment Plan -
The template will act as a guide for the drill bits during drilling operations





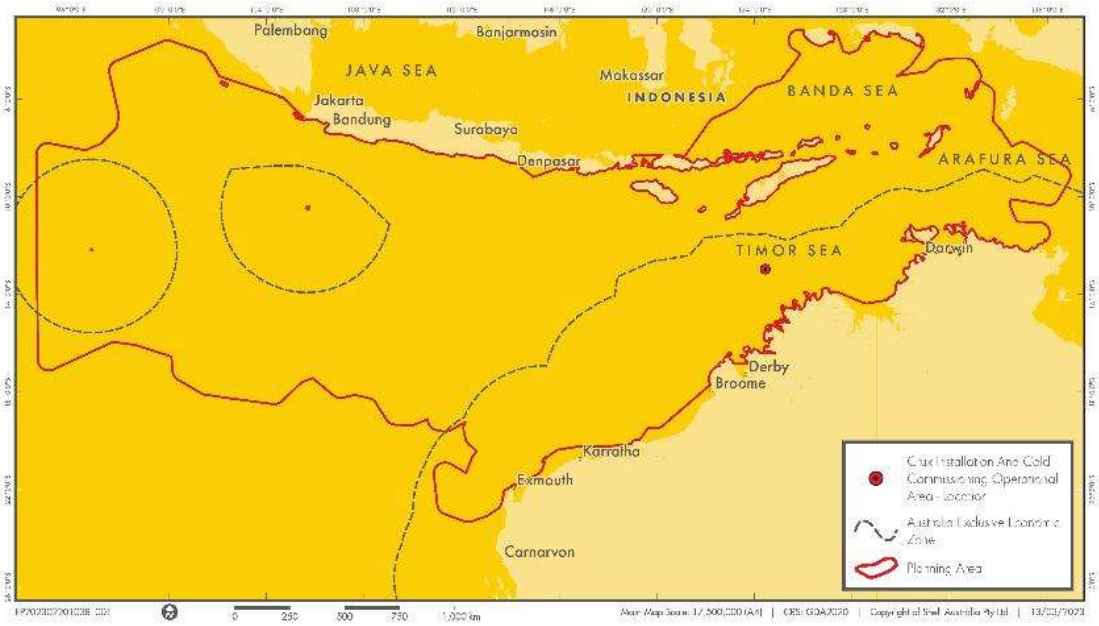
Activity: Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux platform.

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2. It weights 200 tonnes

Duration: <7 days **Timing:** 1 September 2023 – 1 April 2024*

Key points

3. Crux Development Drilling Environment Plan – drilling the wells



Graphic showing individual spill – show NOPSEMA video here:

https://www.nopsema.gov.au/offshore-industry/environmental-management/oil-pollution-risk-management

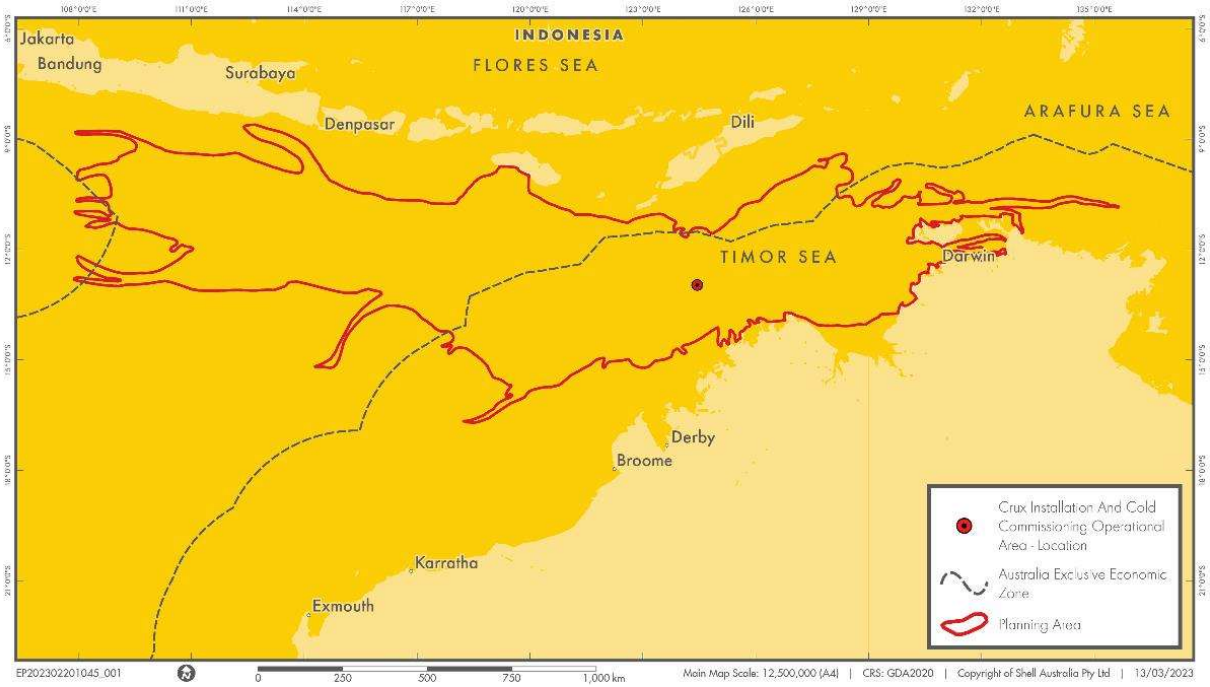
Activity: Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Duration: approximately 10 months, with 10 months contingency. Expected temporary well suspension period, approximately 2-3 years.

Timing: Expected Mobile Offshore Drilling Unit Operations start date – end 2023 - early 2024.

Key point

4. Crux Installation and Commissioning Environment Plan – putting in the pipeline and substructure and checking everything works



The facility will commence cold commissioning(testing) once installation is complete.

Duration: Mid 2024 – Dec 2026

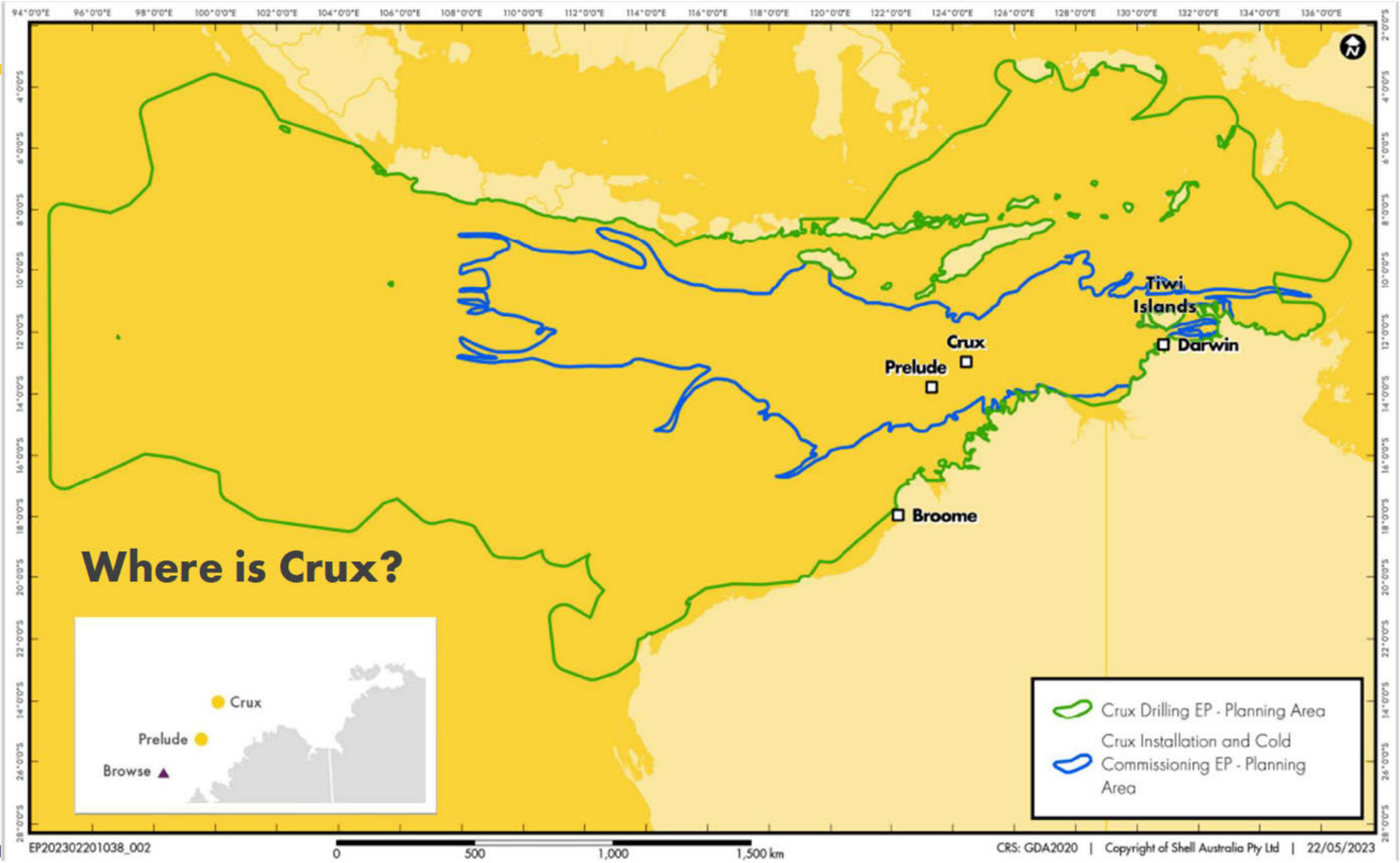
Timing: start mid 2024, pending regulatory approvals.

Key points

Dates for the commencement of activities and duration are subject to schedule change

Crux pipelay

- Putting in the 26-inch export pipeline (~165 km long) from Prelude to Crux
- Vessel operations
- Pre- and post-lay surveys
- Testing it all



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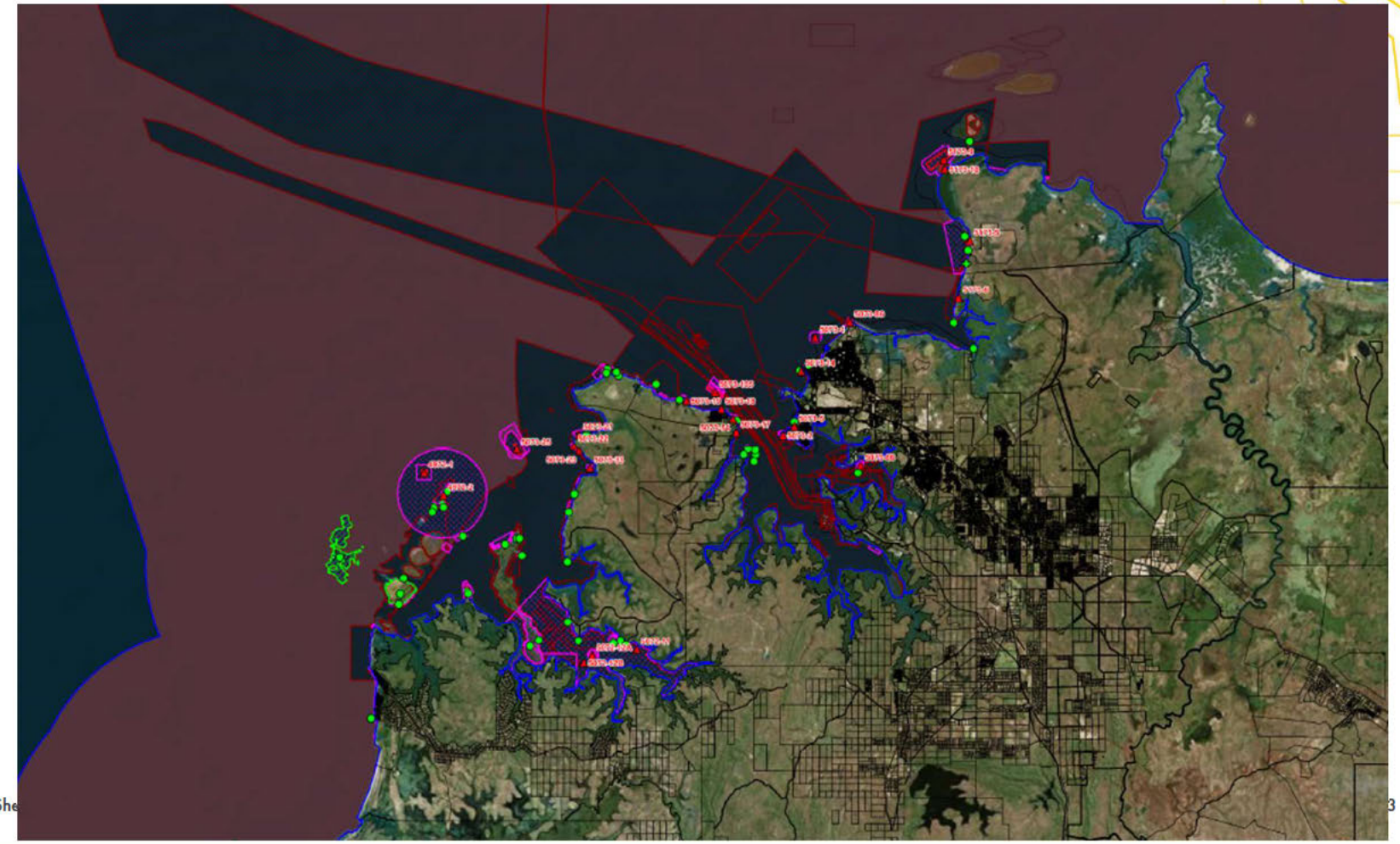
Crux Operations - Protecting land and sea Country.



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Crux Operations - Protecting land and sea Country.

There are places, histories, stories and sites that are important to Aboriginal people in the Crux Planning area. Shell is seeking to understand this, using

- Healthy Country plans,
- Native Title Determinations,
- ILUAs and IPAs
- Cultural Heritage Surveys and Assessments

Shell is also listening directly with Aboriginal people.

Underwater Cultural Heritage

- Shell have searched the WA and NT government systems for registered sites. While many intersect with the larger planning areas, there are no **UCH sites currently registered within the operational areas.**
- The Crux platform is below the historical seabed levels (below 130m sea level). **Its very unlikely there are tangible cultural heritage that far out to sea – the area was never above sea levels when human occupation existed.**
- Further work is being done on what tangible UCH could be in the **broader planning area**
- Shell still needs to understand sites and places that have spiritual and sacred importance

What Shell doesn't know

- Shell's understanding of what is important to Aboriginal people is limited and partial.
- Shell doesn't fully understand the concerns Aboriginal people have for particular areas and sites, especially as these differ from group to group.
- If Shell's current management methods are good enough

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Shell Community Programs relevant to NT & Tiwi Islands

Prelude to the future (Darwin)

- Qualifications and training in areas of skills shortage for to get people employed
- Shell co-funds the program with Department of Trade, Business and Innovation, and Group Training NT (GTNT) run the program.
- 70 of the 83 graduates have gained full time work since the program commenced in 2016
- A sixth group intake focussing on areas of skills shortage will occur in the second half of 2023.

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Shell Community Programs relevant to NT & Tiwi Islands

Indigenous Business Support Program – Darwin

- TOs have said they want pathways to jobs and business opportunities for economic independence.
- The IBS program is delivered by Northern Territory Indigenous Business Network (NT IBN) and supported by Shell as part of Shells social investment portfolio.
- The program provides business development, training and networking services.

Lidiar Group – Darwin and Brisbane

- Enterprise development support available for Indigenous businesses within our supply chain.
- Assist with retaining and growing genuine Indigenous business opportunities within our supply chain.

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Environmental Panel

A panel of subject matter experts has been established.
Indigenous relevant can use the panel, with the costs incurred by Shell.

Shell wants to ensure that anyone can ask whatever they like from people who are not part of Shell, but who are experts in the areas of environmental protection .

The panel made up of specialists who are independent of Shell although there is some who have previously worked for Shell.

Key points to know:

- Costs to be covered by Shell
- Selection of what panel member to be used is up to you
- You will be the panel's clients – Shell will not see any of the information shared, or advice sought between the panel and the client, only the amount of hours worked and to which party the advice was provided for acquittal purposes.

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Crux Environment Plans – Additional Information

Additional information is available on the **Shell Crux Website**:

www.shell.com.au/crux

Independent technical environmental assistance:

- There is an independent panel, who you can go to with questions, concerns and complaints. Its anonymous, unless you want it not to be. These consultants don't work for Shell and will comment freely on their project, give their opinion and help answer your questions.

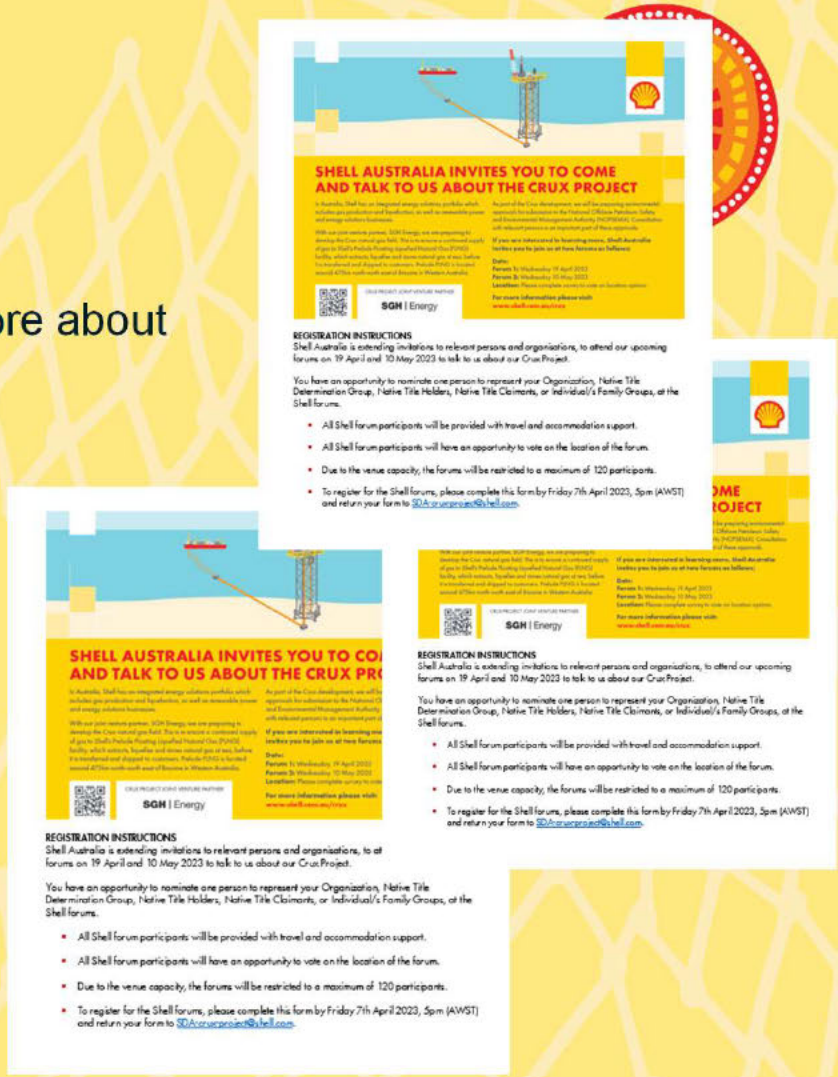
Shell Crux Project

After this?

- Possible further meetings – let Shell know
- Talk to your communities
- Ask questions of the Panel
- Ask questions of Shell what you want to know more about or have concerns
- Info on the web

Email:
SDA-crux-project@shell.com

Web:
- www.shell.com.au/about-us
- Google “Shell Crux”



Appendix A - 7.06 Presentation - Bardi Jawi, Mayala and Walalakoo Meeting – 15 August 2023

Shell Australia
Bardi and Jawi Niimidiman Aboriginal Corporation, Mayala Inninalang Aboriginal Corporation and Walalakoo Aboriginal Corporation

15 August 2023

Aims of today

1. Introductions – who's in the room – Walalakoo, Mayala, Bardi Jawi, Shell
2. Some background on Shell in Australia and Shell in WA
3. Crux - what it is, where it is at now.
4. Environmental issues – Q and A
5. Priorities for Aboriginal groups- Indigenous Social and Economic Impacts
6. Traditional Owner only time
7. Regroup - Where to from here – relationships into the future, opportunities

Who is Shell?

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
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NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

Crux

- What is the Crux Project?
- The four Environmental Plans and what they cover
  1. Seabed survey
  2. Drilling template
  3. Drilling development
  4. Installation and Commissioning
  5. There will be more EPs to come

  - Crux Video -

- What the Crux Environmental Plans do to protect cultural heritage, marine systems, coastlines, TO access to country
- Ongoing engagement with TO groups and other Relevant Persons.
- The Independent Panel

What is Prelude?

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 1.3 mtpa LPG, 1.3mtpa condensate

Water depths:
250m

Status:
In operation

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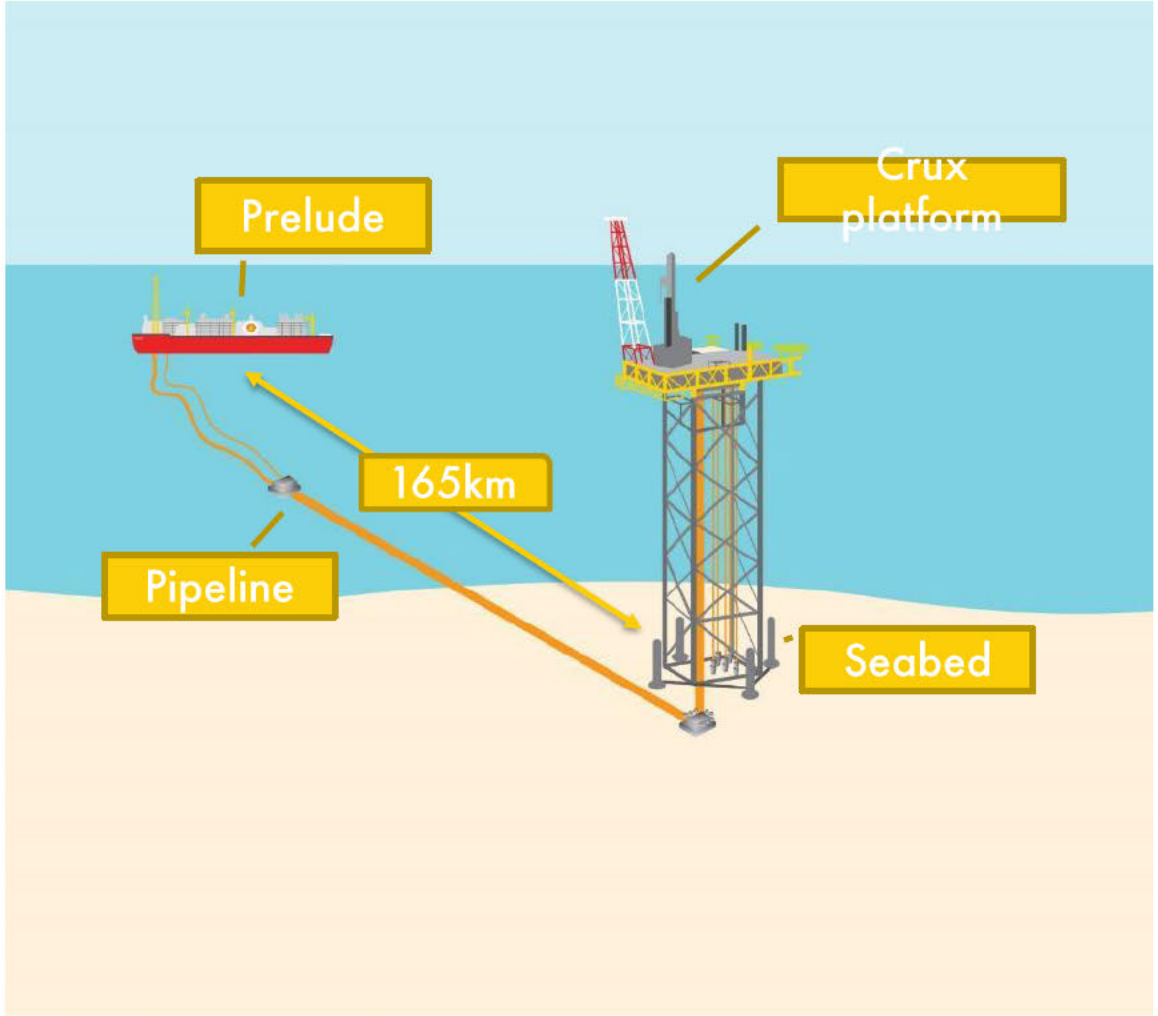
What is Crux?

- In May 2022, Shell Australia and SGH decided to go ahead with Crux.
- The project is a long-term extension to the existing Prelude FLNG facilities.
- Crux consists of a platform (which is not normally manned), above 5 gas wells. The gas is delivered via a pipeline to Shell's Prelude project, which is moored some 165 Km away, and processed onboard.
- The project is part of Shell's strategy to help meet the needs of gas users as the energy market moves to a lower carbon future.



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The environmental plans

There are four Environment Plans for Crux that describe what Shell will do to protect the environment. These must be submitted to, and approved by NOPSEMA.

1. *Seabed Survey Environment Plan – submitted*
2. *Drilling Template Environment Plan – submitted*
3. **Development Drilling Environment Plan – submitted**
4. **Crux Installation and Cold Commissioning Environment Plan – to be submitted in November**
5. **Additional EPs will deal with the operations of Crux and modifications to Prelude.**

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Crux Environment Plans

These describe the impacts and risks, both planned and accidental that may occur

Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area. Shell has means to control the impact of these.

Accidents could include:

- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.
- Introduction of invasive species from the vessels that will be entering Australian waters.

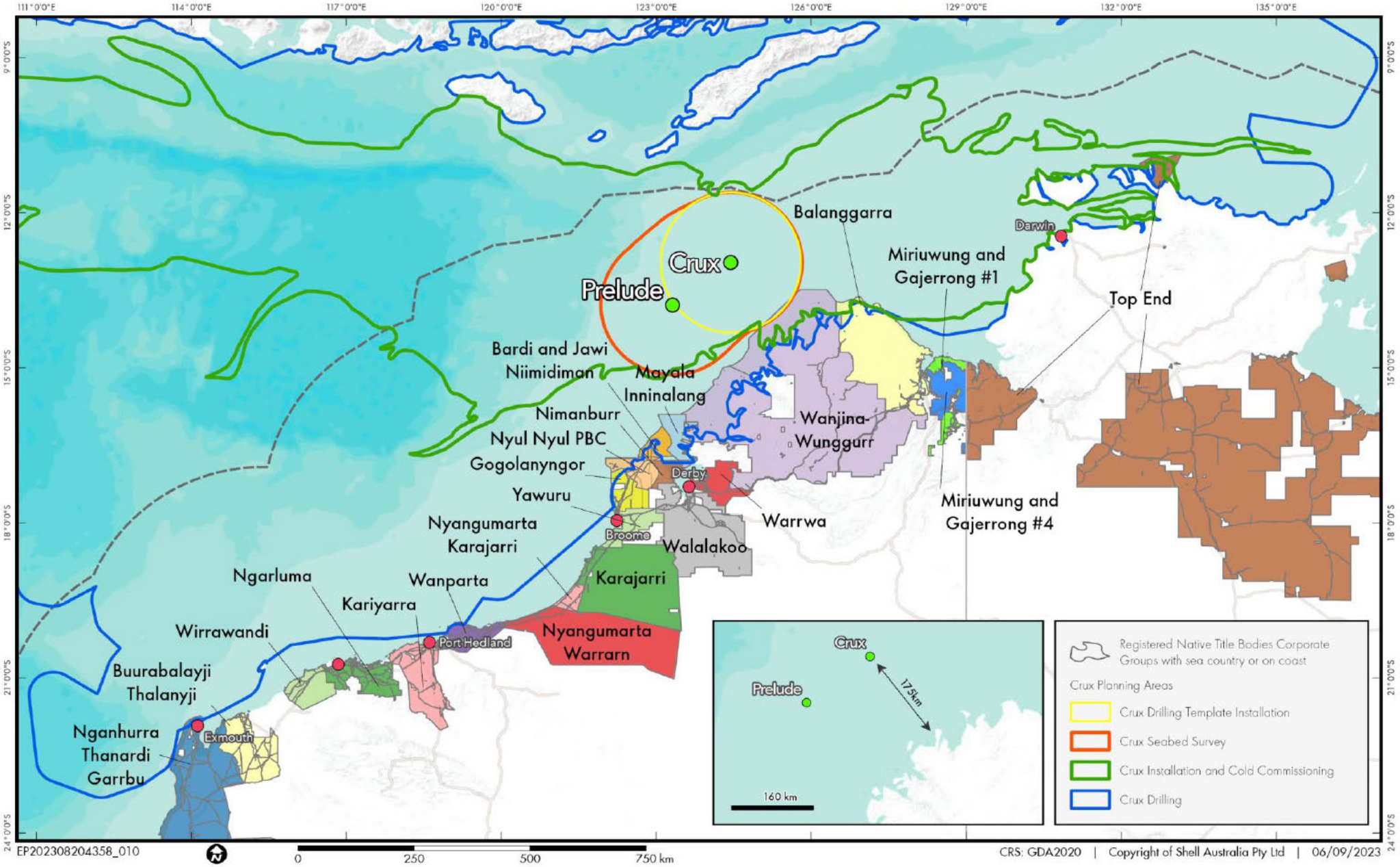
Such accidents are very rare. Shell has to be prepared for them, to ensure they have adequate controls. For each key stage of Crux, Shell develops an Environmental Plan which looks at the key risks of that stage, and the size and scale of any impacts – planned or accidental.

The Environmental **Planning Areas are the outside limit of hundreds of individual, mapped accidents**

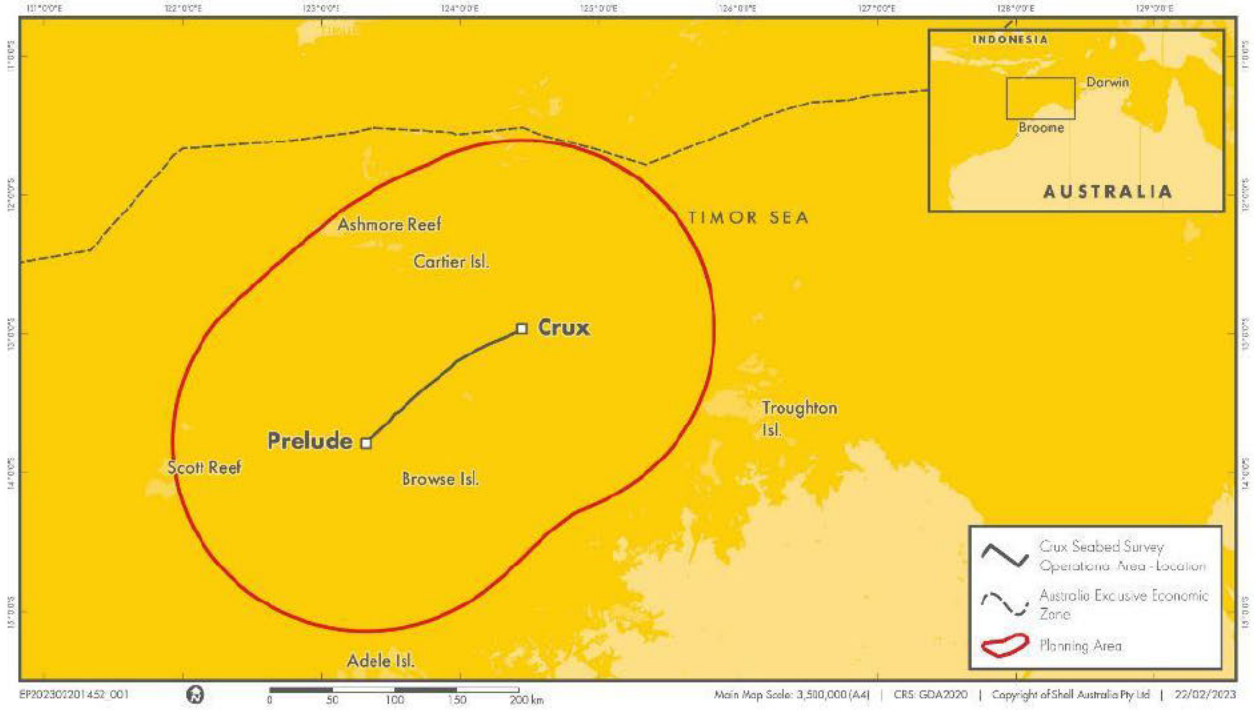
Oil Spill modelling

NOPSEMA

The 4 EP planning areas



1. Crux Seabed Survey Environment Plan -
Looking at the seabed and sub-seabed conditions



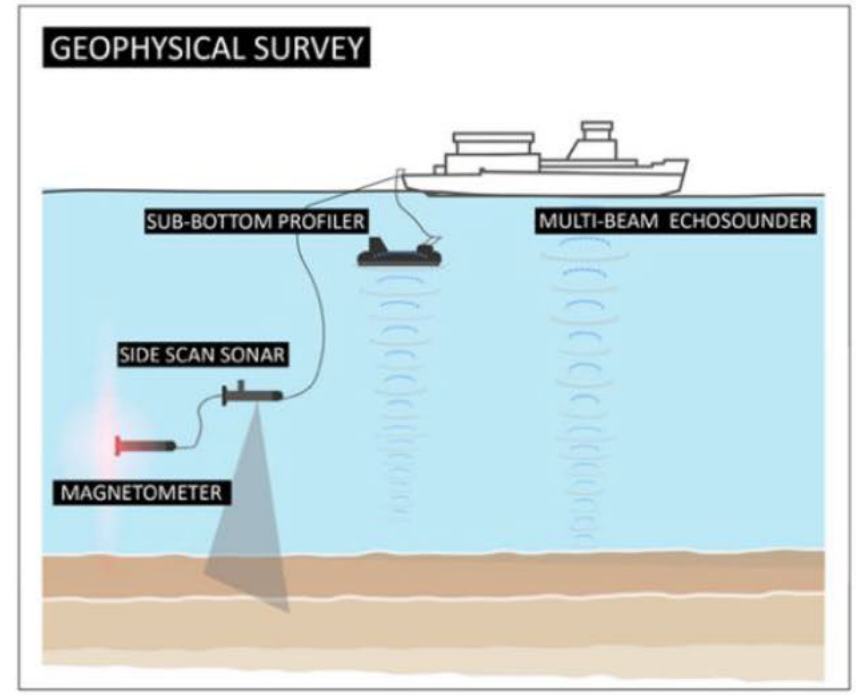
Activity: Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

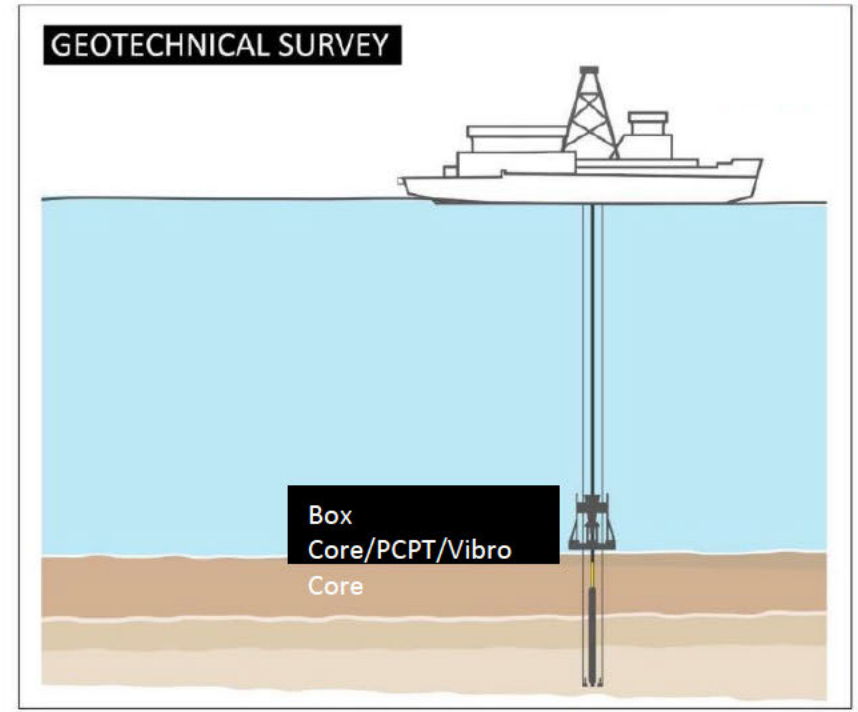
A vessel will traverse the pipeline route, towing survey equipment and deploying coring equipment.

Duration: <5 days

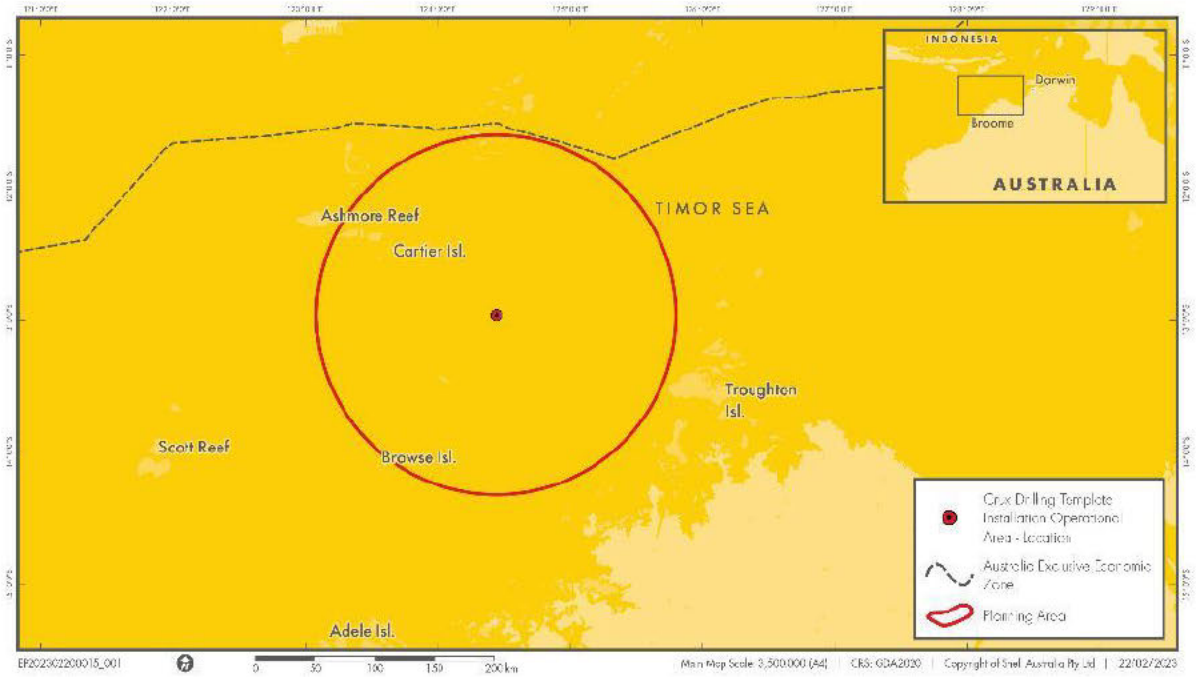
Timing: 1 July – 31 December 2023*

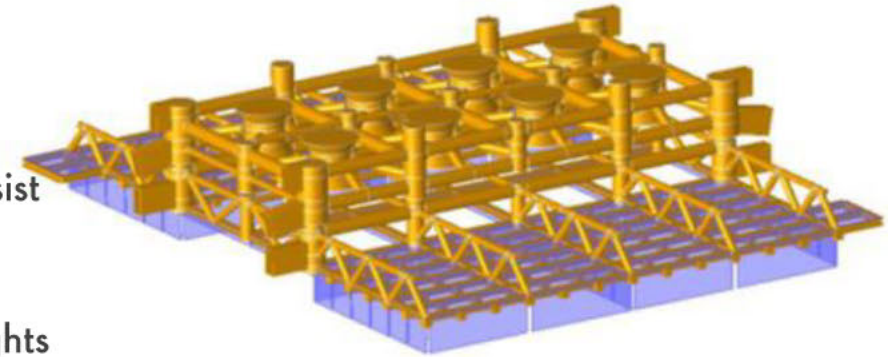
Key points





2. Crux Drilling Template Installation Environment Plan -
The template will act as a guide for the drill bits during drilling operations





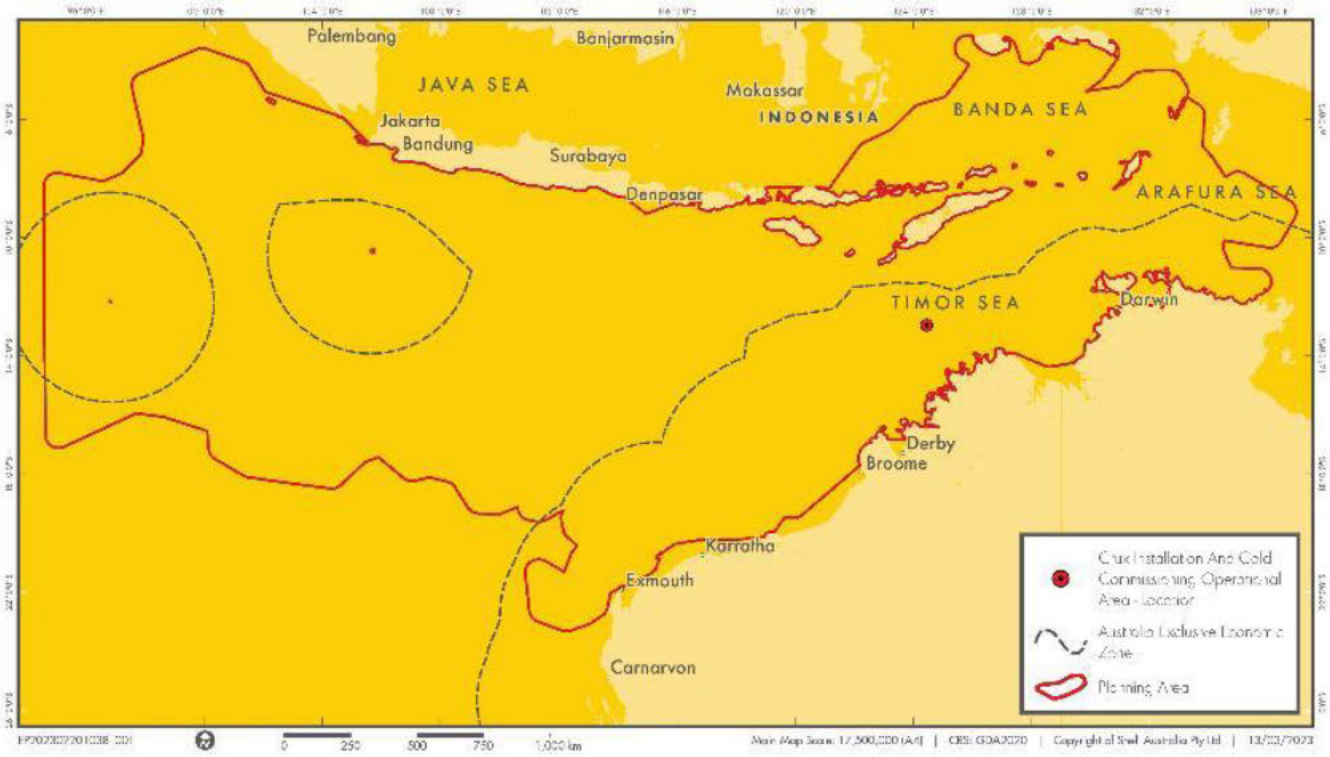
Activity: Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux platform.

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2. It weights 200 tonnes

Duration: <7 days **Timing:** 1 September 2023 – 1 April 2024*

Key points

3. Crux Development Drilling Environment Plan – drilling the wells



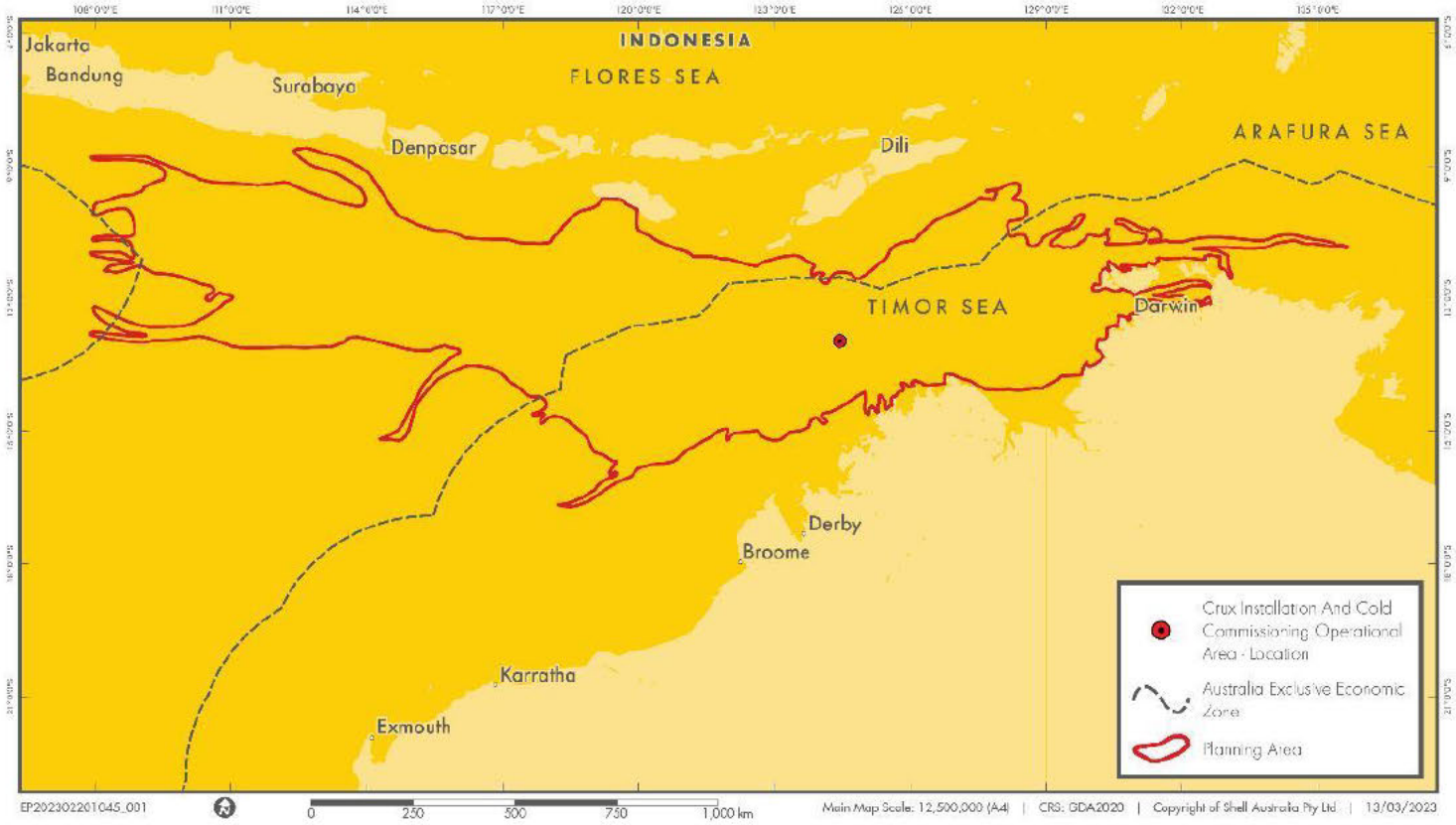
Activity: Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Duration: approximately 10 months, with 10 months contingency. Expected temporary well suspension period, approximately 2-3 years.

Timing: Expected Mobile Offshore Drilling Unit Operations start date – end 2023 - early 2024.

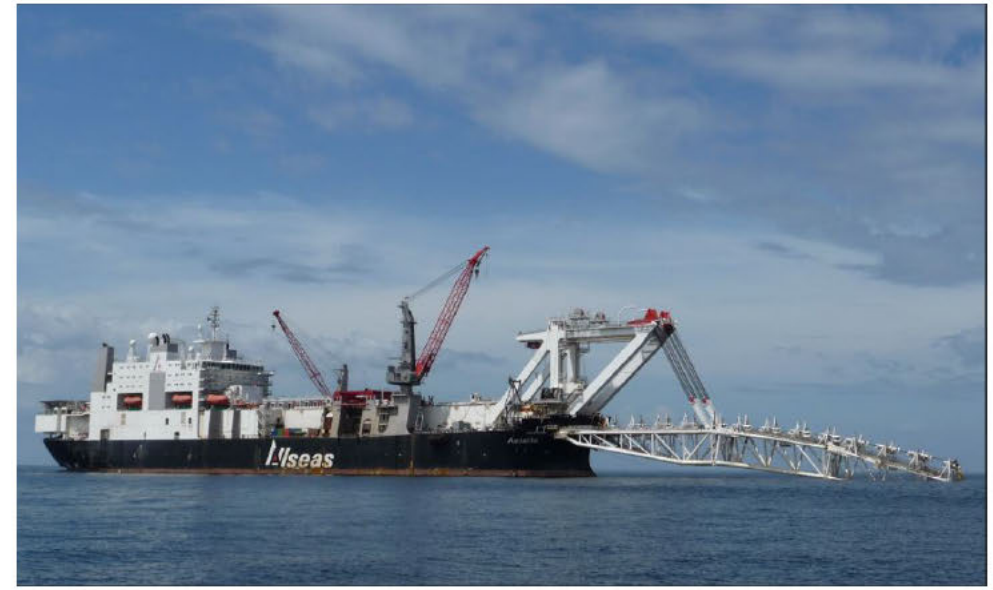
Key point

4. Crux Installation and Commissioning Environment Plan – putting in the pipeline and substructure and checking everything works



Crux pipelay

- Putting in the 26-inch export pipeline (~165 km long) from Prelude to Crux
- Vessel operations
- Pre- and post-lay surveys
- Testing it all



The facility will commence cold commissioning(testing) once installation is complete.

Duration: Mid 2024 – Dec 2026

Timing: start mid 2024, pending regulatory approvals.

Key points

Dates for the commencement of activities and duration are subject to schedule change

Shell has done a lot of research into what is important to Aboriginal people in the Crux Planning area.

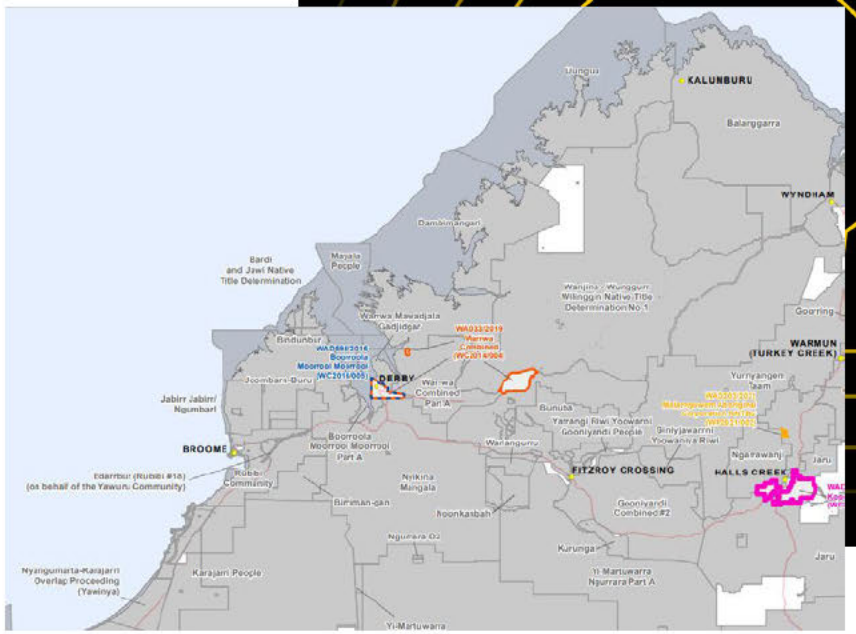
This has been done using Healthy Country plans, Native Title Determinations, ILUAs, IPAs, Cultural Heritage Surveys and Assessments, heritage site registration and talking directly with Aboriginal groups.

Underwater Cultural Heritage

- We've looked at WA and NT databases for registered sites. There are no sites currently registered within the operational areas.
- The Crux operating area is below the historical seabed levels (below 130m sea level). Its very unlikely there is any cultural heritage that far out to sea – the area was never above sea levels when human occupation existed.
- Further work mapping is being done on what tangible underwater cultural heritage could remain in the larger planning area

What we don't know

- Any concerns for particular areas and sites that may exist for each different TO groups
- What you think of our current management methods



Crux Operations Protecting land and sea Country.

Copyright of Shell International B.V.

Environmental Panel

A panel of subject matter experts has been established, who you can go to with questions, concerns and complaints
You have access to the panel, with the costs incurred by Shell. It is anonymous.

You can ask whatever you like from the Panel.

They are independent of Shell (although some have previously worked for Shell)

- Shell will not see any of the information shared.
- Any conversation is between you and the panel member.

[redacted]

[redacted]

Copyright of Shell International B.V.

Now what

Shell is keen to keen in touch and develop stronger relationships.

- Possible further meetings – let Shell know
- Talk to your communities
- Ask questions of the Panel
- Ask questions of Shell what you want to know more about or have concerns
- Info on the web

Web:

- www.shell.com.au/about-us
- Google “Shell Crux”

SHELL AUSTRALIA INVITES YOU TO COME AND TALK TO US ABOUT THE CRUX PROJECT

In Australia, Shell has an integrated energy solutions portfolio which includes gas production and liquefaction, as well as renewable power and energy solutions businesses.

With our joint venture partner, SGH Energy, we are preparing to develop the Crux natural gas field. This is to ensure a continued supply of gas to Shell's Prelude Floating Liquefied Natural Gas (FLNG) facility, which extracts, liquefies and stores natural gas at sea, before it is transferred and shipped to customers. Prelude FLNG is located around 475km north-north east of Broome in Western Australia.

As part of the Crux development, we will be preparing environmental approvals for submission to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). Consultation with relevant persons is an important part of these approvals.

If you are interested in learning more, Shell Australia invites you to join us at two forums as follows:

Date:
Forum 1: Wednesday 19 April 2023
Forum 2: Wednesday 10 May 2023
Location: Please complete survey to vote on location options

For more information please visit
www.shell.com.au/crux

CRUX PROJECT JOINT VENTURE PARTNER
SGH | Energy

REGISTRATION INSTRUCTIONS
Shell Australia is extending invitations to relevant persons and organisations, to attend our upcoming forums on 19 April and 10 May 2023 to talk to us about our Crux Project.

You have an opportunity to nominate one person to represent your Organization, Native Title Determination Group, Native Title Holders, Native Title Claimants, or Individual/s Family Groups, at the Shell forums.

- All Shell forum participants will be provided with travel and accommodation support.
- All Shell forum participants will have an opportunity to vote on the location of the forum.
- Due to the venue capacity, the forums will be restricted to a maximum of 120 participants.
- To register for the Shell forums, please complete this form by Friday 7th April 2023, 5pm (AWST) and return your form to SDA-cruxproject@shell.com.

Appendix A - 7.07 Presentation – Wunambal Gaambera Aboriginal Corporation – 15 September 2023

Shell Australia
Wunambal Gaambera

15 September 2023

Aims of today

1. Some background on Shell in Australia and Shell in WA
2. Crux - what it is, where it is at now.
3. Environmental Management and Impacts
4. Your priorities
5. Where to from here

- ask questions at any time -

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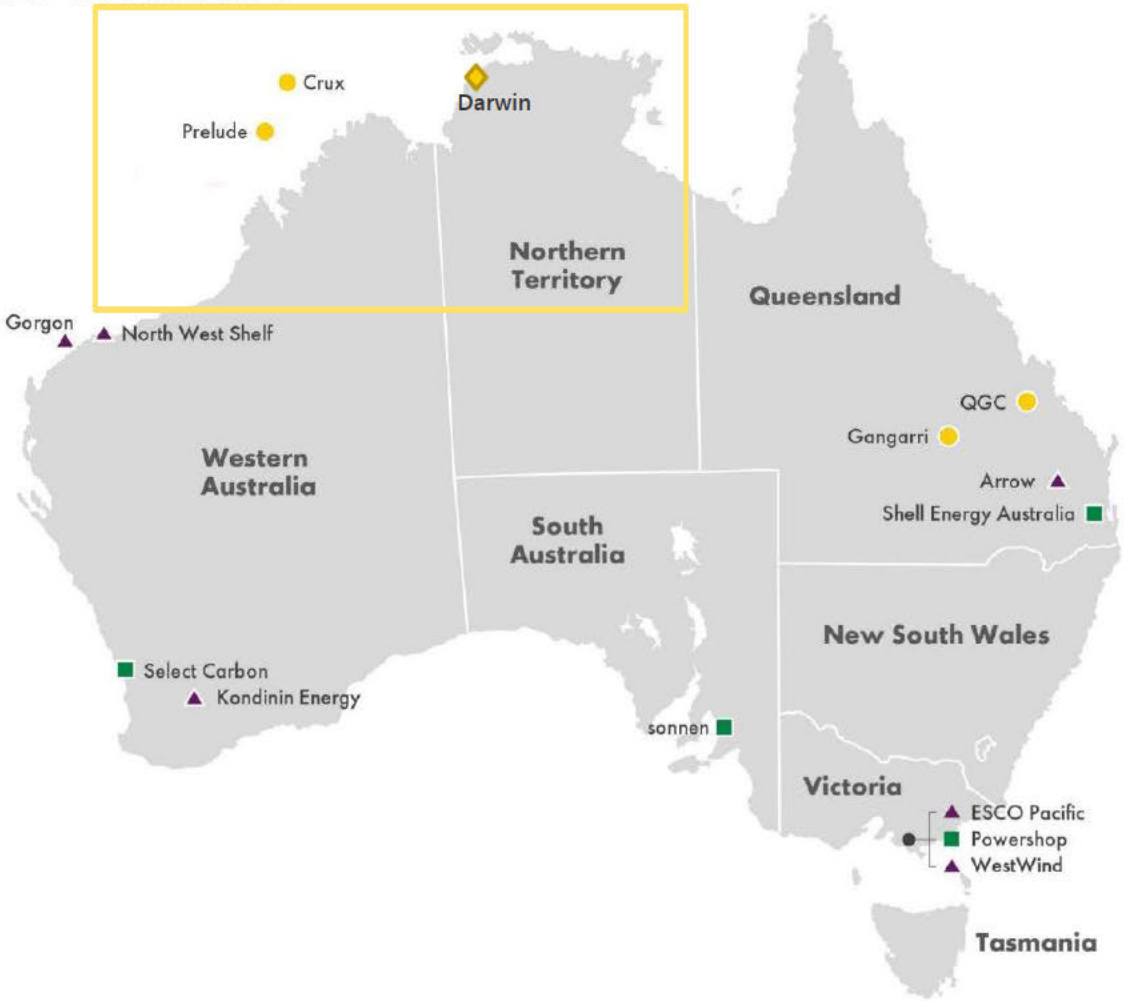
Who is Shell?



SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

What is Prelude?

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 1.3 mtpa LPG, 1.3mtpa condensate

Water depths:
250m

Status:
In operation

Copyright of Shell International B.V.

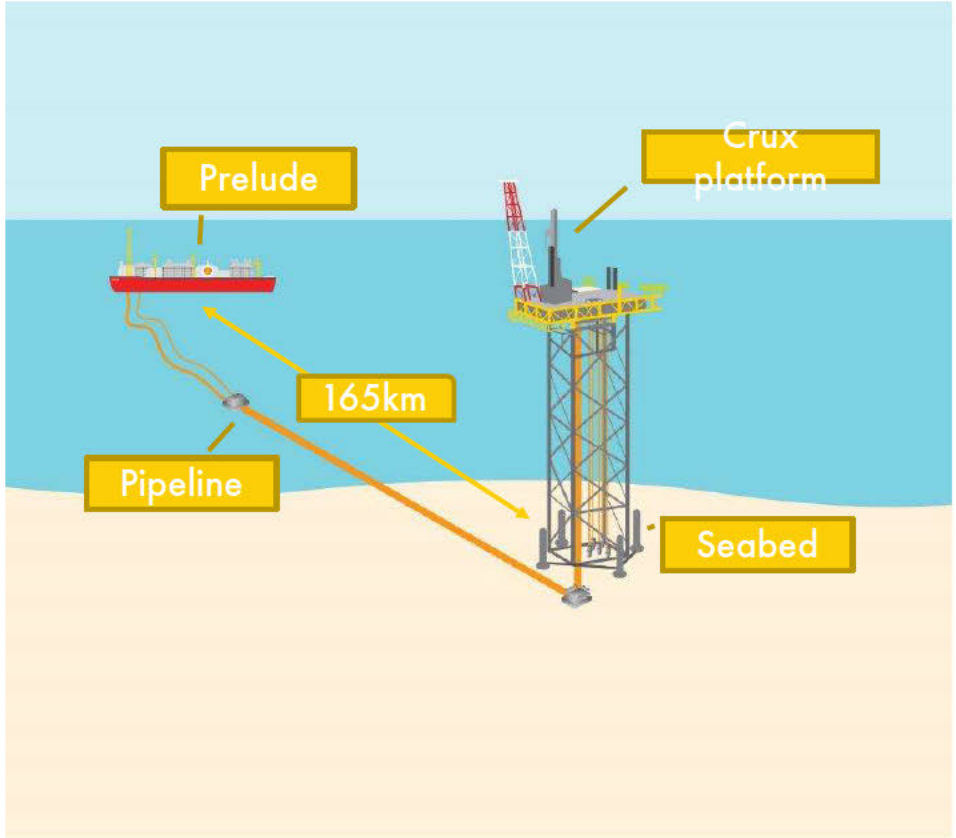
The Crux Project

[redacted]

Copyright of Shell International B.V.

What is Crux?

- In May 2022, Shell Australia and SGH decided to go ahead with Crux.
- The project is a long-term extension to the existing Prelude FLNG facilities.
- Crux consists of a platform (which is not normally manned), above 5 gas wells. The gas is delivered via a pipeline to Shell's Prelude project, which is moored some 165 Km away, and processed onboard.
- The project is part of Shell's strategy to help meet the needs of gas users as the energy market moves to a lower carbon future.



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Crux

- The five Environment Plans and what they cover
  1. Seabed survey
  2. Drilling template
  3. Drilling development
  4. Installation and Commissioning
  5. Completions, Start-up and Operations (just started preparation)

- **Shell's obligations to consult, and your rights to raise objections and claims.**
- Are there others we should consult?
- What the Crux Environmental Plans do to protect cultural heritage, marine systems, coastlines, Traditional Owner access to country
- Ongoing engagement with Traditional Owner groups and other Relevant Persons.
- The Independent Panel

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Slide 7

WNFSP0 Important this stays in every Shell consultation information package initially sent out from now moving forward. Good to reinforce in the meeting too.
Waugh, Nathan F SDA-PTS/SD/I, 2023-09-04T01:32:05.897

WNFSP1 This is also a question we should ask all TO groups now moving forward. Put it in the slide is important I think.
Waugh, Nathan F SDA-PTS/SD/I, 2023-09-04T01:32:55.634

Crux Environment Plans

These describe the impacts and risks, both planned and accidental that may occur

Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area. Shell has means to control the impact of these.

Accidents could include:

- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.
- Introduction of invasive species from the vessels that will be entering Australian waters.

Such accidents are very rare. Shell has to be prepared for them, to ensure they have adequate controls. For each key stage of Crux, Shell develops an Environmental Plan which looks at the key risks of that stage, and the size and scale of any impacts – planned or accidental.

The Environmental **Planning Areas represent the maximum outside limit of hundreds of individual, possible spill incidents. They take into account weather, waves, currents, and other conditions.**

The environmental plans

There are four Environment Plans for Crux that describe what Shell will do to protect the environment. These must be submitted to, and approved by NOPSEMA.

1. *Seabed Survey Environment Plan – submitted*
2. *Drilling Template Environment Plan – submitted*
3. **Development Drilling Environment Plan – submitted**
4. **Crux Installation and Cold Commissioning Environment Plan – to be submitted in November**
5. **Completions, Start-up and Operations Environment Plan – just started preparation**

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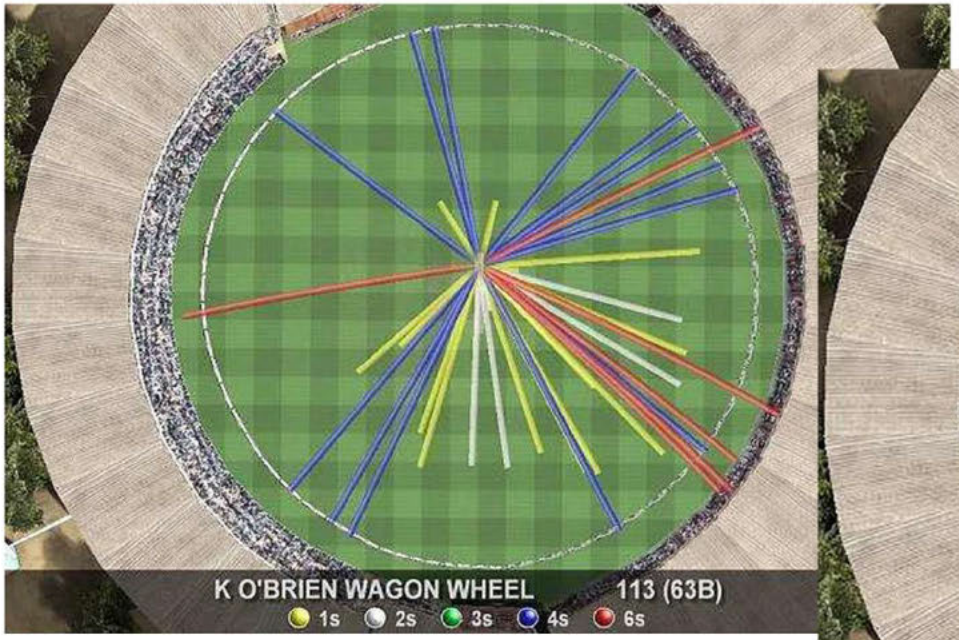
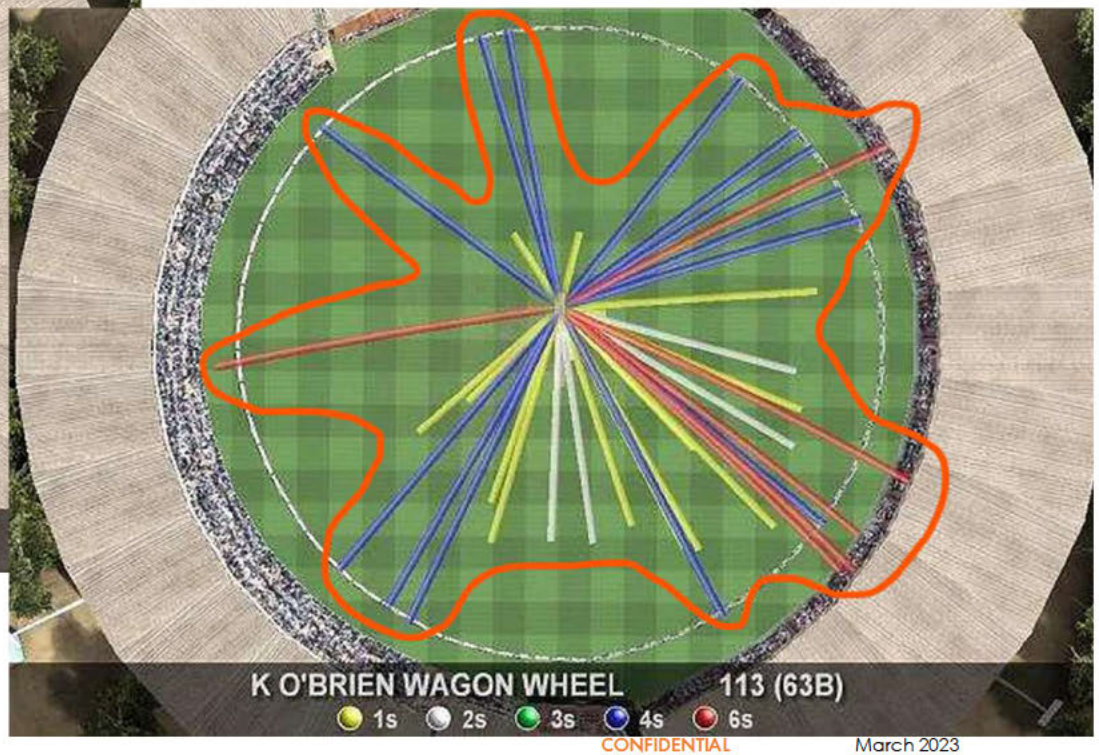
Environmental Plans

The Environmental Planning Areas are the outside limit of hundreds of individual, mapped accidents. A single incident will not affect the entire Planning area. Like in a cricket game...





Oil Spill modelling

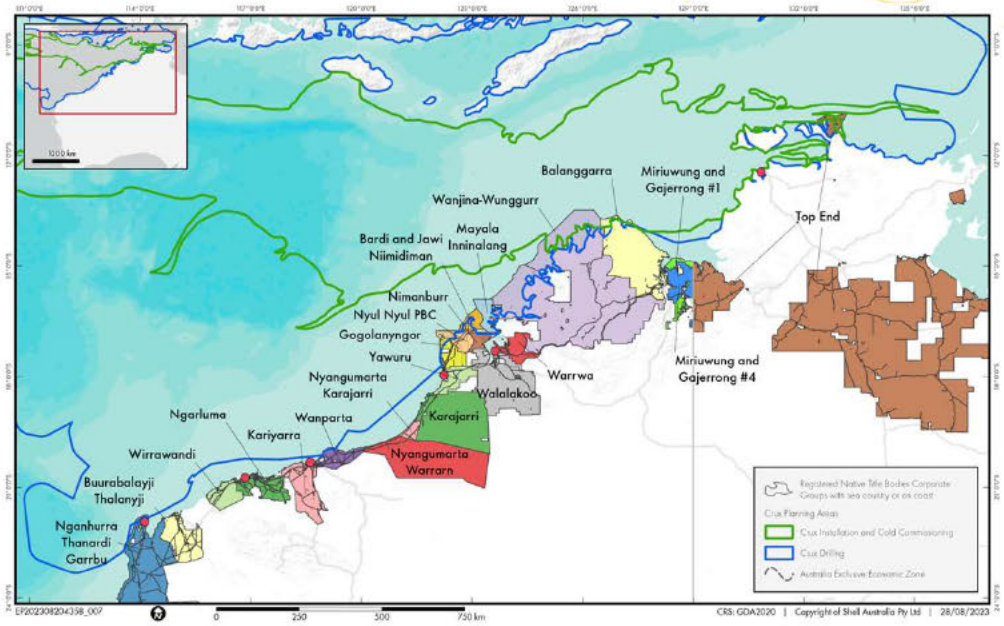
NOPSEMA

Crux Operations - Protecting land and sea Country.

Shell has done a lot of research into what is important to Aboriginal people in the Crux Planning area. We used Healthy Country plans, Native Title Determinations, ILUAs, IPAs, Cultural Heritage Surveys and Assessments, heritage site registration and are talking directly with Aboriginal groups.

Underwater Cultural Heritage

- We've looked at WA and NT databases for registered sites. There are no sites currently registered within the operational areas.
- The Crux operating area is below the historical seabed levels (below 130m sea level). Its very unlikely there is any cultural heritage that far out to sea – the area was never above sea levels when human occupation existed.
- Further work mapping is being done on what tangible underwater cultural heritage could remain in the larger planning area



What we don't know

- Any concerns for particular areas and sites that may exist for each different Traditional Owner groups
- What you think of our current management methods

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Environmental Panel

A panel of subject matter experts has been established, who you can go to with questions, concerns and complaints
You have access to the panel, with the costs incurred by Shell. It is anonymous.

You can ask whatever you like from the Panel.

They are independent of Shell (although some have previously worked for Shell)

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- Any conversation is between you and the panel member.

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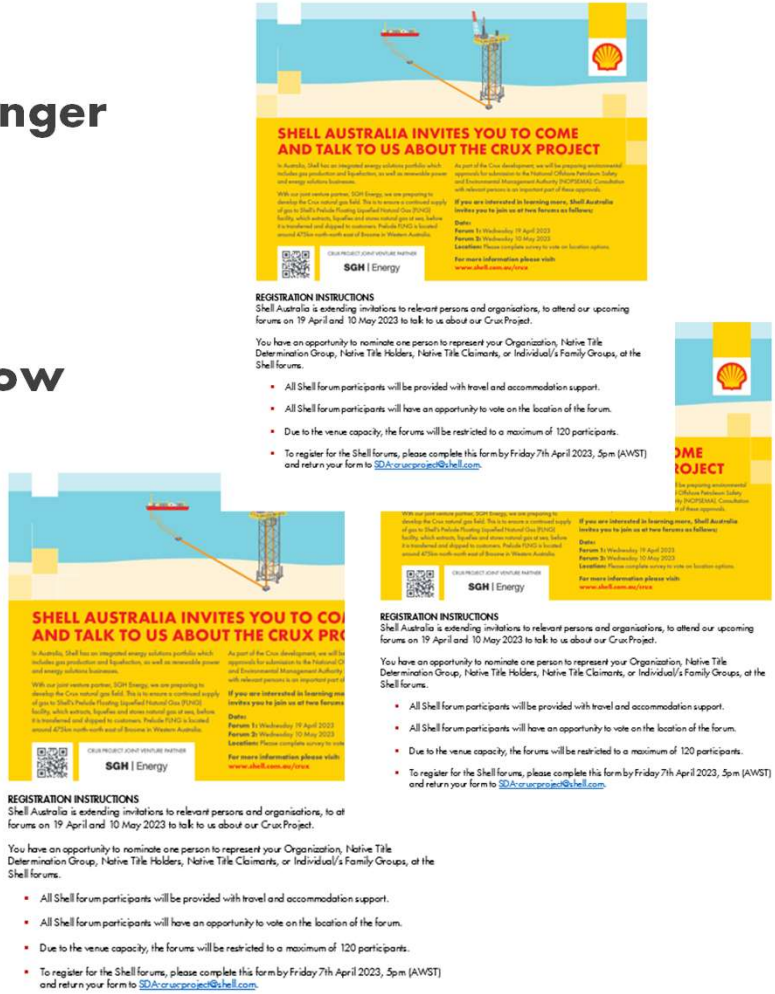
Now what

Shell is keen to keen in touch and develop stronger relationships.

- **Possible further meetings – let Shell know**
- **Talk to your communities**
- **Ask questions of the Panel**
- **Ask questions of Shell what you want to know more about or have concerns**
- **Info on the web**

Web:

- **www.shell.com.au/about-us**
- **Google "Shell Crux"**



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Appendix A - 7.08 Presentation - Dambimangari Meeting – 19 September 2023

Shell Australia Dambimangari Aboriginal Corporation

19 September

Acknowledgement of Country

Aims of today

1. Introductions – who's in the room
2. Shell and the Crux project
3. Overview of the environmental management plans (incl clarification on question from DAC re seismic surveys)
4. Key issues for Dambimangari
5. Further consultation from here

Who is Shell?

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

Crux

- What is the Crux Project?
- The four Environmental Plans and what they cover
  1. Seabed survey
  2. Drilling template
  3. Drilling development
  4. Installation and Commissioning
  5. There will be more EPs to come

  - Crux Video -

- What the Crux Environmental Plans do to protect cultural heritage, marine systems, coastlines, TO access to country
- Ongoing engagement with TO groups and other Relevant Persons.
- The Independent Panel

What is Prelude?

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 1.3 mtpa LPG, 1.3mtpa condensate

Water depths:
250m

Status:
In operation

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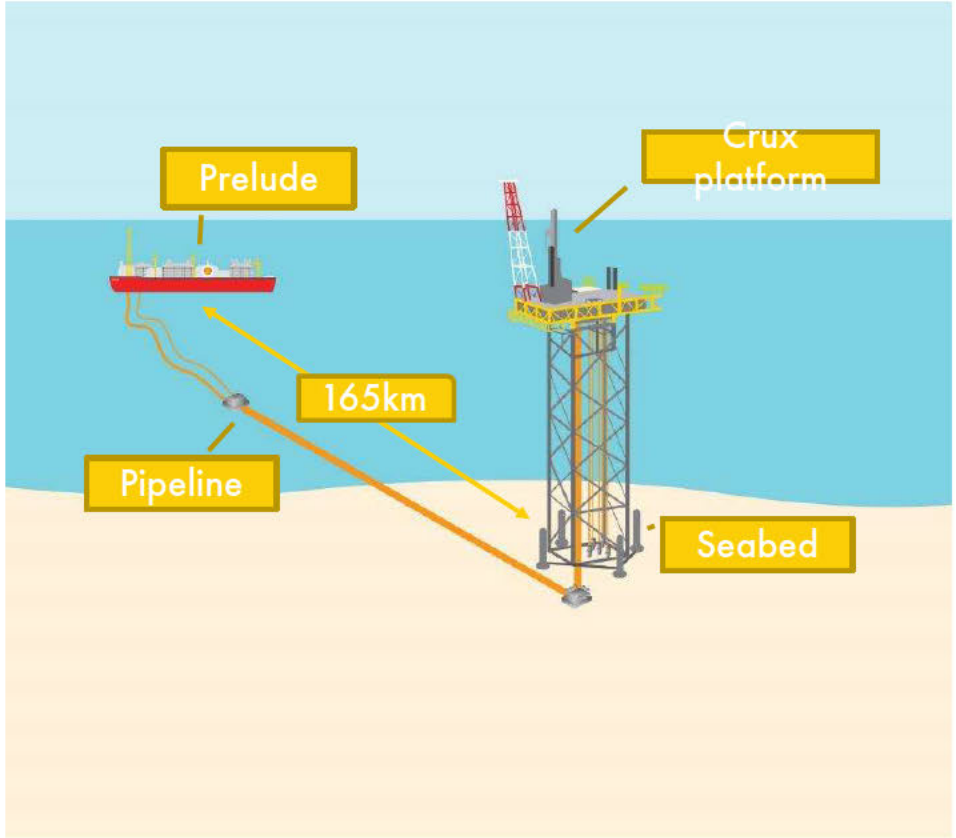
What is Crux?

- In May 2022, Shell Australia and SGH decided to go ahead with Crux.
- The project is a long-term extension to the existing Prelude FLNG facilities.
- Crux consists of a platform (which is not normally manned), above 5 gas wells. The gas is delivered via a pipeline to Shell's Prelude project, which is moored some 165 Km away, and processed onboard.
- The project is part of Shell's strategy to help meet the needs of gas users as the energy market moves to a lower carbon future.



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The environmental plans

There are four Environment Plans for Crux that describe what Shell will do to protect the environment. These must be submitted to, and approved by NOPSEMA.

1. *Seabed Survey Environment Plan – submitted*
2. *Drilling Template Environment Plan – submitted*
3. **Development Drilling Environment Plan – submitted**
4. **Crux Installation and Cold Commissioning Environment Plan – to be submitted in November**
5. **Additional EPs will deal with the operations of Crux and modifications to Prelude.**

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Crux Environment Plans

These describe the impacts and risks, both planned and accidental that may occur

Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area. Shell has means to control the impact of these.

Accidents could include:

- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.
- Introduction of invasive species from the vessels that will be entering Australian waters.

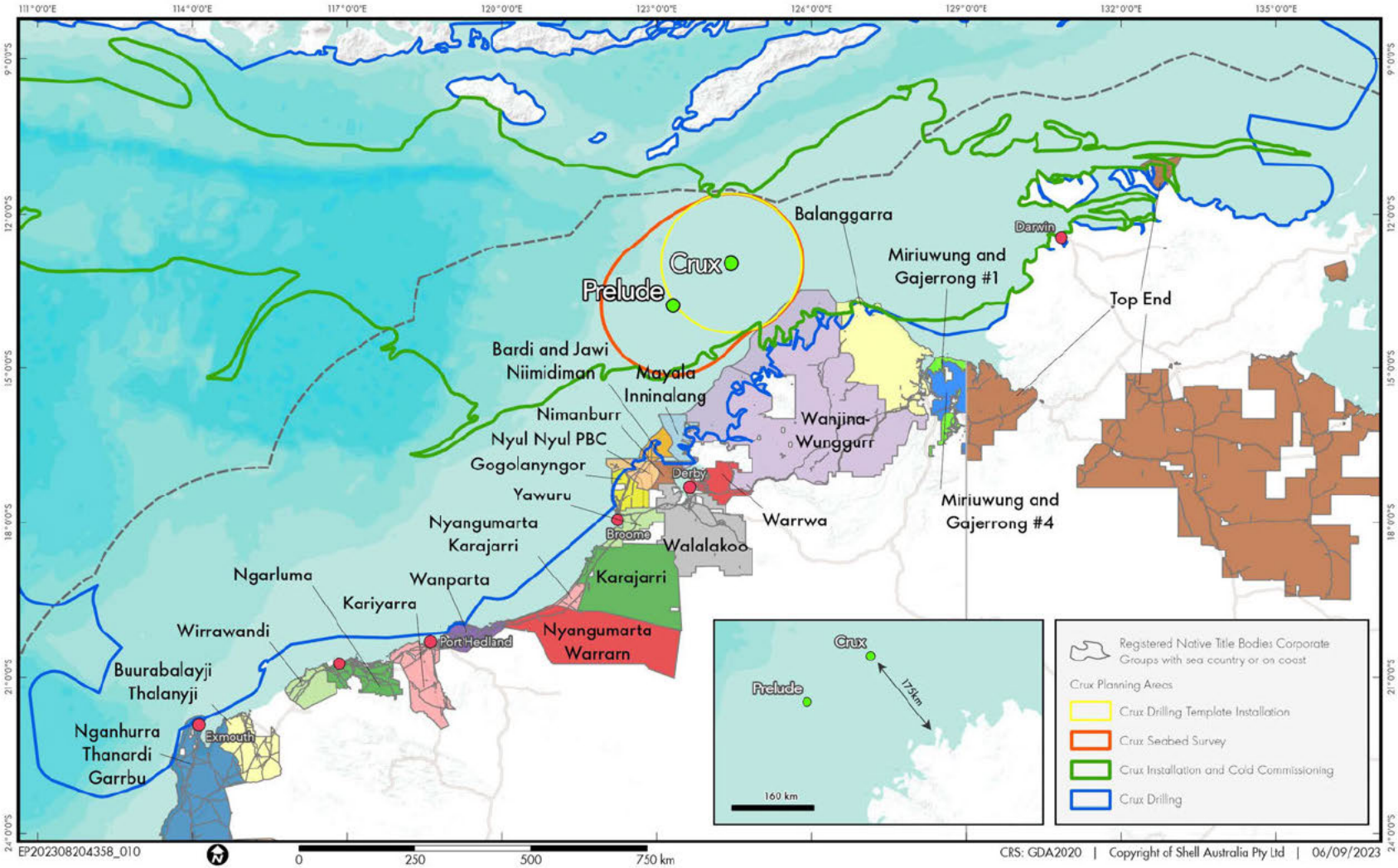
Such accidents are very rare. Shell has to be prepared for them, to ensure they have adequate controls. For each key stage of Crux, Shell develops an Environmental Plan which looks at the key risks of that stage, and the size and scale of any impacts – planned or accidental.

The Environmental **Planning Areas are the outside limit of hundreds of individual, mapped accidents**

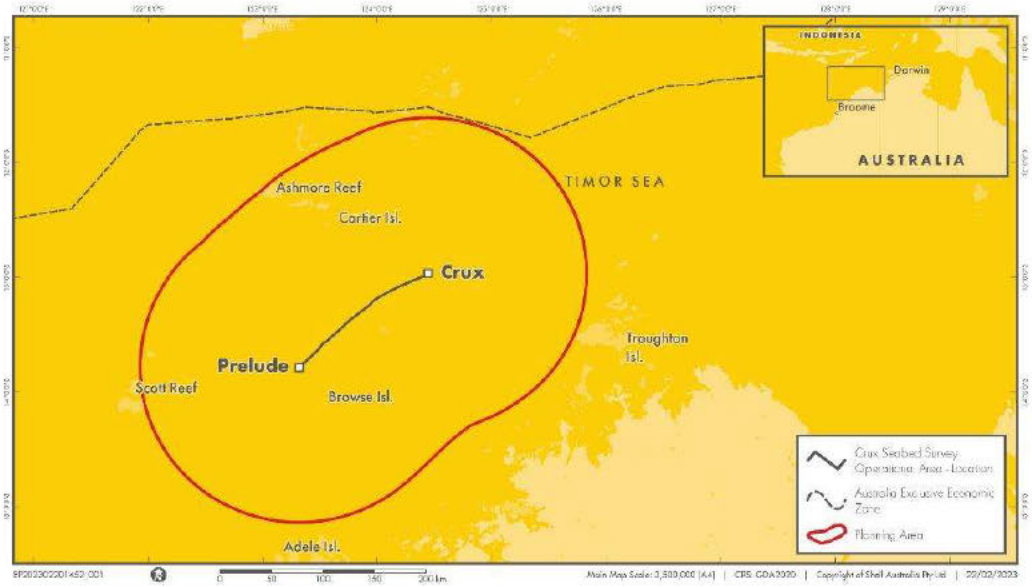
Oil Spill modelling

NOPSEMA

The 4 EP planning areas



1. Crux Seabed Survey Environment Plan -
Looking at the seabed and sub-seabed conditions



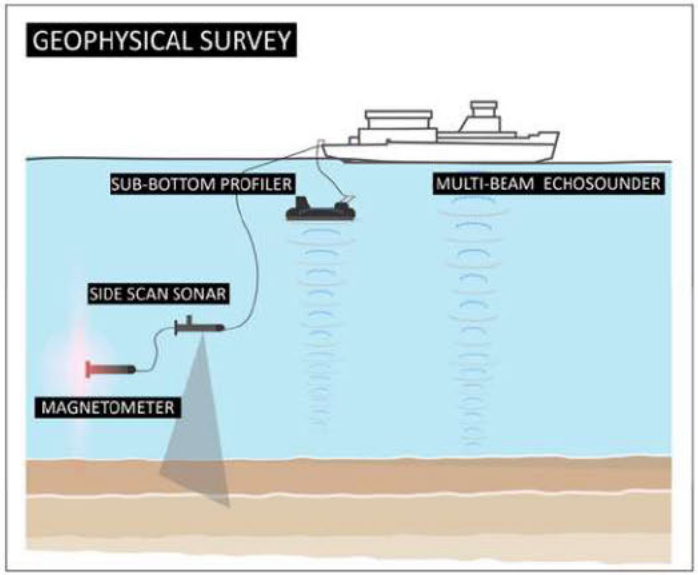
Activity: Shell is planning to carry out a survey of the pipeline route and terminals connecting the Crux and Prelude facilities.

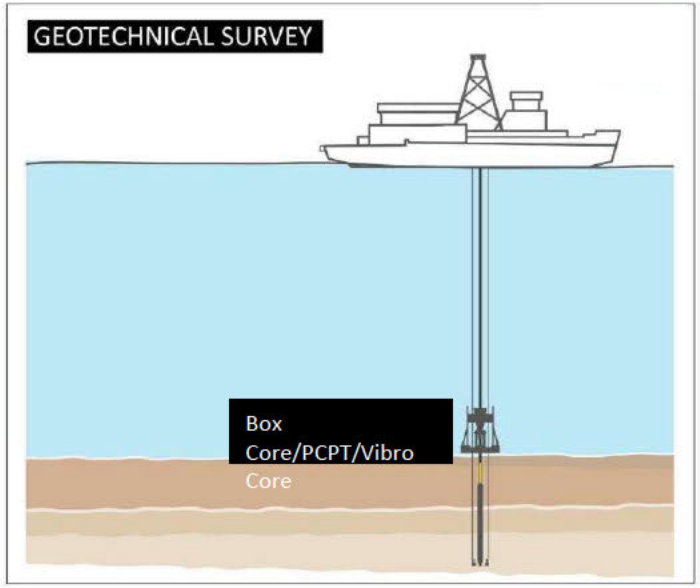
A vessel will traverse the pipeline route, towing survey equipment and deploying coring equipment.

Duration: <5 days

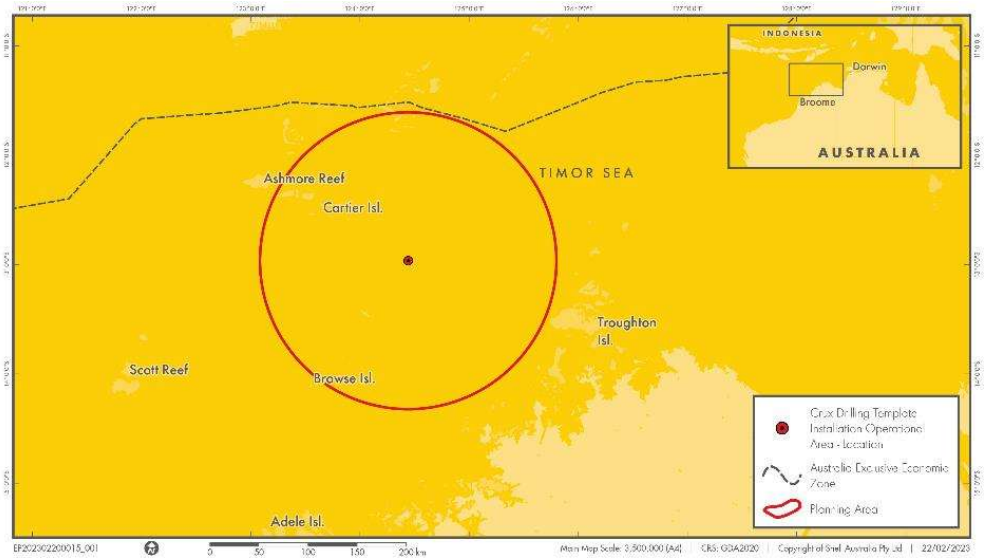
Timing: 1 July – 31 December 2023*

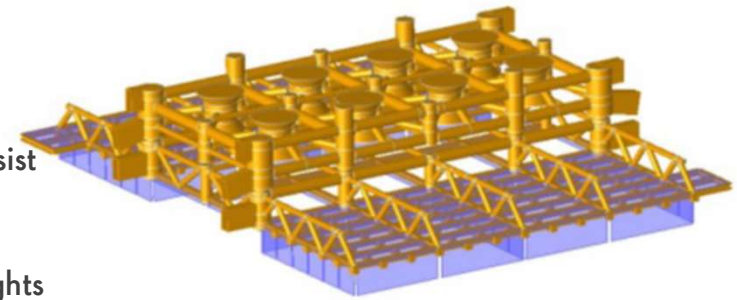
Key points





2. Crux Drilling Template Installation Environment Plan -
The template will act as a guide for the drill bits during drilling operations





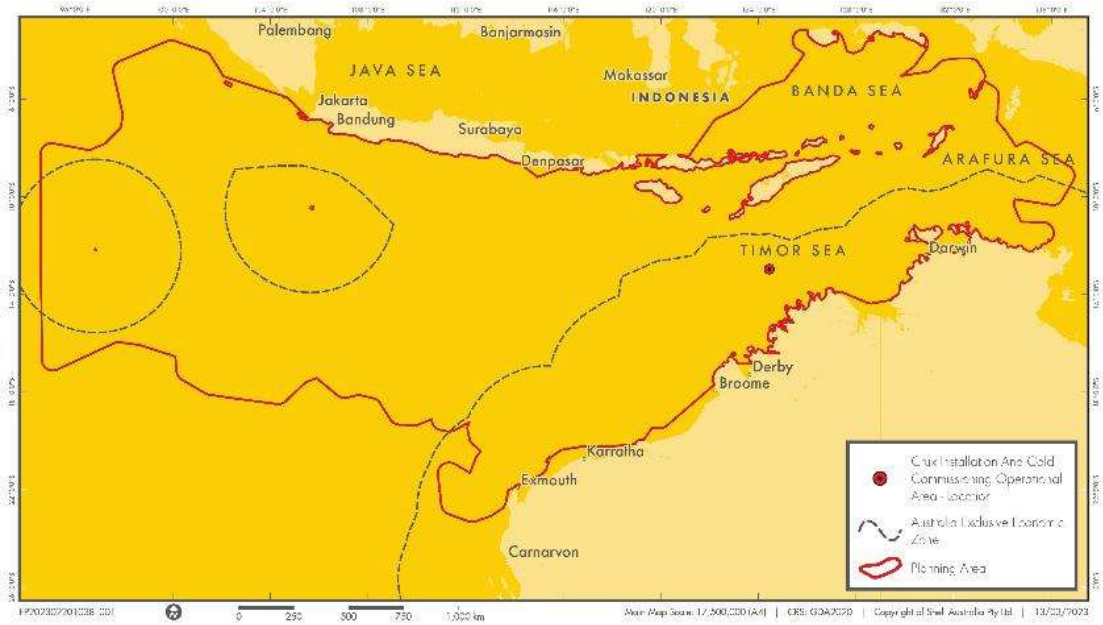
Activity: Shell is planning to lower a fabricated steel structure onto the seabed, which will assist with orienting and locating the drilling activities and the installation of the Crux platform.

Dimensions: 19m length, 14m width, 4m high and covers a seabed footprint of 266m2. It weights 200 tonnes

Duration: <7 days **Timing:** 1 September 2023 – 1 April 2024*

Key points

3. Crux Development Drilling Environment Plan – drilling the wells



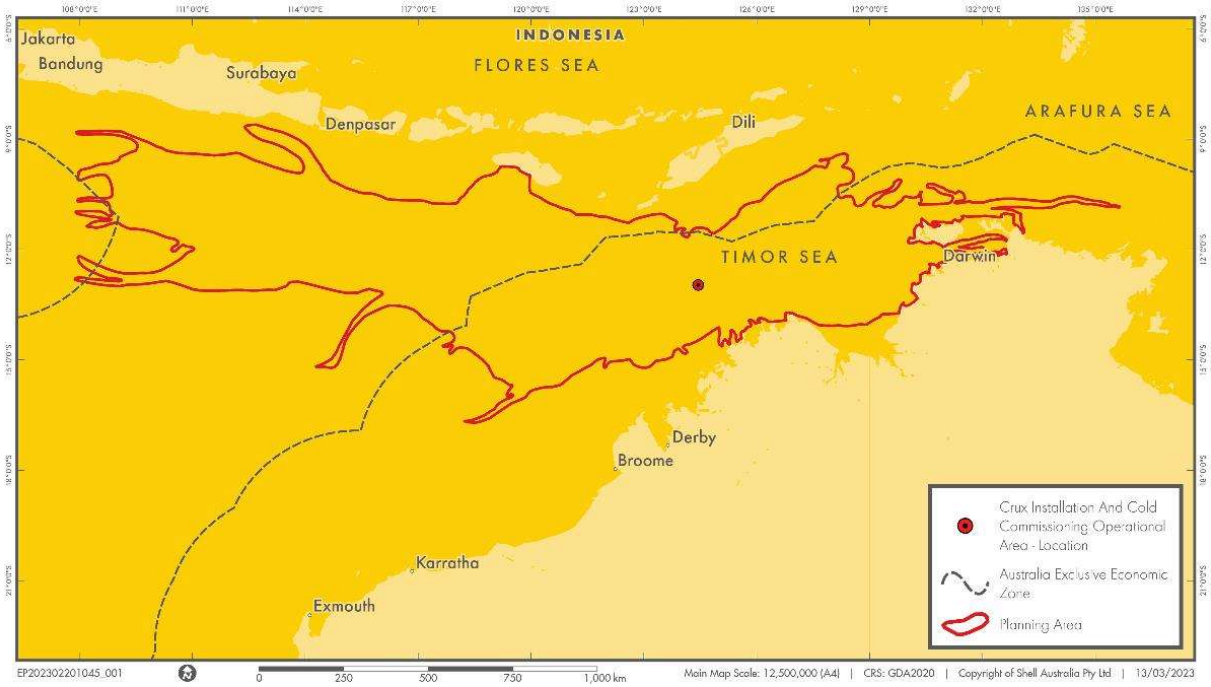
Activity: Shell is planning to drill five production wells through a drilling template and suspend them. The suspended wells will be commissioned once the Crux facility has been installed.

Duration: approximately 10 months, with 10 months contingency. Expected temporary well suspension period, approximately 2-3 years.

Timing: Expected Mobile Offshore Drilling Unit Operations start date – end 2023 - early 2024.

Key point

4. Crux Installation and Commissioning Environment Plan – putting in the pipeline and substructure and checking everything works



The facility will commence cold commissioning(testing) once installation is complete.

Duration: Mid 2024 – Dec 2026

Timing: start mid 2024, pending regulatory approvals.

Key points

Dates for the commencement of activities and duration are subject to schedule change

Crux pipelay

- Putting in the 26-inch export pipeline (~165 km long) from Prelude to Crux
- Vessel operations
- Pre- and post-lay surveys
- Testing it all

Shell has done a lot of research into what is important to Aboriginal people in the Crux Planning area.

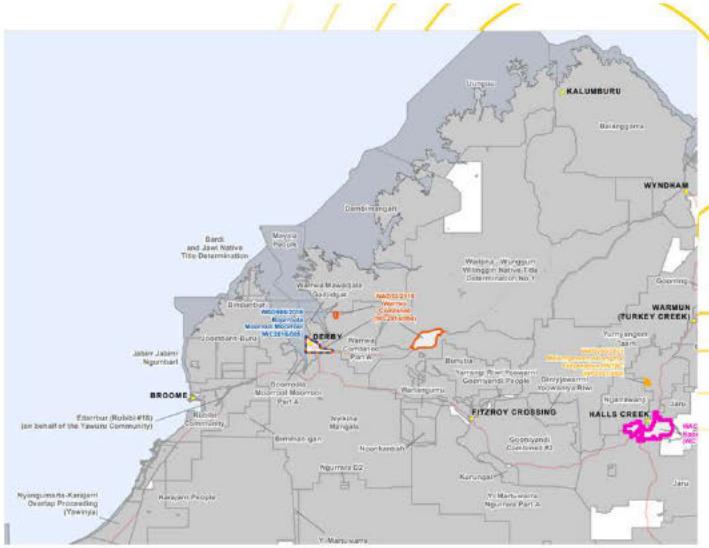
This has been done using Healthy Country plans, Native Title Determinations, ILUAs, IPAs, Cultural Heritage Surveys and Assessments, heritage site registration and talking directly with Aboriginal groups.

Underwater Cultural Heritage

- We've looked at WA and NT databases for registered sites. There are no sites currently registered within the operational areas.
- The Crux operating area is below the historical seabed levels (below 130m sea level). Its very unlikely there is any cultural heritage that far out to sea – the area was never above sea levels when human occupation existed.
- Further work mapping is being done on what tangible underwater cultural heritage could remain in the larger planning area

What we don't know

- Any concerns for particular areas and sites that may exist for each different TO groups
- What you think of our current management methods



Crux Operations Protecting land and sea Country.

Copyright of Shell International B.V.

Environmental Panel

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You can ask whatever you like from the Panel.

They are independent of Shell (although some have previously worked for Shell)

- Shell will not see any of the information shared.
- Any conversation is between you and the panel member.

[redacted]

[redacted]

[redacted]

Copyright of Shell International B.V.

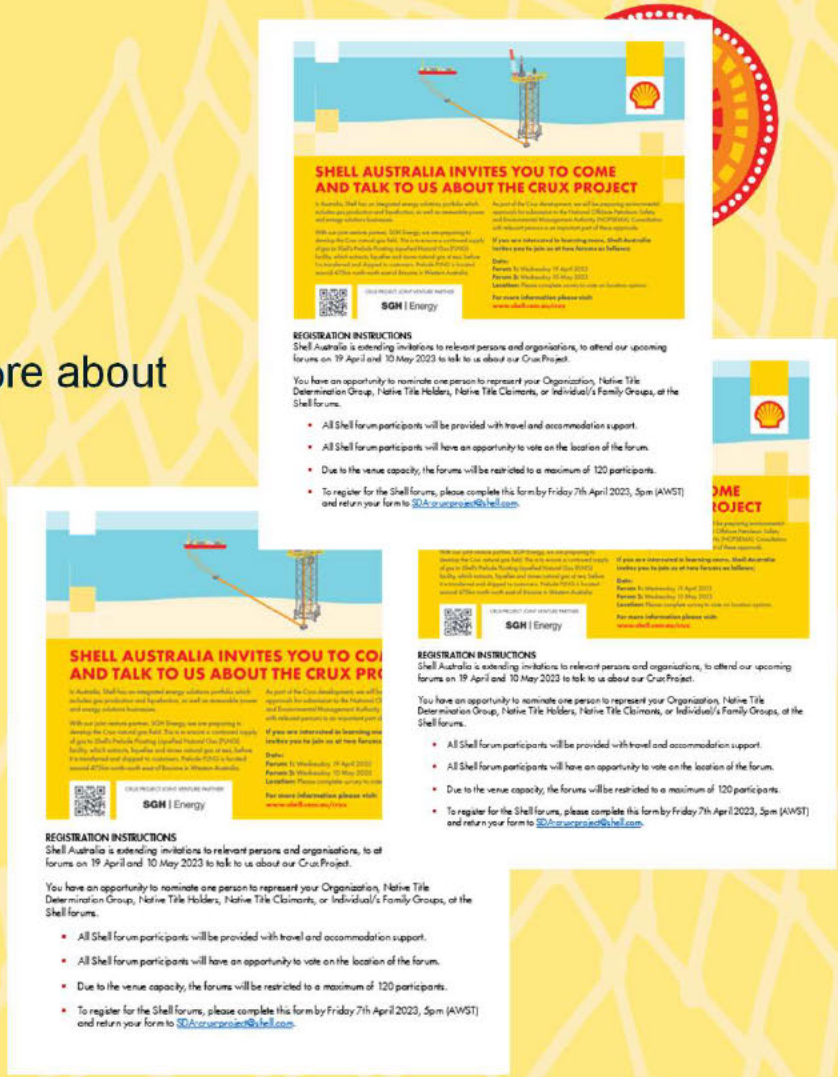
Now what

Shell is keen to keen in touch and develop stronger relationships.

- Possible further meetings – let Shell know
- Talk to your communities
- Ask questions of the Panel
- Ask questions of Shell what you want to know more about or have concerns
- Info on the web

Web:

- www.shell.com.au/about-us
- Google “Shell Crux”



Appendix A - 7.09 Email invitation to Broome forum – end of April

Traditional Owners in Australia's North West,

You are invited to a meeting to talk about Shell Australia's Crux project.

Crux is a gas project, located 190km off the Kimberley coast which will provide future supply for Shell's existing Prelude Floating Liquid Natural Gas (FLNG) facility. We want to give you the opportunity to hear about the project and for you to ask any questions. Detailed information about the project is available on our website
- http://www.shell.com.au/crux

We are holding a full day forum, details as follows :

Date: Wednesday 10 May 2023
Time: 9.30am – 3.00pm
Venue: Nyamba Buru Yawuru, 55 Reid Road Cable Beach, Broome
Food and drink provided.

(If you received an earlier invite from us, this meeting was called "Forum 2")

If you missed Forum 1 in Perth, Forum 2 will cover a similar update. If you attended Forum 1 and have feedback or new questions– please come along.

We'll provide food and drinks throughout the day, so come as early as you like – we'll start around 9.30am. We'll provide a good lunch at 12.30 too.

Please let us know if you are coming, by sending your RSVP to SDA-crux-project@shell.com by Friday 5 May . In your response please let us know if you need to travel to Broome as we may be able to assist.

Also, please pass the word on –TO groups from Exmouth through to Darwin have land and sea country and your views matter - we want to hear from you. If you can't come, but still want to talk to us, let us know and we will follow up with you.

In the meantime if you have any questions, please call [details redacted]

The Crux Team

Appendix A - 7.10 Email follow up – end of May

PBCs, Traditional Owners, and Aboriginal Organisations,

In recent weeks, Shell has held several forums and meetings to provide information about plans to install a gas platform, called Crux.

Crux will be installed offshore, about 620km north-east of Broome, and it will supply gas to Prelude, via a 160km pipeline, which is Shell's existing gas facility in the Browse basin.

To do this, environmental approvals need to be in place, from NOPSEMA. NOPSEMA is the National Offshore Petroleum Safety and Environmental Management Authority. To give approval, NOPSEMA must be confident that Shell will act responsibly to protect the environment, limit emissions, and that it can respond quickly and effectively to any incidents.

NOPSEMA also require that Shell has made information available to all relevant persons who may be affected.

If you have attended one of the forums, you will know a bit about the project by now, but you or your community may have other questions.

If you were not able to attend, Shell is still keen to hear from you, and to respond to your questions.

- Either way**, you can contact Shell via this email address: SDA-crux-project@shell.com, or** call: 1800 059 152**.**

Shell also filmed the first forum, and you can watch parts of it via this link: [link redacted].

Shell has also established an independent environmental panel – people who are not employed by Shell, who can answer any questions you have. If you are unsure about what you've heard at a Forum, or would like more information, please contact any of the people listed below. There is no cost to this, and anything you ask or say will be confidential.

Independent Panel Members
[Details redacted]

Detailed information about these activities is available on our website - http://www.shell.com.au/crux - together with maps of impacted areas. For convenience, please review the below factsheets outlining the main areas of activity for your understanding of the project overall:

- Seabed Survey Environment Plan Factsheet
- Drilling Template Environment Plan Factsheet
- Development Drilling Environment Plan Factsheet
- Crux Installation and Cold Commissioning Factsheet

There are also draft versions of the Environment Plans that will be submitted to NOPSEMA.

A final forum will be held in Darwin at the Hilton Boardroom on 31 May (32 Mitchell St, Darwin), from 9.30 – 1.30pm.

We hope to see you there. Please let Shell know on this email address **SDA-crux-project@shell.com**, if you are attending, or need help getting there, as Shell can help with travel.

Thanks,
The Crux Team.

Appendix A - 7.11 Presentation – Larriakia meeting - 5 September 2023

Shell Australia
Larrakia

5 September 2023

This is Larrakia Country

Aims of today

1. Some background on Shell in Australia and Shell in WA
2. Crux - what it is, where it is at now.
3. Environmental Management and Impacts
4. Priorities for Larrakia
5. Where to from here

- ask questions at any time -

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Who is Shell?

SHELL OPERATED

Crux	82%
Gangarri	100%
Prelude	67.5%
QGC	75%

WHOLLY OWNED SUBSIDIARIES

Powershop	100%
Select Carbon	100%
Shell Energy Australia	100%
sonnen	100%

NON-OPERATED

Arrow	50%
Browse	27%
ESCO Pacific	49%
Gorgon	25%
Kondinin Energy	50%
North West Shelf	16.67%
WestWind	49%

What is Prelude?

- Prelude is a Floating Liquefied Natural Gas (FLNG) project located 475km north-northeast of Broome, Western Australia, in the Browse Basin.
- The Prelude FLNG facility is moored over the Prelude gas field in 250m water depth and more than 200km from the coastline.
- Prelude produces LNG, LPG and condensate.
- Prelude has an onshore supply base in Darwin.

Location:
WA-44-L, in Commonwealth marine waters, 475 km north-north east of Broome in Western Australia

Facility Type:
Floating liquefied natural gas (FLNG) facility

Number of wells:
Seven

Production capacity:
3.6 million tonnes per annum (mtpa) LNG, 1.3 mtpa LPG, 1.3mtpa condensate

Water depths:
250m

Status:
In operation

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The Crux Project

[redacted]

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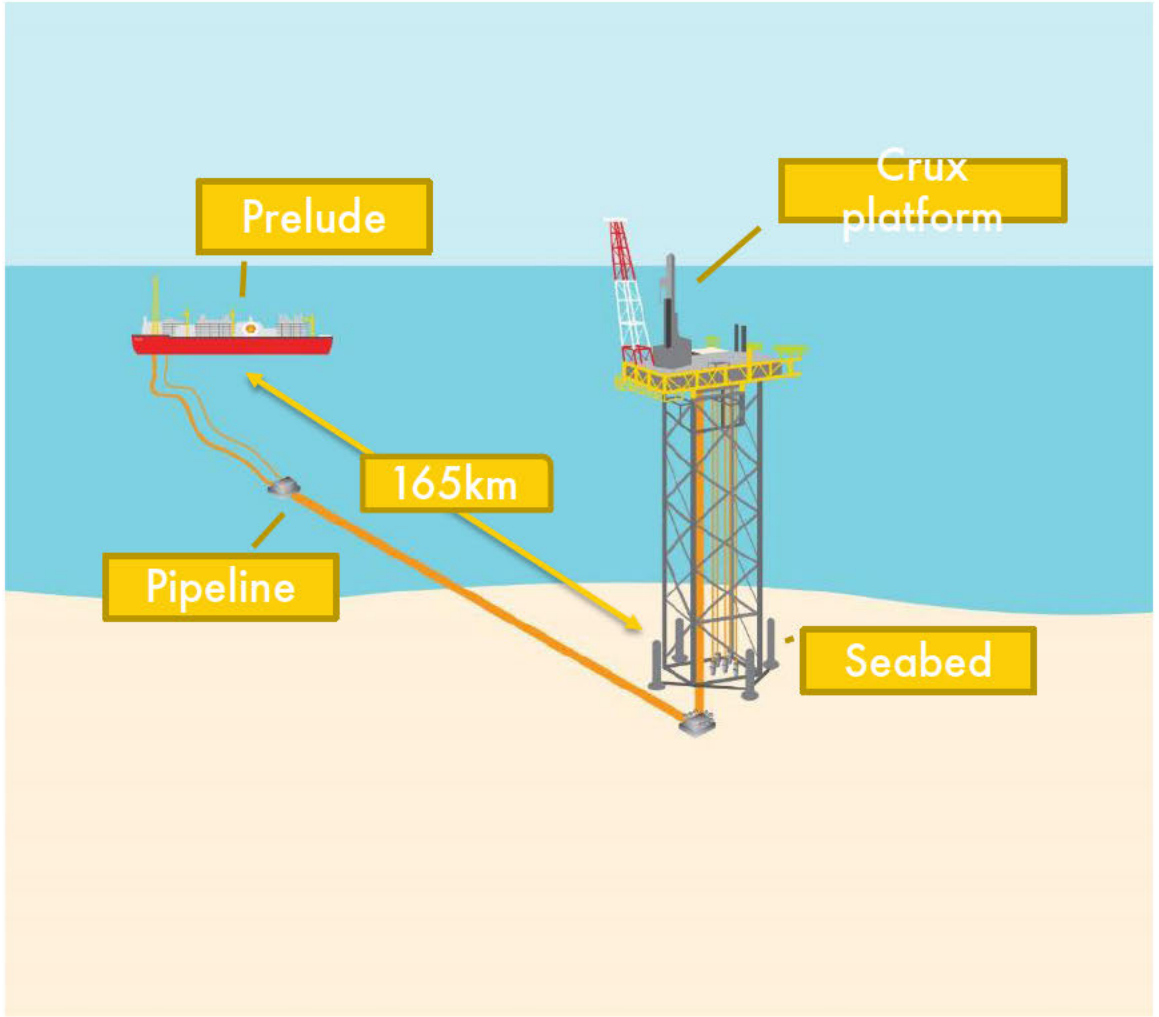
What is Crux?

- In May 2022, Shell Australia and SGH decided to go ahead with Crux.
- The project is a long-term extension to the existing Prelude FLNG facilities.
- Crux consists of a platform (which is not normally manned), above 5 gas wells. The gas is delivered via a pipeline to Shell's Prelude project, which is moored some 165 Km away, and processed onboard.
- The project is part of Shell's strategy to help meet the needs of gas users as the energy market moves to a lower carbon future.



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Crux

- Crux Project?
- The five Environmental Plans and what they cover
    1. Seabed survey
    2. Drilling template
    3. Drilling development
    4. Installation and Commissioning
    5. Completions, Start-up and Operations (just started preparation)

- <u>Shell's obligations to consult, and your rights to raise objections and claims.</u>
- Are there others in Larrakia we should consult?
- What the Crux Environmental Plans do to protect cultural heritage, marine systems, coastlines, TO access to country
- Ongoing engagement with TO groups and other Relevant Persons.
- The Independent Panel

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Crux Environment Plans

These describe the impacts and risks, both planned and accidental that may occur

Planned impacts are known activities that result in physical impact to the environment, i.e.:

- Disturbances to the seabed.
- Drilling Fluid Discharges.
- Noise generated from construction activities.

These planned impacts will occur within close proximity to the operational area. Shell has means to control the impact of these.

Accidents could include:

- Diesel spill as a result of a vessel collision.
- Hydrocarbon spill as a result of loss of well control.
- Introduction of invasive species from the vessels that will be entering Australian waters.

Such accidents are very rare. Shell has to be prepared for them, to ensure they have adequate controls. For each key stage of Crux, Shell develops an Environmental Plan which looks at the key risks of that stage, and the size and scale of any impacts – planned or accidental.

The Environmental Planning Areas represent the maximum outside limit of hundreds of individual, possible spill incidents. They take into account weather, waves, currents, and other conditions.

The environmental plans

There are four Environment Plans for Crux that describe what Shell will do to protect the environment. These must be submitted to, and approved by NOPSEMA.

1. *Seabed Survey Environment Plan – submitted*
2. *Drilling Template Environment Plan – submitted*
3. Development Drilling Environment Plan – submitted
4. Crux Installation and Cold Commissioning Environment Plan – to be submitted in November
5. Completions, Start-up and Operations Environment Plan – just started preperation

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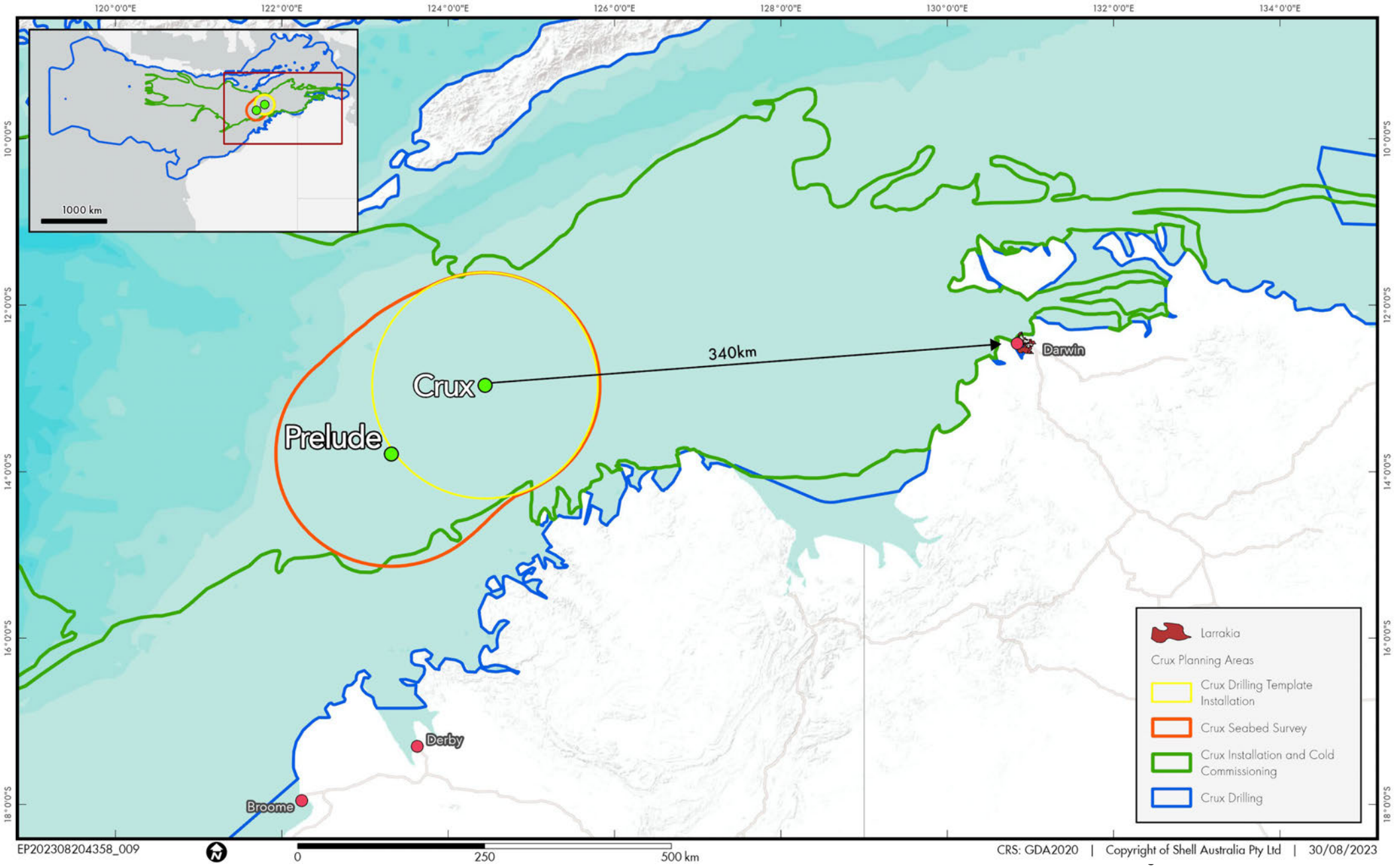
The 4 EP planning areas, Larrakia country.

- Each of the 4 plans relates to a specific geographic area.
- Only EPs 3 and 4 have potential impact to the NT



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Oil Spill modelling

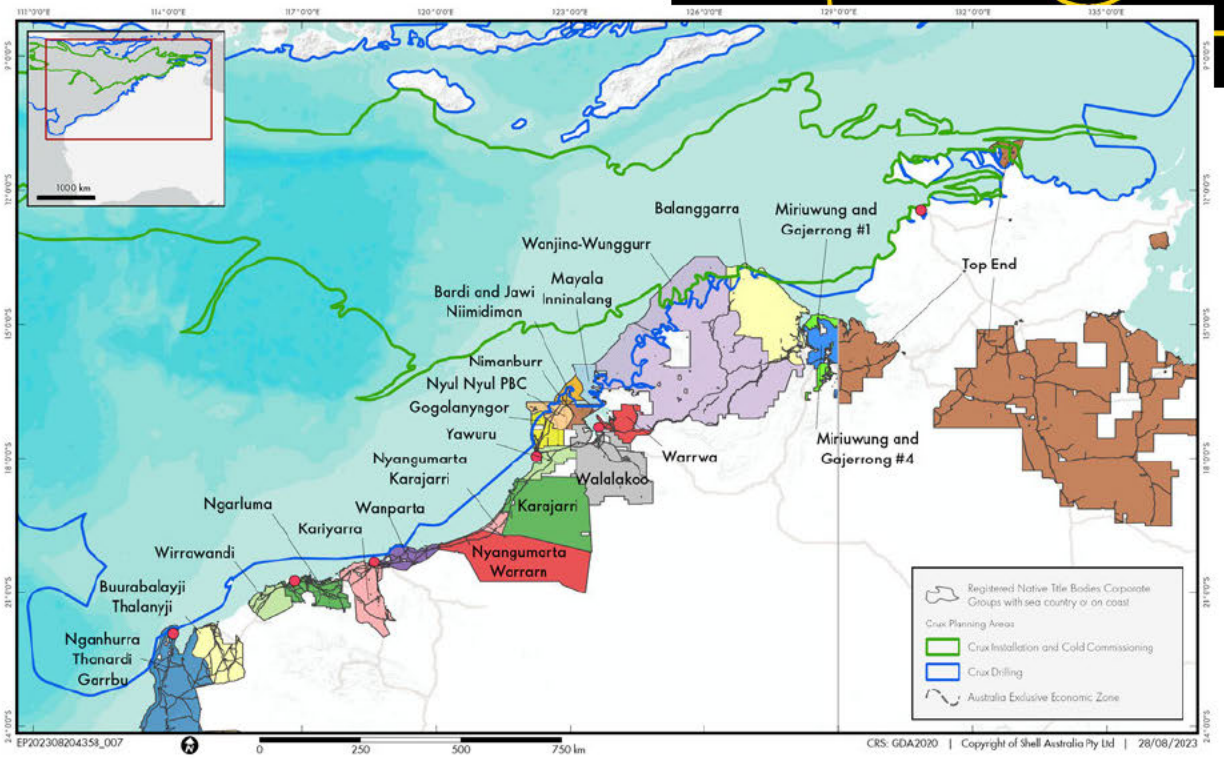
NOPSEMA

Crux Operations - Protecting land and sea Country.

Shell has done a lot of research into what is important to Aboriginal people in the Crux Planning area. We used Healthy Country plans, Native Title Determinations, ILUAs, IPAs, Cultural Heritage Surveys and Assessments, heritage site registration and are talking directly with Aboriginal groups.

Underwater Cultural Heritage

- We've looked at WA and NT databases for registered sites. There are no sites currently registered within the operational areas.
- The Crux operating area is below the historical seabed levels (below 130m sea level). Its very unlikely there is any cultural heritage that far out to sea – the area was never above sea levels when human occupation existed.
- Further work mapping is being done on what tangible underwater cultural heritage could remain in the larger planning area



What we don't know

- Any concerns for particular areas and sites that may exist for each different TO groups
- What you think of our current management methods

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Environmental Panel

A panel of subject matter experts has been established, who you can go to with questions, concerns and complaints
You have access to the panel, with the costs incurred by Shell. It is anonymous.

You can ask whatever you like from the Panel.

They are independent of Shell (although some have previously worked for Shell)

- Shell will not see any of the information shared.
- Any conversation is between you and the panel member.

Redacted names

Redacted phone numbers

redacted emails

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Now what

Shell is keen to keen in touch and develop stronger relationships.

- **Possible further meetings – let Shell know**
- **Talk to your communities**
- **Ask questions of the Panel**
- **Ask questions of Shell what you want to know more about or have concerns**
- **Info on the web**

Web:

- **www.shell.com.au/about-us**
- **Google "Shell Crux"**

SHELL AUSTRALIA INVITES YOU TO COME AND TALK TO US ABOUT THE CRUX PROJECT

In Australia, Shell has an integrated energy solutions portfolio which includes gas production and liquefaction, as well as renewable power and energy solutions businesses.

With our joint venture partner, SGH Energy, we are preparing to develop the Crux natural gas field. This is to ensure a continued supply of gas to Shell's Prelude Floating Liquefied Natural Gas (FLNG) facility, which extracts, liquefies and stores natural gas at sea, before it is transferred and shipped to customers. Prelude FLNG is located around 475km north-north west of Broome in Western Australia.

As part of the Crux development, we will be preparing environmental approvals for submission to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). Consultation with relevant persons is an important part of these approvals.

If you are interested in learning more, Shell Australia invites you to join us at two forums as follows:

Date:
Forum 1: Wednesday 19 April 2023
Forum 2: Wednesday 10 May 2023
Location: Please complete survey to vote on location options

For more information please visit
www.shell.com.au/crux

CRUX PROJECT JOINT VENTURE PARTNER
SGH | Energy

REGISTRATION INSTRUCTIONS
Shell Australia is extending invitations to relevant persons and organisations, to attend our upcoming forums on 19 April and 10 May 2023 to talk to us about our Crux Project.

You have an opportunity to nominate one person to represent your Organization, Native Title Determination Group, Native Title Holders, Native Title Claimants, or Individual/s Family Groups, at the Shell forums.

- All Shell forum participants will be provided with travel and accommodation support.
- All Shell forum participants will have an opportunity to vote on the location of the forum.
- Due to the venue capacity, the forums will be restricted to a maximum of 120 participants.
- To register for the Shell forums, please complete this form by Friday 7th April 2023, 5pm (AWST) and return your form to SDA-cruxproject@shell.com.

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Appendix A - 8.01 NOPSEMA Consultation on Offshore Petroleum Environment Plan Brochure

NOPSEMA | Australia's offshore energy regulator

Consultation on offshore petroleum environment plans

Information for the community

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is Australia's independent expert regulator for health and safety, structural and well integrity, and environmental management for offshore petroleum and greenhouse gas storage activities in Commonwealth waters.

The protection and preservation of the marine environment is best achieved when there are opportunities for the community to participate in the environmental approvals process through consultation.

Who can participate?

Under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the regulations) there are several ways the community can participate in the environmental approvals process for offshore petroleum activities in Commonwealth waters.

Public comment for new projects and exploration activities

Offshore project proposals (OPPs) for new offshore petroleum projects and environment plans for offshore petroleum exploration activities are subject to a mandatory public comment period. Public comment must be done before the OPP or environment plan is submitted to NOPSEMA for assessment. Further information about public comment can be found at nopsema.gov.au.

Relevant persons consultation

Titleholders must consult with a specific category of people or organisations referred to as 'relevant persons' while preparing an environment plan for any offshore petroleum activity. This consultation must be done before the environment plan is submitted to NOPSEMA.

Some categories of relevant persons are specified in the regulations, such as government departments, however the information in this brochure is for the category of relevant persons who are not specified but who have 'functions, interests or activities' that may be affected by the offshore activity.

Correspondence directly to the regulator (NOPSEMA)

You can send correspondence directly to NOPSEMA; however, this generally cannot be considered until after the environment plan has been submitted. It is always better to use the public comment and relevant persons consultation processes in the first instance.

What is 'relevant persons' consultation?

Consultation on offshore petroleum activities is a two-way process where information is shared between titleholders and relevant persons. It is a requirement for titleholders when preparing an environment plan and is an important part of good environmental management.

Consultation provides an opportunity for people or organisations who may be affected by an offshore petroleum activity to raise concerns, including objections or claims, about the potential impacts of the activity, to seek information about how they may be affected, and how the titleholder intends to manage the activity to ensure the associated impacts are as low as reasonably practicable and are acceptable.

Information provided by relevant persons in consultation may also help titleholders better understand the values and sensitivities of the environment and inform the evaluation of the potential impacts and risks associated with the activity and how to manage them appropriately.

Am I a relevant person?

You may be a relevant person if you or your organisation have functions, interests, or activities that may be affected by an offshore petroleum activity proposed under an environment plan being prepared or already underway under an environment plan being revised.

The terms 'functions' 'interests' and 'activities' should be read broadly. You do not have to have a legal or financial interest that may be affected by an offshore petroleum activity to be a relevant person.

Interests that may be affected can include things like cultural and spiritual connections to the sea or interests in the protection of specific marine species. However, to be a relevant person your interests should be more than a general interest in the environment and/or offshore petroleum activities.

If I am a representative body, can I consult on behalf of all my members?

The law recognises that interests may be held communally. In some cases, all members of a community may agree that their representative body can consult on their behalf. However, this may not always be the case. Representative bodies should inform titleholders whether or not they have the authority to consult with titleholders on behalf of all their members.

Representative bodies, such as peak bodies and prescribed body corporates, may be relevant persons in their own right. They may also be an initial point of contact for titleholders to seek information about who else they should approach for consultation.

It is the titleholder's responsibility to provide all members of a community who have a shared interest opportunities to participate in consultation. In some circumstances, representative bodies may offer to assist titleholders with this.

Do I have to participate?

If you are a relevant person, you have the right to be consulted by titleholders of offshore petroleum activities when they are preparing an environment plan to submit to NOPSEMA.

Titleholders have a duty to provide you an opportunity to be consulted, however there is no obligation on you to participate in consultation. If you do not wish to be consulted, you should advise titleholders of this when they first contact you.

Titleholders must make reasonable efforts to consult with relevant persons, but the regulations do not require them to get a response to their requests. If you want to participate in consultation but need more information or time then it is best to communicate this to titleholders when they contact you. If you do not respond, they might assume you do not wish to be consulted.

If you are an organisation or representative body that is regularly approached for consultation you may consider developing guidance outlining how and when you want to be consulted. You could also consider documenting your functions, interests and activities. Both measures may help with managing regular requests for consultation.

In some instances, the likelihood of you being affected by an activity is very low and/or the impact on your functions, interests or activities may be minor. For example, if you are only going to be affected by the activity in the very unlikely event of an oil spill you may wish to inform titleholders you only want to be consulted if a spill occurs as part of the requirement for ongoing consultation set out in the regulations.

What if I want to be consulted but the titleholder hasn't contacted me?

Titleholders have a duty to identify who may be a relevant person and provide them opportunities to participate in consultation. However, even with best endeavors, titleholders may miss people or organisations who may be relevant.

If you believe you are a relevant person and you want to be consulted on offshore petroleum activities, then you should contact titleholders directly and identify yourself as a relevant person.

If a titleholder refuses to consult with you, and you believe you are a relevant person, you can write to NOPSEMA. Once an environment plan is submitted to NOPSEMA, this information can be considered in the assessment of whether or not the titleholder has met the requirements for consultation.

It is always better to attempt to resolve issues with the titleholder in the first instance. Relevant persons consultation is carried out before an environment plan is submitted, so NOPSEMA is limited in its ability to require titleholders to consult with a particular person or organisation.

What is the process for consultation?

There is no detailed process set out for how consultation should be carried out, however there are requirements that must be met under the regulations. These include:

- That you are given sufficient information to make an informed assessment about whether you are likely to be affected by the activity, how you may be affected, and to raise any concerns, including objections or claims, about the potential impacts of the activity.
- That you are given a reasonable period of time to consider the information provided to you and give feedback to the titleholder on the potential impacts of the activity on your functions, interests or activities.

What constitutes sufficient information and a reasonable period of time depends on several factors including the nature of your functions, interests and activities. You should communicate as early as possible in consultation with titleholders about what information and how much time you may need so that they can consider, respond and address these in their planning.

The information provided to you should be in a form that is appropriate and readily accessible to you. Consultation is generally a two-way process where information is shared between titleholders and relevant persons rather than a one-way process of seeking feedback to a fact sheet or high-level information.

What if I don't have the resources to participate?

If you are a relevant person and you believe you have information that is important to the understanding of the potential impacts of an offshore petroleum activity or you want to raise concerns, including objections or claims, then you should discuss with the titleholder how you can participate in consultation.

This might include requesting information in a different format, asking for more time to consider information or help to understand the information to provide an informed response.

There is no requirement in the law for titleholders to pay the costs incurred by relevant persons to be consulted, however they may choose to provide assistance to relevant persons to ensure consultation is carried out efficiently and is robust. This is a matter between the titleholder and relevant persons.

How do I make sure my views are considered?

It is important to communicate clearly when participating in consultation with titleholders. You may provide information to titleholders that helps them understand the environment and raise specific concerns, objections or claims about the potential impacts of the activity or the way the titleholder proposes to manage the activity to ensure the associated impacts are as low as reasonably practicable and are acceptable.

The information you provide to a titleholder during consultation must be considered by that titleholder and addressed in their environment plan for NOPSEMA to consider in its assessment and decision-making.

NOPSEMA publishes environment plans on its website when they are submitted for public comment, for assessment and when they are approved. Relevant persons have the right to request that the information they have provided in consultation is not published and titleholders must ensure they communicate this right to relevant persons.

Relevant persons should be aware that while you are free to respond on any matter and raise any concern, this may not be able to be considered if it is outside the scope or purpose of the environment plan and approval process. Examples of issues that may not be considered under the regulations include statements of fundamental objection to offshore petroleum activities or information containing personal threats or profanities.

Do titleholders need my consent?

Titleholders are not required by law to obtain agreement or consent from relevant persons for their offshore petroleum activities to proceed; however, they are required to demonstrate in their environment plan how the concerns, objections or claims raised by relevant persons were considered and demonstrate that their response to that information was appropriate.

NOPSEMA's assessment and decision-making will consider if titleholders have adequately demonstrated in the environment plan that genuine consultation has taken place with relevant persons in accordance with regulations.

Do I need to respond to a request for consultation?

There is no obligation for relevant persons to respond to a request for consultation from a titleholder. However, if you are provided an opportunity to participate in consultation and you do not want to be consulted, or you only want to be consulted on specific offshore petroleum activities or environmental matters, then it is best that you communicate this to titleholders as soon as they contact you. If you do not respond to requests for consultation, titleholders may make many repeated attempts to contact you.

NOPSEMA can help you understand the requirements for consultation and how to effectively participate in the process. Please contact communications@nopsema.gov.au for assistance.

NOPSEMA | Australia's offshore energy regulator

Further information

For further information visit nopsema.gov.au or contact communications@nopsema.gov.au.

Key legislation

Offshore Petroleum and Greenhouse Gas Storage Act 2006
Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
Environment Protection and Biodiversity Conservation Act 1999.

Contact details

p: +61 (08) 6188 8700
e: communications@nopsema.gov.au

Head office: Level 10, Alluvion Building
58 Mounts Bay Road, Perth WA 6000

Postal: GPO Box 2568 - Level 10 58 Mounts Bay Road, Perth WA 6000

nopsema.gov.au

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

ABN 22 385 178 289

Published May 2023

Appendix C Summary of Consultation

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
Section 25(1)(a) of the OPGGS(E) Regulations							
Commonwealth & State Government Departments or Agencies							
8.	Australian Border Force (Maritime Border Command)	27 March 2023 *(Initial email)* **Email from Shell** 04 April 2023 (Calendar invite) 20 April 2023 09 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
4.	Australian Communications and Media Authority (ACMA)	27 March 2023 *(Initial email)* **Email to Shell** 03 April 2023 **Email from Shell** 20 April 2023 23 May 2023	**Email on 03 April 2023** Confirmed that: ACMA regulates the submarine cable regime as set out in Schedule 3A to the *Telecommunications Act 1997* (Cth). ACMA may declare 'protection zones' for submarine cables of national significance and permit the installation of submarine cables. The Planning Area does not overlap any existing protection zones but overlaps the North-West Cable System owned and operated by Vocus. Recommended that Shell contact the: AHO for further assistance in identifying submarine cables that may be impacted by the Activity. Owner of any existing or planned submarine cables within the Project Area.	**Email on 23 May 2023** Confirmed that a contract between Shell and Vocus is in place for the Prelude fibre optic cable and connecting the Crux platform to the existing North-West Cable System is in place. Weekly engagement, including Crux Project updates occurs with Vocus. Recapped on what Shell is consulting on and the obligation to consult under the OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details.	No objections or claims have been received about activity impacts or risks.	Provided information regarding existing and proposed submarine cables within the Planning Area which was considered to be a relevant matter. Shell confirmed through consultation with the owner/proponents that the cables would not be affected by the activity covered by this EP.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of this EP has been completed in accordance with the OPGGS(E) Regulations.
5.	Australian Fisheries Management Authority (AFMA)	27 March 2023 *(Initial email)* **Email to Shell** 30 March 2023 06 April 2023 26 April 2023 12 September 2023 13 September 2023 **Email from Shell** 04 April 2023 20 April 2023 21 April 2023 26 April 2023 27 April 2023 11 September 2023 13 September 2023 18 September 2023	**Email on 30 March 2023** Recommended that Shell contact fisheries. **Email on 06 April 2023 & 26 April 2023** Accepted the invitation and then apologies for not attending the Industry Briefing. **Email on 12 September 2023** Provided an update that the best AFMA contact person is yet to be confirmed. **Email on 13 September 2023** Advised that: Numerous traditional and illegal foreign fishers may operate within the MOU Box. Indonesian fishers who currently access the MOU Box are from a wide geographical area across East Nusa Tenggara province. AFMA doesn't license, regulate or have contact details for traditional fishers.	Information was used to obtain relevant licensed fishers contact details. **Email on 11 September 2023** Requested a AFMA contact to discuss fisheries operating within the MOU Box 74 and a process for consulting with these traditional fishers. **Email on 18 September 2023** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	Provided information regarding fishing activity/ contacts for fishers that may be affected by the Activity which is considered a relevant matter. Shell has consulted with relevant fishers during preparation of this EP.	Section 5.6.4.4 details how Shell has undertaken consultation with relevant commercial fishers. Outcomes of consultation with the fishers and associated fishing industry representatives is summarised in this table and considered where relevant in Section 7.4.4, Section 9.3 and Section 9.14. The consultation approach with MOU Box fishers

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
			Contacting Indonesian fishers will require direct work in-Country, and the Northern Compliance team could assist with suggesting areas within Indonesia if Shell wanted to pursue this option.				is described in Section 5.5.2.10. Accordingly, consultation in the course of preparation of this EP has been completed in accordance with the OPGGS(E) Regulations.
2.	Australian Hydrographic Office (AHO) – Department of Defence Operations Branch	27 March 2023 *(Initial email)* **Email to Shell** 28 March 2023 27 April 2023 **Email from Shell** 22 May 2023 18 September 2023	**Email on 28 March 2023** Advised that the data supplied will be registered, assessed, prioritised and validated in preparation for updating navigational charting products in accordance with the International and Australian Charting Specifications and standards. **Email on 27 April 2023** Advised that: The Activity Area is located within the North Australian Exercise Area (NAXA) and restricted airspace. The unexploded ordnance (UXO) may be present on and in the sea floor, hence Shell must consider the risks associated with conducting activities in the area (for example, the detonation of UXO) and provided an overview of other things to consider. Requested the continued AHS liaison and that AHS is notified three weeks prior to the activity commencing to enable the issuing of the Notice to Mariners.	**Email on 22 May 2023** Confirmed that Shell: is informed as to the risks associated with UXO and the Activity will continue to liaise with the AHS/AHO for Notices to Mariners. Recapped on what Shell is consulting on and the obligation to consult under the OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	The issuance of information to support a Notice to Mariners is a relevant matter. An existing control, performance standard (Table 9-9 and Table 9-83) and notification requirement (Table 10-6) is detailed within the EP. Shell investigated the risk of UXO. The NAXA is located within the Planning Area and does not intersect the Activity Area (where seabed disturbance is planned), therefore this is not a relevant matter for the preparation of this EP. This is further described in Section 7.4.6.	Table 9-9, Table 9-83 and Table 10-6 have been updated to reflect the Notice to Mariners submission timing (four weeks). No other additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
3.	Australian Maritime Safety Authority (AMSA)	27 March 2023 *(Initial email)* **Email to Shell** 28 March 2023 04 April 2023 24 April 2023 26 April 2023 **Email from Shell** 20 April 2023 26 April 2023 04 May 2023 22 May 2023 18 September 2023 **In Person** 27 April 2023	**Email on 28 March 2023** Continue to provide project updates to AMSA as per initial advice received during the field development plan and Crux Pipeline and Production license consultation in 2021. Request that: AHO is notified no less than 4 weeks prior to operations, with relevant details. AMSA's JRCC is notified by email for promulgation of radio navigation warnings at least 24–48 hours before operations commence. Commented on vessel compliance requirements – appropriate lights and shapes to reflect the nature of operations. Industry Forum on 27 April 2023 AMSA attended Shell's Industry Forum held at Shell House.	**Email on 04 May 2023** Shell shared presentation and publicly available Crux EPs with AMSA post the Industry Forum. **Email on 22 May 2023** Close out email sent which covered the following: AMSA's initial advice that Shell: Contact the AHO no less than 4 weeks prior to operations, with details relevant to the operations. Notify AMSA's JRCC by email for promulgation of radio navigation warnings at least 24–48 hours before operations commence.	No objections or claims have been received about activity impacts or risks.	Raised relevant matters in regards pre-activity notifications and vessel navigation compliance requirements. Matters raised have been addressed as controls, EPS and/or notifications requirements stipulated in the EP.	Requirement to notify AHO 4 weeks prior to operations is included as a control in Table 9-9 and Table 9-83 and listed in notifications table (Table 10-6). Requirement to notify AMSA's JRCC 24–48 hours before vessel activities commence is stipulated in notifications Table 10-6.

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				Adhere to vessel compliance requirements – appropriate lights and shapes to reflect the nature of operations. Recapped on what Shell is consulting on and the obligation to consult under the OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 18 September** Email sent to all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			Navigation safety requirements for project vessels are included as a control in Table 9-9 and Table 9-83. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
10.	Clean Energy Regulator (CER)	27 March 2023 *(Initial email)* **Email to Shell** 06 April 2023 **Email from Shell** 04 April 2023 (calendar invite) 06 April 2023 20 April 2023 26 April 2023 18 September 2023	**Email on 06 April 2023** Accepted invitation to Industry Forum but did not attend.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
13.	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	**Email to Shell** 21 April 2023 24 April 2023 26 April 2023 27 April 2023 24 May 2023 **Email from Shell** 04 April 2023 (calendar invite) 17 April 2023 20 April 2023 22 April 2023 *(Initial email)* 04 May 2023 23 May 2023 7 June 2023 18 September 2023 **Virtual attendance at Industry Forum**	**Virtual attendance at the Industry Forum on 27 April 2023** Enquired about the public availability of the Crux EPs. **Email on 24 May 2023** Advised that: DCCEEW administers the UCH Act and EPBC Act and provided a UCH (maritime and First Nations) legislative requirement overview. potential for First Nations cultural heritage remains to occur within Australian waters up to depths of approximately 130–140 m. Recommended that Shell: Engage a suitably qualified and experienced maritime or underwater archaeologist for advice on how to mitigate risks associated with protected UCH. Undertake a Desktop UCH Assessment to identify known and potential UCH resource that may be impacted by the Activity and to propose a forward work program for additional UCH Impact Assessment if required. A detailed assessment program should describe and assess the UCH resource, identifying potential UCH risks of impact, and mitigation measures to adequately reduce the risk of or avoid impacts. Undertake ongoing consultation with the DCCEEW UCH team regarding the activities that have the potential to impact UCH.	**Virtual attendance at the Industry Forum on 27 April 2023** Confirmed Crux EPs will be made public and offered to share website links. **Email on 04 May 2023** Thanked DCCEEW for attendance at the Industry Forum and provided links to the draft EPs. **Email on 23 May 2023** Close out email sent. **Email on 24 May 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under the OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details.	No objections or claims have been received about activity impacts or risks. Consultation regarding potential UCH has been undertaken for the EP, including with First Nations peoples, and ongoing consultation will include the DCCEEW UCH team.	DCCEEW raised the following matters that were considered relevant to the activity: Need to engage a suitably qualified and experienced maritime or underwater archaeologist to assist with identifying and managing potential impacts to UCH. Inclusion of DCCEEW UCH team in ongoing consultation processes in relation to activities that have	The outcomes of an archaeological UCH assessment have been incorporated into Section 7.4.1.3 and the assessment of potential impacts (Section 9.6.2.3). Extensive consultation has been undertaken with First Nations peoples (Section 5.6.4), consistent with relevant guidance (Section 5.3.2 – including the Interim Guidance) and outcomes used to inform the EP description of the environment (e.g.

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		27 April 2023	Has regard to the Interim Engaging with First Nations People and Communities on Assessments and Approvals under the EPBC Act when planning activities that have the potential to impact on First Nations heritage. Engage early and often with First Nations people who may have an interest in the Project to provide an opportunity to voice concerns and assist in the design of an adequate assessment program to protect UCH, if required.	**Email on 7 June 2023** Confirmed that: The planned activity does not overlap or impact the values of any Commonwealth Marine Park or any known UCH site (noting underwater archaeological studies and impact assessment are currently being undertaken). While impacts to Commonwealth Marine Parks and UCH sites are possible in the event of an unplanned hydrocarbon spill, Shell considers the adoption of the proposed controls will reduce the likelihood and mitigate possible impacts. Shell is engaging with Indigenous people on their values and interests (including heritage). Shell will notify DPIRD, WAFIC, and relevant fishery licence holders prior to the commencement and at the end of the activity. Shell considers the measures and controls in the EP address DCCEEW's and DAFF's functions, interests, or activities. Ongoing consultation and evaluation of feedback will occur throughout the life of the EP. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.		the potential to impact UCH. Consider and engage with First Nations people in relation to potential UCH impacts, with regard to the DCCEEW's interim guidance. Shell has commissioned a specialist UCH assessment and relevant outcomes have been used to inform the description of environment and impact assessment in the EP. Shell's statement to "notify DPIRD, WAFIC and relevant fishery licence holders prior to the commencement and at the end of the activity" is not considered a relevant matter to this EP. This was an error in response and was not requested by the relevant persons.	Section 7.4.1) and assessment of potential impacts to UCH (e.g. Section 9.14.6). For any matters regarding the likelihood, or actual establishment of cultural heritage features within the Activity Area, ongoing consultation will be implemented with the DCCEEW UCH Team (Table 5-14). Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
9.	Department of Foreign Affairs (DFAT)	27 March 2023 *(Initial email)* **Email to Shell** 26 April 2023 19 May 2023 08 June 2023 14 Sept 2023 22 Sept 2023 29 Sept 2023 **Email from Shell**	**Email on 19 May 2023** DFAT noted the Activity, that NOPSEMA is the relevant regulator for EPs and that DFAT can assist with consulting Indonesian or Timor-Leste Governments, if required. **Email on 08 June 2023** Provided points of contact for Timor-Leste and Indonesia Governments for consultation in case of a worst-case oil spill event. Confirmed that AMSA notified DFAT in the event of a maritime incident involving another country. **Email on 14 September 2023**	**Email on 7 June 2023** Close out email sent which covered the following: Outlined the Crux EP approval process and noted DFAT assistance for contacting the Indonesian or Timor-Leste Governments if required. Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations.	No objections or claims have been received about activity impacts or risks.	The outcomes from DFAT's advice to identity traditional fishers contact details resulted in additional consultation with AMFA and Shell's specialist government affairs personnel located in Indonesia. The specialist advice confirmed that the	The MOU Box traditional fishers consultation approach, developed in consultation with both DFAT and AFMA, is described in Section 5.5.2.10. Based on consultation undertaken for preparation of this

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		04 April 2023 (Calendar invite for industry forum) 20 April 2023 04 May 2023 09 May 2023 17 May 2023 07 June 2023 11 Sept 2023 14 Sept 2023 18 September 2023 21 Sept 2023 10 October 2023	Update provided on DFAT's response. **Email on 14 September 2023** Confirmed that the DFAT Timor-Leste and Indonesian branches will review and provide input on the Shell Crux EPs. **Email on 29 September 2023** Confirmed that AFMA is responsible for the MoU Box and providing high level advice on the joint management of the waters in the MoU Box, however unlikely to provide traditional fishers contact details. Suggested that the best contact for identifying traditional fishers contacts details would be Indonesian Government's Directorate of Surveillance of Marine and Fisheries Resources (within the Ministry for Marine Affairs and Fisheries).	Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 11 September 2023** Requested assistance with identifying the contact details of traditional fishers that may occur within the MOU Box. **Email on 14 September & 21 September 2023** Follow up emails. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 10 October 2023** Communicated that AFMA confirmed that AFMA cannot provide contact details for traditional fishers.		Indonesian Government would not be able to provide traditional fishers contact details within a reasonable period.	EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
14.	Department of Industry, Science, and Resources (DISR) (Including NOPTA)	**Email from Shell** 04 April 2023 (Calendar invite) 17 April 2023 20 April 2023 22 April 2023 *(Initial email)* 09 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
6.	Director of National Parks (DNP)	27 March 2023 *(Initial email)* **Email to Shell** 14 April 2023 21 April 2023 **Email from Shell** 20 April 2023 22 May 2023 7 June 2023 18 September 2023	**Email on 14 April 2023** Confirmed: No authorisation requirements from the DNP are required. Nearby marine parks and values (refer to management plans) that should be considered during the impact and risk assessment. DNP notification requirement for pollution incidences which occur within or likely to impact a marine park. Noted the acceptable level of impact identified as outlined in the Crux OPP and confirmed that the DNP has no objections and claims at this time.	**Email on 22 May 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under the regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 7 June 2023** Confirmed that: The proposed activities are outside of Marine Park and no credible impacts to the values of any Commonwealth Marine Parks will result from planned activities. While impacts to Commonwealth Marine Parks are possible in the event of an unplanned hydrocarbon spill, Shell considers the adoption of the proposed controls	No objections or claims have been received about activity impacts or risks.	Requested to be notified in the event of an incident that is within or likely to affect an Australian Marine Park. Provided advice regarding sources of information on the objectives and values of Marine Parks and how these should be considered in the EP. Shell assessed the matters raised to be relevant matters and has addressed them accordingly in this EP.	A description of the objectives and values of Australian Marine Parks within the Planning Area, including information sourced from the North-west Marine Parks Network Management Plan and Australian Marine Parks Science Atlas is included in EP Section 7 and considered in the assessment of potential impacts from the activity (Section 9.14.6). The listed acceptable level

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				will reduce the likelihood and reduce possible impacts to ALARP. The activity is not inconsistent with any marine park management plans. Shell will notify DNP, as outlined in the Oil Pollution Emergency Arrangements (Australia) and Oil Pollution First Strike Plan and aligned to the DNP notification request. Ongoing consultation and evaluation of feedback will occur throughout the life of the EP.			of impacts set during the Crux OPP have been incorporated in this EP (Table 8-3) and assessment against these acceptable levels of impacts have been completed for relevant environmental aspects throughout Section 8.3. The DNP notification requirements are listed in Table 10-8. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
22.	Indigenous Land and Sea Corporation (ILSC)	01 May 2023 (registered letter)	No response	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
7.	National Native Title Tribunal (NNTT)	27 March 2023 *(Initial email)* **Email from Shell** 04 April 2023 20 April 2023 09 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
15.	Department of Agriculture Fisheries and Forestry (DAFF)	22 April 2023 *(Initial email)* **Email to Shell** 27 April 2023 **Email from Shell** 24 May 2023 7 June 2023 18 September 2023	**Email on 27 April 2023** Provided advice regarding possible biosecurity risk between the proposed Crux topsides and domestic conveyances (support vessels and aircraft) interactions. This included regulatory and DAFF process guidance.	**Email on 24 May 2023** Close out email sent which covered the following: Shell has procedures to meet DAFF and biosecurity requirements. Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details.	No objections or claims have been received about activity impacts or risks.	The EP considers the Biosecurity Offshore Installation Guide and MARS reporting requirements including the adoption of controls consistent with the applicable requirements (noting the non-relevant matter detailed below). The matters relevant are related	Section 9.8 includes controls and performance standards to meet the applicable requirements including guidelines, legislative requirements and international codes. Table 9-43 lists the control to address MARS reporting and

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				Email on 7 June 2023 Confirmed: project vessels: • are required to comply with the *Biosecurity Act 2015* (Cth), specifically the Australian Ballast Water Management Requirements to prevent introducing IMS. • will be assessed and managed to prevent the introduction of IMS in accordance with Shell's Invasive Marine Species Management Plan. Shell has assessed the relevancy of Commonwealth fisheries issues regarding the possible IMS impacts in this EP. Shell will notify DPIRD, WAFIC, and relevant Fishery Licence Holders that have the potential to be directly impacted by proposed activities in the Planning Area prior to the commencement and at the end of the activity. Shell considers the measures and controls in the EP address DCCEEW and DAFF's functions, interests, or activities. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.		to IMS introduced via biofouling and ballast water. These requirements are adequately controlled as detailed in Section 9.8. The requirement to obtain an exemption from biosecurity control under the Determination is known and understood by Shell and considered not considered a relevant matter to this EP as movements of people and goods between offshore installations and mainland Australia, are not considered a petroleum activity under this EP. This matter will be dealt with through existing internal and related exemption application processes. Shell's statement to "notify DPIRD, WAFIC and relevant fishery licence holders prior to the commencement and at the end of the activity" is not considered a relevant matter to this EP. This was an error in response and was not requested by the relevant persons.	associated biofouling/ballast management requirements. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
Section 25(1)(b) of the OPGGS(E) Regulations							
24.	Aboriginal Areas Protection Authority NT (AAPA)	**Email to Shell** 24 May 2023 21 June 2023 **Email from Shell** 04 April 2023 (calendar invite) 20 April 2023	**Email on 24 May 2023** Advised that AAPA administers the *Northern Territory Aboriginal Sacred Sites Act 1989* (NT) and listed their functions and responsibilities. Noted that the Abstract of Records identifies Aboriginal sacred sites, however there are likely to be more Aboriginal sacred sites than are recorded. Disagreed with the impact assessment made within the Shell Browse Regional OPEP and stated that a spill has the potential to cause damage to sacred sites situated along	**Email on 24 May 2023** Close out email sent which covered the following: Shell will comply will all relevant requirements. Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations.	AAPA raised an objection/claim regarding the conclusions on potential risk to sites of cultural significance in the Browse Regional OPEP. This is a	AAPA provided information regarding sacred sites along the coastline within the Planning Area, confirmed the need for consultation with custodian groups and requirements for	Requirement to notify TEMC in the event of a spill that may impact NT waters has been included in EP notifications Table 10-8.

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		22 April 2023 *(Initial email)* 09 May 2023 24 May 2023 06 June 2023 22 June 2023 04 July 2023 18 September 2023 **Phone call** 26 June 2023	the NT coastline if allowed to reach the shoreline. AAPA stated that it is an offence to damage or desecrate a sacred site under the NT Aboriginal Sacred Sites Act 1989, which may lead to prosecution. An emergency clean-up event may require entry and works on a sacred site and appropriate measures for remediation may not in all instances align with cultural protection measures. If a spill were likely to impact the coastline, AAPA expects to be notified immediately and discuss the mitigation plan. Recommended that Shell applies for an Authority Certificate for emergency response activities, including risk management and spill clean-up/environmental rehabilitation. The Authority Certificate process enables consultation with key custodian groups (of whom there may be many because of the scale) to identify Aboriginal sacred sites and other sites at risk, and to develop protocols for the conduct of a clean-up event prior to it occurring, such as sensitive sacred site areas that must not be entered without nominated custodians being present, or gender restricted areas. A notification protocol would be established as part of the conditions. Actions may have a reporting requirement in a set timeframe after the event. AAPA's comments does not constitute consultation with Aboriginal custodians, however an Authority Certificate process would meet the requirements for consultation. **Email on 21 June 2023** Confirmed that the advice provided on 24 May 2023 regarding Authority Certificate and contacting relevant Indigenous people along the coastline has been retracted. Provided an update that the NT government emergency response team (in consultation with AAPA and APPEA) are updating their plan to coordinate an industry-wide plan for response to a spill affecting NT waters. Therefore, all APPEA members where the spill modelling predicts potential impacts within NT waters, will be bound by the same emergency response protocols with respect to protecting sacred sites.	Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 06 June 2023** Confirmed that: Shell is aware that not all Aboriginal sites are captured in the register and that sites that may be impacted by an oil spill. Shell is consulting with relevant Indigenous people along the coastline within the planning area to discuss these matters. AAPA will be notified in the event of a spill, and that AAPA's contact details are now included in the Browse Regional OPEP. Shell will apply for an Authority Certificate for emergency response activities, including risk management and spill clean-up/environmental rehabilitation. **Email on 22 June 2023** Shell is progressing with the Authority Certificate application. **Phone call on 26 June 2023** Refer to summary provided in email 04 July 2023. **Email on 04 July 2023** Outlined different approaches for Shell to fulfill its responsibility in the event of hydrocarbon spills that may impact the NT coastline, in particular the issue of operating under correct authority through the acquisition of, and compliance with, AAPA Authority Certificate. Confirmed that the NT Government is updating its emergency response approaches, and the discussions between APPEA and other titleholders working on EP/OPEP engagement in the NT. Territory Emergency Management Council (TEMC) will: • be the NT controlling agency, for oil spills which originate in Commonwealth waters, which then enter NT waters/impacting NT shorelines. • assist with remote area response operations, including land access and working with the local councils.	misinterpretation of the Browse Regional OPEP and not considered to have merit. The conclusions cited relate to the efficacy of different response options to reduce impacts from a spill to sites of cultural significance.	arranging access for spill response purposes, which are considered relevant matters. The process for arranging access for spill response, including AAPA certificates, has evolved and is now administered by TEMC. Shell has consulted with First Nations relevant persons, including to establish notification requirements in the event of a spill and to identify additional information that would assist in managing impacts and risks to ALARP. Shell considers the measures and controls in the EP address AAPA's functions, interests, or activities.	Section 7.4.2 includes an assessment of the AAPA database and describes the types of heritage places as they relate to the planning area. Extensive consultation has been undertaken with First Nations peoples (Section 5.6.4), and outcomes used to inform Section 7.4.2 and assessment of potential spill impacts to heritage sites (e.g. Section 9.14.6). Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

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				• act as the incident controller and manage all aspects of acquisition & compliance with AAPA certificates, at the time of the spill event. The TEMC approach to ensure any spill events are responsibly and appropriately managed, and as such, Shell will adopt this approach in the EP where NT coastline may, in the event of an uncontrolled release, be impacted. Confirmed that seeking Authority Certificates represents an untenable workload for AAPA and will not pursue this approach going forward. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
26.	Department of Biodiversity, Conservation and Attractions (DBCA)	27 March 2023 *(Initial email)* **Email to Shell** 06 April 2023 30 October 2023 **Email from Shell** 22 May 2023 18 September 2023 08 December 2023 **Phone call** 07 December 2023	**Email on 06 April 2023** Confirmed that: There are ecologically important areas including marine parks and island/coastal reserves that have the potential to be affected by a substantial hydrocarbon release. Baseline values and state are important. DBCA monitors marine parks and reserves and publishes monitoring reports publicly. This data is used to inform DBCA's values and objectives relating to marine park management and is not necessarily suitable to provide all baseline information required for oil spill risk assessment and management planning. DBCA will not implement an oiled wildlife management response on behalf of a petroleum operator except as part of a whole of government response mandated by regulatory decision makers. Requested that, Shell confirms that appropriate baseline survey data. Shell notify DBCA's Kimberley regional office as soon as practicable after an oil spill. Recommended that Shell: Acquire the necessary information to implement a Before-After, Control-Impact (BACI) framework in planning and evaluating its management response. This may include independently monitoring and collecting data where required or identifying other data sources. Commit to the monitoring and clean-up of any DBCA interests affected by an oil spill in consultation with DBCA. Refer to the DoT (https://www.transport.wa.gov.au/imarine/marine-pollution.asp), and the Offshore Petroleum Industry Guidance Note of September 2018 titled Marine Oil Pollution: Response and Consultation Arrangements. These documents provide information on the WA emergency management arrangements for marine oil pollution incidents in State waters, petroleum titleholders' obligations under those arrangements, and the DoT's expectations as the jurisdictional authority for such incidences.	**Email on 22 May 2023** Close out email sent which covered the following: Confirmed that Shell: Maintains adequate baseline data and provided relevant information to demonstrate this statement. Appropriately manages the risk posed by major hydrocarbon releases including Prelude OPEP with linkages to State Authorities and will build upon this for future oil spill planning and preparedness for the Crux activities as part of future EPs. This includes the consideration of response preparedness arrangement for major spill events and associated operational and scientific monitoring. The Prelude FLNG has recently adopted the APPEA industry operational and scientific monitoring framework, which is a standardised approach to monitoring before, during and following a major hydrocarbon release. This standard takes a risk-based approach to monitoring approaches such as the BACI framework and, subject to future spill planning and preparedness assessments, Crux is also likely to adopt this standard. Considers and applies, as appropriate, all relevant government publications (e.g., managements plans, including the National Light Pollution Guidelines for Wildlife and Offshore Petroleum Industry Guidance Note). **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 8 December 2023**	No objections or claims have been received about activity impacts or risks.	DBCA requested to be notified in the event of a spill and provided information regarding environmental baselines and spill response, and the use of a BACI framework for impact monitoring. These matters are considered relevant and have been addressed by the EP (and associated spill response documents). Other issues raised were not considered relevant matters	Requirement to notify DBC in the event of a spill that may impact WA marine parks or reserves has been included in EP notifications Table 10-8. Requirement to notify DBCA in the event of a spill has been included in Browse Regional OPEP Table 2.4. Section 10.8.5 describes the OSMP. Within the OSMP the baseline data sources along with the approaches (including BACI) and resourcing that will be applied to appropriately collect and evaluate environmental data in the event of spill impacts is outlined. Accordingly, consultation in the course of preparation of the EP has been completed in

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			Email on 30 October 2023 Reviewed Shell documentation with the following comments: Recommend a comprehensive baseline monitoring of ecologically important areas and reserves which may be impacted by a substantial hydrocarbon release and oil spill response preparedness. Refer to National Light Pollution Guidelines for Wildlife and DoT (WA) Industry Guidance Note of July 2020 titled Marine Oil Pollution: Response and Consultation Arrangements for current information on the WA emergency management arrangements for marine oil pollution incidents. Activities requiring access to reserves managed by DBCA may require additional approvals and early consultation with DBCA.	Confirmed that Shell: Has conducted suitable environmental baseline studies and provided supporting information. Does not undertake comprehensive baseline monitoring of ecologically important areas and reserves to inform oil spill planning; however, areas of protection priority are identified using various literature, including baseline information provided in DBCA conservation management plans. Used the DOT industry guidance note in preparing the Browse Regional OPEP which outlines that additional approvals may be required in an emergency event. Provided Shell's oil response documents for perusal.			accordance with the OPGGS(E) Regulations.
21.	Department of Environment, Parks, and Water Security (DEPWS)	01 May 2023 (registered letter)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
11.	Department of Jobs, Tourism, Science, and Innovation (JTSI)	27 March 2023 *(Initial email)* **Email to Shell** 06 April 2023 (Calendar decline) **Email from Shell** 04 April 2023 (calendar invite) 20 April 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
23.	Department of Planning Lands and Heritage (DPLH) (Includes Heritage Council of WA and Aboriginal Cultural Material Committee (ACMC)	27 March 2023 *(Initial email)* **Email to Shell** 06 April 2023 02 May 2023 **Email from Shell** 04 April 2023 (Calendar invite) 17 April 2023 18 May 2023 30 May 2023 18 September 2023	**Email on 06 April 2023** Requested further information regarding land development in order to determine any possible heritage listings. **Email on 02 May 203** Noted that the: Activity will not be impacting a place that is in the State Register of Heritage Places, within the vicinity of a place on the Register, subject to a heritage agreement, or identified as a place warranting assessment by the Heritage Council. There is no objection to the proposal from a historic heritage perspective. Recommended that additional consultation regarding Troughton Island (Aboriginal Heritage Place) and Ashmore Reef (Commonwealth Heritage List) occurs.	**Email on 17 April 2023** Confirmed that there is no land development within the scope of this EP. **Email on 18 May 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	Requested information regarding the activity and advised re Commonwealth heritage sites in/proximal to the Planning Area, which is considered a relevant matter. The information requested was provided and advice regarding heritage sites appropriately addressed in the EP.	The Commonwealth heritage listing of Ashmore Reef is described in EP Section 7.3.4. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
12.	Department of Primary Industries and Region Development (DPIRD) – Fisheries Division	27 March 2023 *(Initial email)* **Email to Shell** 05 April 2023 06 April 2023 (Calendar decline) 21 April 2023 **Email from Shell** 04 April 2023 (Calendar invite) 20 April 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
16.	Department of Transport (DoT)	27 March 2023 *(Initial email)* **Email to Shell** 13 April 2023 14 June 2023 04 July 2023 05 July 2023 09 July 2023 10 January 2024 **Email from Shell** 04 April 2023 20 April 2023 18 May 2023 7 June 2023 14 June 2023 30 June 2023 04 July 2023 05 July 2023 18 September 2023 04 December 2023 15 December 2023 19 February 2024 **Phone call** 22 June 2023 Virtual Meeting 27 June 2023	**Email on 13 April 2023** Requested that DoT (WA) is notified if there is a risk of an oil spill impacting WA waters and consulted in accordance with the Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020). **Email on 14 June 2023** Requested a copy of the OPEP for review prior to an EP being accepted. **Email on 9 July 2023** Confirming recipient of EP and Browse Regional OPEP documents. **Email on 10 January 2024** Provided comments from the review of the EP, Shell Browse Regional OPEP and WA Oil Spill Control Agencies – Consultation Report.	**Email on 18 May 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under the regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 7 June 2023** While impacts in the event of an unplanned hydrocarbon spill are possible, Shell considers it adopts appropriate controls to prevent a hydrocarbon spill and controls to respond in the highly unlikely event of a hydrocarbon spill. This EP demonstrates how Shell will identify and reduce all impacts and risks to ALARP and that the activity is not inconsistent with the management plan. Shell will notify the DoT (WA) of any incidences within or in proximity to a marine park, as outlined in the Oil Pollution Emergency Arrangements (Australia) and Oil Pollution First Strike Plan. **Phone call 22 June 2023** Discussed the review of the Browse Regional OPEP and provided context to the development approach including adoption of the INPEX Browse Regional OPEP, which DoT were consulted. **Meeting on 27 June 2023**	No objections or claims have been received about activity impacts or risks.	DoT provided advice regarding preferred consultation processes and requested a copy of the OPEP, which are considered relevant matters. Shell has consulted with DoT consistent with the relevant guidance and has provided copies of the spill response documents.	DoT's consultation guidance adopted for the EP consultation, including provision of spill response documentation. Based on the consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
				Relevant actions agreed as follows: Provide the Browse Regional OPEP for DoT for review. DoTs review is not a regulatory function buts a function under the relevant person consultation requirements. **Email 30 June 2023** Confirmed the suite of Crux EPs, proposed activities and associated OPEPs. Provided links and file transfers of DoT requested documents. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 4 December 2023** Provided a copy of the Cold Commissioning Environment Plan – WA Oil Spill Control Agency - Consultation Report. Available in Appendix B. **Email on 15 December 2023** Responded to comments on the Browse Regional OPEP. **Email on 19 February 2024** Responded to comments on the Crux Installation and Cold Commissioning Activity WA Oil Spill Control Agencies – Consultation Report.			
17.	Department of Water & Environmental Regulation (DWER)	27 March 2023 *(Initial email)* **Email to Shell** 28 March 2023 **Email from Shell** 20 April 2023 09 May 2023 18 September 2023	**Email on 28 March 2023** Confirmed that the Crux Project is not subject to Part IV approval, and therefore will not be providing any comments.	Not applicable.	No objections or claims have been received about activity impacts or risks.	Not applicable.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
20.	Environment Protection Authority (EPA)	27 March 2023 *(Initial email)* **Email from Shell** 04 April 2023 (Calendar invite) 20 April 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		18 September 2023					
18.	Federal Member for Kimberley – Melissa Price	27 March 2023 *(Initial email)* **Email to Shell** 05 April 2023 **Email from Shell** 04 April 2023 (Calendar invite) 22 May 2023 18 September 2023	**Email on 05 April 2023** Declined the invitation for attending the Shell event and offered to meet in future.	**Email on 22 May 2023** Confirmed that Shell will continue to provide Project updates. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	No relevant matters raised. Shell's response to the feedback, detailing the response and how that feedback has been actioned, is set out here.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
19.	State Member for Kimberley – Divina Grace D'Anna	27 March 2023 *(Initial email)* **Email from Shell** 04 April 2023 (Calendar invite) 20 April 2023 09 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Section 25(1)(c) of the OPGGS(E) Regulations							
28.	Department of Industry Tourism and Trade (DITT) Marine safety branch and Fisheries	27 March 2023 Initial email) **Email to Shell** 21 April 2023 26 April 2023 **Email from Shell** 04 April 2023 17 April 2023 20 April 2023 08 May 2023 18 September 2023 **In Person at Darwin Drop-in** 17 May 2023	**Email on 21 April 2023** Confirmed that licensee information is restricted by the Fisheries Act 1999 (NT) provisions and provided clarification on the process to request licensee lists. **Email on 26 April 2023** Provided updated licensee list for fisheries. **In Person on 17 May 2023** Raised matters unrelated to this EP.	**In Person on 17 May 2023** Shell advised Darwin-based fishers on matters unrelated to this EP. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	Shell has responded and actioned DITT's feedback.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
27.	Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	27 March 2023 *(Initial email)* **Email to Shell** 17 April 2023 **Email from Shell** 04 April 2023 (calendar invite) 20 April 2023 09 May 2023	**Email on 17 April 2023** Declined the Industry Forum Invite.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		18 September 2023					
Section 25(1)(d) of the OPGGS(E) Regulations							
Commercial Fisheries							
133.	A12 Aquarium *(9 license holders)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
134.	A5 Offshore Net Line *(8 license holders)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
135.	A4 Spanish Mackerel *(9 license holders)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
136.	A6 Demersal *(12 license holders)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
137.	A13 Trepang *(1 license holder)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
138.	A18 Timor Reef *(10 license holders)*	27 April 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
139.	Abalone Managed Fishery Licence (25 license holders)	26 April 2023 *(Initial email)* Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
183.	Australia Bay Seafoods	30 March 2023 initial email) **Email to Shell** 31 March 2023 **Email from Shell** 09 May 2023 18 May 2023 Consulted via WAFIC	**Email on 31 March 2023** Confirmed fisheries location and stated concern relating to tidal movements in the case of an unplanned event and attendance at the Shell Darwin roadshow on the 17th May 2023. Requested to be kept informed of any issues that could affect the fishing industry and livelihood. **Email on 16 May 2023** Confirmed that would like to be updated on the development and planning of the Crux Project.	**Email on 18 May 2023** Close out email sent which covered the following: Recapped on what we're consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details.	No objections or claims have been received about activity impacts or risks.	Requested to be kept informed of progress and any issues that may affect their industry/livelihood. Shell responded to feedback accordingly and will provide project updates as part of ongoing consultation.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
166.	Australian Northern Prawn Fishery	30 March 2023 (letter)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
179.	Australian Southern Bluefin Tuna Industry Association	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
141.	Broome Prawn (1 license holder)	26 April 2023 *(Initial email)* Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
142.	Commonwealth Fisheries Association	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
143.	Individual fishery license holder	26 April 2023 (On-line form submission) **Email from Shell** 2 May 2023 18 September 2023	**Email on 26 April 2023** Confirmed that fishing vessels are operated in the area and requested project and platform co-ordinates.	**Email on 02 May 2023** Provided the relevant coordinates and map for Seabed Survey EP (area aligned with this EP). Confirmed that WAFIC will also be consulting all WA managed fisheries in the activity / operations area on behalf of Shell. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	Requested further information regarding the activity. Shell responded to feedback accordingly and will provide project updates as part of ongoing consultation.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
144.	Kimberley Crab Managed Fishery Licence (1 license holder)	26 April 2023 (Letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
168	Kimberley Gillnet and Barramundi Managed Fishery Licence	26 April 2023 (letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
145.	Kimberley Prawn Managed Fishery Licence (65 license holders)	27 April 2023 (Letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
146.	Mackerel Managed Fishery Licence (24 license holders)	26 April 2023 (Letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
147.	Marine Aquarium Fish Managed Fishery Licence (11 license holders)	26 April 2023 (Letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
170.	North Coast Shark	01 May 2023 (letter) Consutled via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
148.	Northern Demersal Scalefish Managed Fishery Licence (6 license holders)	26 April 2023 (Letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
163.	Northern Prawn Fishery Industry Pty Ltd	04 April 2023 *(Initial email)* 08 May 2023 (follow up) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
172.	Pilbara Crab Managed Fishery Licence	26 April 2023 (letter) Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
157.	Seafarms Group Ltd	04 April 2023 *(Initial email)* 08 May 2023 (follow up) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
151.	Seafood Industry Association	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
181.	Tropical Tuna Management Advisory Committee	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
182.	TUNA Australia	30 March 2023 *(Initial email)* **Email to Shell** 30 March 2023 31 March 2023 05 April 2023 18 May 2023	**Emails on 30, 31 March, 5 April, and 18 May 2023** Provided industry position statement for engaging with energy companies repeatedly.	**Email on 30 May 2023** Confirmed that Shell: Received the industry position statement on 'Engagement with companies seeking to conduct marine activities within Australian tuna longline fishery areas.	No objections or claims have been received about activity impacts or risks.	Provided information regarding preferred engagement processes. Shell responded to feedback accordingly.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		Email from Shell 04 April 2023 09 May 2023 30 May 2023 18 September 2023		Is required to consult directly with concession holders (under OPGGS(E) Regulations). discuss the industry position statement with NOPSEMA to determine if it is considered as the consultation mechanism for your members for future EPs. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
162.	WA Seafood Exporters	04 April 2023 *(Initial email)* 08 May 2023 (follow up) 18 September 2023 Consulted via WAFIC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
155.	Western Australian Fishing Industry Council (WAFIC)	27 Mar 2023 *(Initial email)* **Email to Shell** 04 April 2023 19 April 2023 28 April 2023 16 May 2023 17 May 2023 22 May 2023 26 May 2023 29 May 2023 01 June 2023 18 September 2023 21 September 2023 **Email from Shell** 04 April 2023 06 April 2023 17 April 2023 18 April 2023 19 April 2023 26 April 2023 09 May 2023 16 May 2023 17 May 2023 19 May 2023 02 June 2023 14 September 2023 18 September 2023	**Email on 4 April 2023** Provided information to assist in planning the consultation requirements for the WA managed fisheries. **Meeting on 6 April 2023** Discussed guidance around EP consultation with WA commercial fisheries. **Email on 19 April 2023** Confirmed NOPSEMA guidance that WAFIC are the suitable mechanism / organisation to consult with WA managed fisheries. This was also communicated over phone on 18 April. **Email on 21 April** Provided recommendations for the consultation material. **Meeting on 27 April 2023** Confirmed the revised EP Factsheets were appropriate for distribution to relevant fisheries. **Email on 28 April 2023** (sent by WAFIC to all WA Managed fishers) Distributed consultation material to relevant WA managed fishers. **Email on 22 May 2023** Confirmed that the invitation (scheduled for 29 May) to consult further on the EP was sent to relevant concession holders. **Email on 26 May 2023** Advised on the information session (scheduled 29 May) response to invitations and approach. **Virtual Meeting on 29 May 2023** Addressed questions, objections or claims provided by WAFIC members. **Email on 29 May 2023**	**Email on 27 March** Requested a meeting to discuss appropriate consultation with WA managed fisheries. **Email on 17 April 2023 and call on 18 April.** Confirmed WAFIC is contracted to contact relevant members as per information sent by WAFIC on 4 April, in addition to contacting concession holders directly. **Email and Phone call on 26 April 2023** Provided a list of relevant WA managed fisheries. **Email on 28 April 2023** WAFIC provided a consultation pack (produced in collaboration with Shell) to relevant license holders. **Email on 22 May 2023** WAFIC invitation to a briefing session was sent to relevant licence holders. **Email on 2 June 2023** Confirmed WAFIC's consultation approach and assessment will be considered to inform the development of Crux EPs. **Email on 14 September 2023** Requested further consultation to support this EP. **Email on 18 September 2023** Provided this EP supporting information.	No objections or claims have been received about activity impacts or risks.	WAFIC's recommendations have been appropriately addressed during the development of this EP and informed by baseline studies and timing /sensitivities (see Section 7) and impacts considered in the assessment of impacts/risks (Section 9.3.2) and spill response measures described in Section 9.14. With regard to the adjustment protocols developed for the NERA Collaboration EP, Shell commits to adopt these protocols when applicable to the unplanned activities described within this EP.	With regard to the adjustment protocols developed for the NERA Collaboration EP, Shell commits to adopt these protocols when applicable to the unplanned activities described within this EP. This has been addressed in the implementation statement, Section 10.8.6. Based on consultation undertaken for preparation of this EP, no other additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		19 September 2023 21 September 2023 Teams meeting 06 April 2023 21 April 2023 27 April 2023 **Phone calls** 18 April 2023 26 April 2023	Confirmed that given there was no further questions and no RSVP to the briefing that the briefing will be cancelled. WAFIC will provide an assessment of the planned activities to inform the Crux EPs. **Email on 1 June 2023** Confirmed that no feedback has been received from licence holders. Provided WAFIC's assessment and recommendations with no further concerns regarding the project activities. **Email on 18 September 2023** Requested clarification on an EP, if substantial activity change is proposed and the reasoning for consultation to inform an assessment. **Email on 21 September 2023** Confirmed that consultation needs to be managed specifically cumulative consultation fatigue and WAFIC's recommendation is not to send out another notice.	**Email on 19 September 2023** Confirmed update for relevant persons for this EP including a main update to table of aspects and controls in the factsheet. Requested assistance with providing updates with specific fisheries. **Email on 21 September 2023** Confirmed advise received.			
164.	Western Rock Lobster Council	04 April 2023 *(Initial email)* 09 May 2023 (follow up) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
156.	Western Tuna and Billfish Fishery (59 license holders)	30 March 2023 *(letter)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Titleholders and Operators							
184.	Carnarvon Energy Ltd	08 May 2023 *(Initial email)* **Email to Shell** 17 May 2023 **Email from Shell** 23 May 2023 18 September 2023	**Email on 17 May 2023** Confirmed that consultation information was reviewed and no further request for information.	**Email on 23 May 2023** Close out email sent which covered the following: Recapped on what we're consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.	No objections or claims have been received about activity impacts or risks.	No relevant matters raised. Shell responded to feedback accordingly.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
201.	Eni Australia Ltd	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
202	EOG Resources Australia Block WA-4-488 P/L	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
185.	Finder No 1	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
191.	INPEX	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023 **In person at Darwin Drop-in Session** 17 May 2023	**In person on 17 May 2023** Asked whether there would be a control room on the Crux platform.	**In person on 17 May 2023** There will not be a control room on the Crux platform, it will be operated remotely (NNM).	No feedback, objections or claims received.	Not applicable.	*See footnote
186	Jadestone Energy	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
187	Melbana Energy AC/P70	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
212.	MEO International	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
214.	Neptune Energy Bonaparte	08 May 2023 *(Initial email)* 25 May 2023 18 September 2023 15 November 2023 **Email to Shell** 20 September 2023	**Email on 20 September 2023** Confirmed that Neptune would like to continue receive future communications and supportive of the Crux Project.	**Email on 15 November 2023** Confirming receipt of support and acknowledgement of the request for future information.	No feedback, objections or claims received.	Not applicable.	*See footnote
215.	NT Gas Aust	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
188.	PTTEP Australasia (Ashmore Cartier)	08 May 2023 (**Phone call** – no email available. Number rings off). 18 September 2023 (tried to call again – same response)	No contact made.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
189.	Santos Ltd	08 May 2023 *(Initial email)* **Email to Shell** 11 May 2023 20 September 2023 **Email from Shell** 11 May 2023 18 September 2023 15 November 2023	**Email on 11 May 2023** Requested the use of a different email address. **Email on 20 September 2023** Requested additional information on the proposed activities relating to vessel movements, timing, and future communication to coordinate activities.	**Email on 11 May 2023** Redirected email as requested. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 15 November 2023**	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
				Confirmed that increase in vessel movements and suggested routine formal meetings to exchange information during 2024 and 2025.			
219.	SundaGas Banda Uniperssoal Lda	09 May 2023 (submitted via online form, as no email address) 18 September 2023 (submitted via online form, as no email address)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
190.	Vulcan Exploration P/L	08 May 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Commercial Operators							
234.	AAT Kings Darwin Day Tours	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
235.	Absolute Ocean Charters	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
237.	Alure Fishing Charters NT	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
240.	Auriga Marine	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
239.	Aurora Expeditions	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
251.	Borrgoron Cultural Tours	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
269.	Coconutz BnB	04 April 2023 *(Initial email)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		08 May 2023 (Follow-up email) 18 September 2023					
270.	Coral Expeditions	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
372.	Eco Abrolhos	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
286.	Fishabout Fishing Tours – Bathurst Island	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
287.	Fishing Melville Island Lodge	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
296.	Kimberley Air Tours	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
297.	Kimberley Boat Cruises	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
308.	Kuri Bay Sport Fishing Tours	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
309.	Lady M Cruising	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
313.	Mantiyupwi Motel	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
315.	Matt Wright Wild Territory	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
318.	Mud Crab Motel	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
319.	Munupi Wilderness Lodge (also known as Clearwater Island Lodge)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
328.	Odyssey Australia (Odyssey Traveller)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
329.	Odyssey Expeditions	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
330.	One Tide Charters	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
228.	Oolin Sunday Island Cultural Tours	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
336.	Port of Darwin	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		18 September 2023 **In person at Darwin Information session** 17 May 2023					
344.	Sealink Northern Territory	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
346.	Seaswift	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
347.	Seven Spirit Bay (Resort)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
351.	Spinifex Hotel	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
229.	The Great Escape Charter Company	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
358.	The Travelling Naturalist	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
360.	Tiwi Island Adventures	04 April 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
361.	Tiwi Island Retreat	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
230.	True North Kimberley Cruises	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
363.	Ultimate Watersports	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
374.	Unreel Adventure Safaris	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
366.	Walk Darwin Pty Ltd	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023 **Unsubscribe button used** 19 September 2023	**19 September 2023** Unsubscribed from consultation for this EP.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
371.	YKNOT Fishing Charters	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Interest Groups							
376.	10,000 Birds	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
377.	Australasian Seabird Group	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
381.	Australasian Wader Studies Group (AWSG)	04 April 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
375.	Australian Wildlife Conservancy	04 April 2023 *(Initial email)* 09 May 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		(Follow-up email) 18 September 2023					
382.	Birding in Kimberley	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
383.	Birdlife Top End	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
378.	BirdLife WA	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Non-Government Organisations							
418.	AIATSIS (Australian Institute of Aboriginal and Torres Strait Islander Studies)	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
399.	Australian Conservation Foundation	01 May 2023 (Letter) 18 September 2023 (Letter)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable	*See footnote
400.	Australian Marine Conservation Society	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable	*See footnote
401.	Australian Marine Oil Spill Centre (AMOSC)	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
395.	Ben and Jerry's	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
402.	Conservation Council of WA	04 April 2023 *(Initial email)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		09 May 2023 (Follow-up email)					
421.	Conservation Volunteers Australia	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
403.	Environmental Defenders Office WA	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
404.	Environs Kimberley	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
405.	Greenpeace	04 April 2023 *(Initial email)* **Email to Shell** 05 June 2023 **Email from Shell** 09 May 2023 23 June 2023	**Email on 5 June 2023** Confirmed Greenpeace is a relevant person for the EP. Requested additional information such as identifying relevant persons, consultation requirements, how Shell proposes to address World Energy Outlook 2022, GHG related impacts and oil spill modelling.	**Email on 23 June 2023** Provided a response to Greenpeace email received on 5 June 2023 and offered to meet in future. .	No objections or claims have been received about activity impacts or risks.	Greenpeace requested information, and Shell provided a draft of the Emergency Events section of the EP, no feedback was received on this content. The other requests were considered not relevant matters, however meeting the intent of what they were requesting, Shell revised the GHG section of the EP and supplied this information to Greenpeace. All other matters raised were considered not to be relevant matters.	Based on consultation undertaken for preparation of this EP, the Section 9.12 of the EP was updated. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
406.	High Seas Alliance	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
407.	Martuwarra Fitzroy River Council	04 April 2023 *(Initial email)*	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		09 May 2023 (Follow-up email) 18 September 2023					
425.	Northern Territory Land Corporation	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
	Same as Environs Kimberley						
410.	Save the Kimberley	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
411.	Sea Turtle.org	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
397.	Surfrider Foundation Australia	04 April 2023 *(Initial email)* 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
412.	The Wilderness Society	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
413.	United Nations	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
414.	WA Marine Science Institute	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
415.	WA Parks Foundation	04 April 2023 *(Initial email)* 09 May 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
		(Follow-up email) 18 September 2023					
427.	WWF	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Academic and Research							
432.	Australian National University	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
434.	CSIRO	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
428.	Deep History of Sea Country Research Project	04 April 2023 *(Initial email)* **Email to Shell** 08 May 2023 18 September 2023 **Email from Shell** 08 May 2023 11 May 2023 18 May 2023 18 September 2023	**Email on 08 May 2023** Requested information to confirm if a pre-development assessment and survey will be conducted to mitigate impacts on submerged archaeology. **Email on 18 September 2023** Requested coastal and marine cultural heritage and archaeology surveys and mitigation strategies.	**Email on 10 May 2023** Confirmed that: underwater archaeological assessment is being conducted and that the information will inform an impact assessment on any values (if any), as well as the need for subsequent development of controls where potential impacts require mitigation. in addition, consultation with Indigenous people to understand their values and interests (including heritage) are also occurring. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 19 September 2023** Provided links to the Crux EPs and offered to discuss further. Confirmed that no other relevant information has been published.	No objections or claims have been received about activity impacts or risks.	Queried Shell's approach to managing potential impacts on submerged archaeology. Shell responded to feedback accordingly.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
528.	Fisheries Research and Development Corporation (FRDC)	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
433.	The Ecology Centre (UQ)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable	*See footnote
Industry Representative Bodies							
436.	Australian Energy Producers	04 April 2023 (calendar invite) **Email from Shell** 20 April 2023 04 May 2023 18 September 2023 **In Person** 27 April 2023	**In Person on 27 April** Requested information on waste management, GHG and relevant persons.	**In Person on 27 April** Provided responses to all queries made.	No objections or claims have been received about activity impacts or risks.	Queried some aspects of the project. Shell responded to feedback accordingly.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
437.	Amateur Fishermen's Association NT	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
438.	Australia's North-West Tourism	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
440.	Kimberley Marine Tourism Association	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
441.	North Territory Guided Fishing Industry Association (NTGFIA)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
442.	Western Australian Game Fishing Association (WAGFA)	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
Service Providers							
454.	NT Emergency Service Darwin Volunteer Unit	04 April 2023 *(Initial email)* 09 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Local Councils							
459.	City of Palmerston Municipal Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
460.	Darwin City Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
461.	Darwin Municipal Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
462.	Darwin Waterfront Precinct Municipality	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
463.	East Arnhem Regional Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
464.	Kimberley Development Commission	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
465.	Litchfield Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures adopted and justification for consultation closed
ID	Name						
467.	Tiwi Islands Regional Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
468.	Victoria Daly Regional Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
469.	Wagait Shire Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
470.	West Arnhem Region Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
471.	West Daly Regional Council	04 April 2023 *(Initial email)* 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
Indigenous people and organisations							
Tier 1							
29.	Bardi and Jawi Niimidiman Aboriginal Corporation (BJNAC)	31 March 2023 (Initial email) refer to Table 5-11 and Table 5-12. **Email to Shell** 14 April 2023 23 May 2023 04 July 2023 23 August 2023 27 October 2023 04 January 2024 09 January 2024 15 January 2024	**Email on 14 April 2023** The PBC are due to meet on 19-20 April. Requested time to consider the Santos NA Barossa Pty Ltd v Tipakalippa [2022] FCAFC 193 decision, Shell's compliance with and BJNAC's interpretation of the OPGGS Regulations 2009, as well as the greater effects and risks posed to Bardi and Jawi Sea Country.	**Email on 12 April 2023** General mailout to all Indigenous RPs outlining dates and times for the Indigenous Forums. **Email on 26 April 2023** General mailout to all Indigenous RPs related to Broome Forum. **Email on 17 May 2023** Looking to set up time to meet. Requesting draft resourcing protocol for consideration.	No objection or claims received about activity impacts or risks.	The following relevant matters were raised regarding the activity and/ or their functions, interests, or activities: • presence of cultural sites. • important cultural connections with Country. • preferred engagement process to ensure culturally appropriate consultation. Shell incorporated this information into its assessment of potential impacts and processes for engagement, as reflected in the EP – see Measures adopted for detail.	Description of heritage values in Section 7.4.2 were updated to incorporate information received and updated information considered in risk assessment (e.g. Section 9.14.6). Section 7.4.2 notes that a number of the heritage sites in the Planning Area have not been recorded in Government databases. Consultation included collective engagement with the 3 neighbouring cultural groups and facilitating on-Country meetings wherever requested/practicable (Section 5.6.4).

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		19 February 2024 13 May 2024 22 May 2024 27 May 2024 07 June 2024 22 July 2024 12 September 2024 08 October 2024 22 October 2024 23 October 2024 25 October 2024 06 November 2024 **Email from Shell** 12 April 2023 26 April 2023 17 May 2023 25 May 2023 26 May 2023 26 June 2023 10 July 2023 03 August 2023 10 August 2023 23 August 2023 28 August 2023 18 September 2023 17 October 2023 7 November 2023 22 December 2023 09 January 2024 11 January 2024 15 January 2024 16 January 2024 19 February 2024 15 May 2024 06 June 2024 07 June 2024 20 June 2024 24 June 2024 10 July 2024 21 July 2024 12 September 2024 18 September 2024 16 October 2024 22 October 2024 24 October 2024 25 October 2024 07 November 2024	Raised the Bardi and Jawi Marine Park and Joint Management Plan for the Park. May want more detailed information if a project is likely to have a greater effect on Bardi and Jawi Sea Country. PBC shared a resourcing protocol for consideration. **Email on 23 May 2023** Attached a draft copy of the PBC's protocol for consideration. **Email on 04 July 2023** Concern raised that formal consultation with relevant persons for the submission of the environmental plans has concluded. **Email on 23 August 2023** Meeting arrangements. **Email on 27 October 2023** • Reiterated that consultation has not started. **Phone call on 02 November (second call)** Four points were discussed. a) Outstanding invoice from August not yet paid. b) Discussed Framework agreement (resource protocol). c) BJNAC stated that they do not consider consultation to have started. d) Relationship – Shell wants a stronger and closer relationship going forward, and to give greater support. Hence, we want the framework agreement in	Highlighted the opportunity to use the Independent Environmental Panel. Details of consultation requirements and commitment to ongoing consultation with BJNAC. Attached factsheets and links to draft EP. Offered to provide clarifications prior to the PBC Board were meeting on 19-20 April. **Email on 25 May 2023** Resourcing protocol received. **Email on 26 May 2023** Close out email to all Indigenous relevant persons wrapping up the consultation: sharing the videos from Forum 1. reminding Indigenous relevant persons of the environment panel available to them. recap on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Reconfirmed contact details. **Email on 26 June 2023** Attached changes to the Resourcing Protocol Agreement including the schedule of rates. Notified that we had concluded formal consultation on the Cold Commissioning and Installation environment plan at the end of May 2023 but would continue to engage on the Crux Project. Offered to provide any clarifications from the PBC Board meeting on 19-20 April. **Email on 10 July 2023** Recognise the importance of the resourcing agreement. Reiterated Shell's offer to assist financially with consultation. Attached NOPSEMA brochure.		Other feedback included interest in investigating a local spill response capacity, for quicker initial response, and a resourcing protocol. Section 9.14 demonstrates that response timeframes for spills are adequate to ensure the risks to areas of heritage significance are ALARP. A resourcing protocol in relation to consultation for this EP was provided by BJNAC. Shell has assessed the resourcing protocol as not a relevant matter on the basis that it does not relate to BJNAC's functions, interests or activities that may be affected by the activities. Although one aspect of it relates to funding for consultation, Shell considers that this aspect has been covered separately by covering reasonable costs for the engagements to date. Shell has committed to work towards getting an updated resource protocol in place with Bardi Jawi to support ongoing consultation (Section 5.8) and to participate in industry collaboration on training of indigenous peoples in spill preparedness Table 5-14. All other issues raised were considered to not be relevant matters. Shell responded to feedback accordingly. Whilst this is not considered a relevant matter to this EP, Shell has been trying to progress a consultation protocol with BJNAC throughout the consultation period, as requested by BJNAC and in alignment with Shell's approach to developing genuine relationships. BJNAC and Shell have not been able to reach alignment on this as the current draft contains certain conditions that go over and above the Regulations. Shell has been clear in its explanation around why this cannot be signed at this time. Shell has offered to cover all reasonable costs related to consultation, to meet on country with culturally appropriate representatives, at an appropriate time as advised by BJNAC as well as offering access to an independent Environment Panel with costs covered by Shell.	Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer to Table 5-11 and Table 5-13 for further information supporting this.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	**Name**						
		08 November 2024 **Phone call** 17 October 2023 02 November 2023 x 3 27 February 2024 16 May 2024 31 May 2024 20 June 2024 11 July 2024 15 July 2024 17 July 2024 18 July 2024 08 August 2024 05 September 2024 13 September 2024 18 September 2024 22 October 2024 25 October 2024 30 October 2024 (unanswered) **In Person / Team** 15 August 2023 25 August 2023 19 January 2024 19 February 2024 12 April 2024 19April 2024 24 May 2024 20 June 2024 **Text messages** 10 June 2024 11 June 2024 22 October 2024	place so we can get together and talk. Discussed timing of EPs in the next few days. **Email on 04 January 2024** Requested confirmation whether Shell had submitted its EPs to NOPSEMA and whether feedback, comments and objections were included. Reinforced that BJNAC require a resourcing protocol as a first step to commence discussions. **Email on 04, 09, 15 January 2024** Meeting logistics. **Email on 13 May 2024** Letter received outlining consultation requirements. **Email on 22 May 2024** Confirming meeting on Friday 24 May. **Email on 27 May 2024** Sharing a redrafted resourcing protocol. **Email on 07 June 2024** Meeting logistics. **Text message on 10 and 11 June 2024** Meeting logistics. **Email on 22 July 2024** Confirming receipt of email. Clarification required before they can respond. **Email on 12 September 2024**	Recap on the four environment plans and submission dates. **Email on 03 & 10 August 2023** Related to meeting arrangements. **Meeting Notes from 15 August 2023** Contained in sensitive matters report – summary of key discussion points. Cultural connections with Country Job opportunities Oil spill modelling Cultural awareness training RAP Environmental panel that can be accessed at any point. Issues with consultation and Indigenous values, and resourcing protocol. Shell's commitment to looking at the Social and Cultural Heritage Values and the process Shell took around this. Well integrity and stability, drilling fluid spills and Shell's management plans. Social Impact Assessment **Emails on 23 August 2023** Discussion about resourcing protocol and meeting arrangements. **In Person Meeting 25 August 2023** contained in sensitive matters report – summary of key discussion points. Agreed both parties would like to develop a broader relationship scope beyond EPs. BJNAC attending Spillcon in Brisbane. Discussed resourcing protocol. Two things that are extremely important to BJNAC are: 1. Confidentiality on Culturally Sensitive Information and 2. Acting in good faith to develop an equitable relationship. The development of an MoU		Shell received a letter on behalf of BJNAC and an individual person who is a member of BJNAC in relation to a previous EP. Shell's response offered to consult with BJNAC and the individual. The individual has not come forward and identified as relevant for this EP. Advice received from BJNAC, has directed Shell that the culturally appropriate way to consult with BJNAC members is through BJNAC as opposed to individual members. Shell has respected that advice.	

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			Confirmed BJNAC will be seeking Board instructions in September. **Email on 08 October 2024** Confirming the BJNAC Board do not have space on their agenda for Shell. They have feedback on summary table provided which will be drafted over the course of the next week. Some available times were put forward to meet with the Board. **Email on 22 October 2024** Sharing discussion table with comments from the BJNAC Board. Confirming meeting timing that week. **Email on 23 October 2024** BJNAC outlining position related to consultation protocol. **Email on 25 October 2024** Attaching the revised consultation protocol. **Email on 06 November 2024 from BJNAC** Response to previous email related to consultation protocol.	**Email on 28 August 2023** Attached a draft of the MoU and resourcing protocol. Draft MoU and Resourcing Protocol Rates contained in the Sensitive Information Report. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Phone call on 17 October 2023** Call to inform about closing date of EPs. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings. **Phone call on 02 November 2023** (first call) Advised consultation is now closed, and we are submitting EPs this week. Recapped consultation that has taken place to date with BJNAC and purpose of consultation. Discussed resourcing protocol but Shell advised this is not associated with EPs. BJNAC do not consider consultation to have started until a formal resourcing protocol is in place. **Phone call on 2 November 2023** No response.			

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				Phone call on 2 November 2023 (third call) Reminder that we are submitting EPs in the next couple of days. Confirmed that BJNAC did not consider consultation to have taken place. **Email on 7 November 2023** Advised that Shell is required to consult with all relevant persons about its activities under the Crux EPs, and to provide them with sufficient information and a reasonable time to consult with Shell on matters that are relevant to the Crux EPs. Overview of consultation carried out to date with BJNAC. Advised that the consultation period for the Crux EPs has now closed for the purposes of the submission of EPs to NOPSEMA but that Shell has processes and procedures in place to address relevant new information. Shell wishes to foster a good and genuine relationship with Bardi Jawi people outside of Shell's EPs, including by progressing the resourcing protocol. **Email on 22 December 2023** Intro to new Indigenous Engagement Advisor. Email on 9, 11 and 15 January 2024 Meeting logistics **Email on 16 January 2024** Advised that the EP is planned to be submitted to NOPSEMA in February 2024. Consultation has now closed however, confirmed that latest correspondence will be included with the EP submission. Advised that Shell is also commencing consultation in February on the next Crux EP and will be seeking to consult BJNAC. Suggested a meeting to finalise the resourcing protocol.			

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				Teams meeting on 19 January 2024 Meeting to introduce the new Indigenous Affairs Adviser. Discussed ranger programs, relationships, oil spill training and cadence of board meetings. **Email on 19 February 2024** Oil spill training and potential to meet in Broome this week. **In person on 19 February 2024** A general touch base on various matters including: Executive Officer being appointed as Director to Sea Country Alliance. Shell presenting at first Board meeting of 2024. BJNAC don't see oil spill training as a current priority. **In person on 12 April 2024** A general touch base on various matters including: Resourcing protocol Future consultation Scheduling presentation at Board meeting. **Email on 15 May 2024** Response to letter received on 13 May 2024. **Phone call on 16 May 2024** Calling to discuss letter received on 13 May 2024. **In person on 24 May 2024** • Consultation expectations discussed - general relationship catch up. • Discussed project opportunities. **Phone call on 31 May 2024**			

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				Progressing the resourcing protocol and opportunity to discuss this in person. **Email on 06 and 07 June 2024** Meeting logistics. **Text message on 10 and 11 June 2024** Meeting logistics. **Email on 20 June 2024** High level points shared to discuss at the meeting. **In person meeting on 20 June 2024** **Email on 24 June 2024** Sharing draft table setting out issues and solutions discussed related to consultation protocol. **Email on 10 July 2024** Seeking a number to call on. **Phone call on 18 July 2024** Shared re-submission timing for EP and providing BJNAC with the draft consultation summary section of the EP. Agreed for this to be shared with response due by COB 02/08/2024. BJNAC shared timing for next Board meeting. **Email on 21 July 2024** Attaching relevant section of EP for review. **Phone call on 08 August 2024** Follow up on email related to draft consultation summary of EP and resourcing protocol discussion from 20 June 2024. **Phone call 05 September 2024 (unanswered)** **Email on 12 September 2024** Proposing time for a call. **Phone call on 13 September 2024**			

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ID	**Name**						
				Follow up on previous phone calls from 08 August and 05 September 2024. **Phone call on 18 September 2024** Actions discussed and followed up via email. **Email on 18 September 2024** Shared information sheets for this EP along with status of project. Confirmed Shell would be happy to attend their Board meeting. **Email on 08 October 2024** Shell looks forward to receiving feedback on the summary table. Shell confirmed commitment to consulting in a culturally appropriate and respectful way. **Phone call on 11 October 2024** Follow up from email on 08 October and confirming Shel's attendance at Board meeting and Law Bosses meeting. **Email on 16 October 2024** Shared draft EP and confirmed submission timing. **Text message on 22 October 2024** Confirming logistics for the meeting that week. **Phone call on 22 October 2024** Follow up on text related to logistics for meeting on 24 October 2024. **Phone call on 22 October 2024** Responding to email from BJNAC and response to discussion table and proposed meetings on 24 October 2024. **Email on 22 October 2024** Shell confirmed receipt of discussion table and to consider proposed changes. **Text message on 22 October 2024** Notifying that email had been sent and following up for confirmation on meeting on 24 October 2024.			

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				Phone call on 22 October 2024 Provision of decision from BJNAC Chair whether to progress with Law Boss meeting. **Email on 24 October 2024** Requesting a call. **Phone call on 25 October 2024** Follow up on email received 23 October 2024 following cancellation of Law Boss and Board meetings. **Email on 25 October 2024** Outlining Shell's position on consultation protocol. **Phone call on 30 October 2024** (unanswered). **Phone call on 04 November 2024** (unanswered). **Email on 7 November 2024** Advising Shell were trying to make contact and asking for best time to call. **Email on 8 November 2024** Response to email from 6 November 2024 related to consultation protocol.			
31.	Dambimangari Aboriginal Corporation (DAC)	31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-12. **Email to Shell** 06 Sept 2023 15 Sept 2023 20 Sept 2023 18 October 2023 23 October 2023 24 October 2023 10 November 2023 23 December 2023 29 February 2024 12 March 2024 22 March 2024 26 March 2024 04 April 2024 16 April 2024 19 April 2024 08 May 2024	**Email 6 September 2023** Introductions and meeting arrangements. **Email on 15 September 2023** Adding seismic surveys to meeting agenda. **Emails on 20 September 2023** Meeting summary discussion. **Emails on 18 October 2023** Email correspondence with advisor to Dambimangari: advised that their position had not changed on timing for a meeting and that DAC still wishes to meet with Shell at the first opportunity. asked Shell to provide clarification on any plans	**Email on 26 May 2023** Close out email wrapping up the consultation: sharing the videos from Forum 1 reminder of the environment panel available recap on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. reconfirming contact details. **Email on 28 and 31 August 2023** Following up after sending information in April and May. Ensure all relevant groups have had the opportunity to hear about Crux and be consulted.	Raised objection/claim that impact to DAC Country from a major spill would be unacceptable. This is consistent with Shell's position regarding acceptability of major spills and has been noted in the relevant section of the EP – see Measures adopted for detail.	Provided feedback that Sea Country may extend past current native title borders, going a "long way from shore" which was considered a relevant matter and EP amended to incorporate- – see Measures adopted for detail. Provided a copy of the OPP [available on NOPSEMA's website].	The description of the cultural heritage features (Section 7.4.1) were updated to note that Sea Country may extend beyond current native title boundaries. Table 8-4 and Section 9.14.9 updated to note that consultation with DAC had identified impact to their Sea Country from a major spill was considered unacceptable. Shell has provided sufficient information and a reasonable period to assess information provided. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations. Refer to Table 5-11 and Table 5-12 for further information supporting this.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		13 May 2024 14 May 2024 29 July 2024 14 October 2024 17 October 2024 30 October 2024 05 November 2024 **Email from Shell** 12 April 2023 26 April 2023 02 May 2023 19 May 2023 25 May 2023 26 May 2023 28 August 2023 31 August 2023 06 Sept 2023 07 Sept 2023 18 September 2023 19 Sept 2023 20 Sept 2023 18 Oct 2023 23 October 2023 24 October 2023 26 October 2023 06 November 2023 01 December 2023 01 January 2024 01 March 2024 13 March 2024 14 March 2024 22 March 2024 26 March 2024 04 April 2024 19 April 2024 01 May 2024 10 May 2024 14 May 2024 23 May 2024 27 May 2024 17 June 2024 25 July 2024 29 July 2024 14 October 2024 16 October 2024	involving transport activities that may involve facilities at Cockatoo (or Koolan) Islands. **Phone call 24 October 2023**No response. **Email on 24 October 2023** Dambimangari acknowledged that Shell is open to extending its current partnerships community engagement beyond Broome. emphasised that they did not state they were satisfied that consultation with Dambi in preparation of the EP is complete. noted the newly elected Dambimangari Board were not going to be able to meet with Shell before 27 October. Requested correspondence be addressed to their CEO. **Phone message on 27 October 2023** Dambimangari advisor left message to indicate that next Board meeting was in December 2023. **Call on 2 November 2023** Refer to Shell response column. **Email on 10 November 2023** Advised that: there would not be an opportunity for Shell to meet with the new DAC board at the first meeting in December. There may be an opportunity in March 2024. DAC does not accept that Shell has engaged with Dambimangari in relation to the activities proposed related to Crux EPs since March 2023.	Factsheets attached for 4 Environment Plans and a map showing oil spill modelling. **Email on 6 and 7 September 2023** Meeting arrangements. **Email on 18 September 2023** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Face to face meeting on 19 September 2023** Dambimangari gave an overview of current DAC operations incl. land and sea area. Shell provided an overview of the Crux Project. DAC received Factsheets by email on 31 August 2023 along with the NOPSEMA Consultation Information for the Community Brochure. Dambi adviser clarified that there are multiple native title groups under the Wanjina Wunggurr (Native Title) Aboriginal Corporation RNTBC. Dambi adviser reiterated that any impact to DAC Country from a spill would be unacceptable. Shell agreed that spills are unacceptable, while noting that the risk of a spill event cannot be completely excluded. A further consult should occur in Derby with the DAC Board late October/November or early 2024. Shell discussed project activities schedule and EP submission timing. DAC spoke about maximising economic and employment opportunities. DAC queried Shell's interest in an unrelated supply base project on Cockatoo Island. **Email 19 September 2023**			

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ID	Name						
		17 October 2024 30 October 2024 07 November 2024 **Phone calls** 16 May 2023 -no answer 31 August 2023 20 October 2023 24 October 2023 25 October 202326 October 2023 -no answer 27 October 2023 -no answer (incoming) -message left. -no answer (outgoing) 30 October 2023 – no answer 2 November 2023 23 January 2024 25 January 2024 07 March 2024 08 March 2024 26 April 2024 25 July 2024 27 September 2024 – no answer 30 September 2024 11 October 2024 **In Person** 19 Sept 2023 10 April 2024 **Text messages** 23 January 2024	**Email on 23 December 2023** Query related to information included in EPs. **Text on 23 January 2024** Sorry I can't talk right now. **Email on 29 February 2024** Confirming April Board meeting. **Text on 07 March 2024** Sorry I can't talk right now. **Phone call on 08 March 2024** Discussed agenda for April Board meeting. DAC confirmed multiple oil and gas proponents presenting over the 2 days. Shell reiterated offer of contributing to costs associated with consultation at Board meeting. Discussed Shell vendor setup in Finance system. **Email on 12 March 2024** Provided contact details to set DAC up as a vendor in Shell system. **Email on 22 March 2024** Will get back to you next week. **Email on 26 March and 04 April 2024** Meeting logistics. **Email on 16 April 2024** Follow up actions from the meeting. **Email on 19 April 2024** Clarification on meeting attendees. **Email on 08 and 13 May 2024** Confirming meeting notes.	Shell keen to continue discussions with DAC and attend a Board meeting by end of the year. Shared information on the panel of subject matter experts that has been established. **Email on 20 September 2023** Revision 3 of minutes shared. Outlined that it is important that the record of the meeting show 1] that there were earlier efforts to contact Dambimangari, and 2] that there is agreement on spills being unacceptable, but that it be clear that in marine activity involving such a complexity of activities over a sustained period of time, a spill event cannot be completely excluded. Shell is willing to provide full information by Shell, State and Federal authorities, in the event of a spill. **Emails on 17 October 2023** Detailed how input to an EP helps Shell. Updated on timeframes for EP submissions. Reiterated that relationships beyond EPs are important. Confirmed there are no plans to engage services out of Cockatoo or Koolan Islands. **Phone call on 20 October 2023** DAC would like to meet around broadening Shell's focus and efforts from Broome with a focus in Derby. DAC would still welcome a meeting in future to discuss the project. Advisor to Dambi indicated a 50% chance of a Board meeting in 2023. The next Board meeting would be late Feb/early March. No specific cultural values were identified/discussed.			

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			Email on 14 May 2024 Confirmation of Board Meeting dates in August. **Email on 29 July 2024** Requesting to reschedule meeting. **Email on 14 October 2024** Requesting to delay attendance at Board meeting. **Email on 17 October 2024** Advising changes to structure at DAC. **Email on 30 October 2024** Confirming receipt of last email and noted the due date. **Email on 05 November 2024** Inviting Shell to December Board meeting.	**Email on 23 October 2023** Shell is open to opportunities for broadening our impact across the Kimberley and Derby. Shell is keen to meet at earliest opportunity. Consultation closes this Friday for our current EPs. Noted that DAC is satisfied that consultation in preparation of the EP is complete. **Phone call on 24 October 2023** No response **Email on 24 October 2023** • Trying to establish contact and requesting a call back. **Phone call on 26 October 2023** No response **Email on 26 October 2023** • Final prompt to DAC to input into the Crux EPs by Friday 27 October. • Email outlined the requirement to consult and purpose of consultation. • Reiterated offer to meet with new board. • Outlined processes and procedures should any new matters be raised in relation to EPs. **Phone Call on 27 October 2023** No response. **Phone Call on 2 November 2023** Recapped on consultation undertaken and definition of consultation. Reiterated offer to meet with the Board. Discussed consultation fatigue. **Email on 6 November 2023**			

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				Follow up email on Board meeting week of 11 December. Included apologies for not including the CEO in the email and no intent to misrepresent previous conversations. Recapped on consultation requirements, that Shell considers DAC a relevant person and has engaged with DAC in relation to the Crux EPs since March 2023. The consultation period for the Crux EPs has now closed for submission to NOPSEMA. Assured DAC that Shell has processes in place to address new information should it be raised. Reiterated offer to meet. **Email on 1 December 2023** Confirmed Shell can assist with sitting fees and meeting costs. Requested date and time for the meeting. Advised that 3 EPs had been resubmitted to NOPSEMA. Will be submitting the EP to NOPSEMA in Jan/Feb, so seeking any further input concerning risks and impacts to your functions, interests, or activities no later than 12 January 2024. Shell can arrange free access to environmental consultants to support DAC in assessing the information provided and supporting you in providing relevant input on this EP. Our Completions, Start-up and Operations EP is in preparation, and we will be in a position to discuss that EP at our meeting with the Board. **Email on 4 January 2024** Advised that: Correspondence was received post submission of the EP so would be included in future EP's related to the Crux project.			

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				Reemphasised that Shell would like to present at the March board meeting. **Phone call 23 January 2024** No response **Text message 23 January 2024** Please let me know when's a good time is to call back. **Phone call 25 January 2024** Appreciated clarification provided in email on 04/01 that outlined inclusion of communications in SIR of EP. No update to Board meeting, internal governance training for Directors still taking place. Confirmed intent is for Shell to present on Crux project at first Board meeting available to third party presentations. This is currently planned for March. Noted that Dambi are receiving a lot of proponents reaching out to discuss projects. **Phone call 07 March 2024** No answer **Phone call 08 March 2024** Left a voicemail requesting a return call to discuss Crux EP Consultation with Dambimangari Board. **Email on 13 March 2024** Confirming contact details received to DAC Finance. **Email on 14 March 2024** Making contact with DAC Finance to organise setting up as a vendor. **Email on 22 March, 26 March, 04 April 2024** Meeting logistics.			

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				In person on 10 April 2024 Meeting notes included in the sensitive matters report. **Email on 19 April 2024 x 2** Follow up actions from the meeting. **Phone call on 26 April 2024** No answer. **Email on 01, 10, 14 May 2024** Confirming meeting notes. **Email on 23 May 2024** Details on OPP consultation as requested. **Email on 27 May 2024** Asking how they would prefer Shell to share information raised at the previous meeting. **Email on 17 June 2024** Requesting schedule for Board meeting dates. **Phone call on 25 July 2024** Discussion logistics of upcoming August Board meeting. **Email on 25 July 2024** Logistics for meeting. **Email on 29 July 2024** Confirmed no issue with Shell. **Phone call on 30 September 2024** Discussion on upcoming consultation at Board meeting. **Phone call on 11 October 2024** Follow up on scheduled consultation.			

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				Email on 14 October 2024 Shell to check back for future Board meeting dates. **Email on 16 October 2024** Shared draft of future EP. **Email on 17 October 2024** Thanking DAC for advice. **Email on 30 October 2024** Thanking DAC. **Email on 07 November 2024** Accepting invitation to present to the Board at December meeting.			
38.	Kimberley Land Council (KLC) Please note, significant correspondence took place with KLC for the purposes of consultation with RP 51 Nyul Nyul. This has been captured under Nyul Nyul and not duplicated here.	31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-12. **Email to Shell** 12 April 2023 27 April 2023 03 May 2023 31 August 2023 17 October 2023 19 December 2023 **Email from Shell** 12 April 2023 26 April 2023 27 April 2023 12 May 2023 19 May 2023 26 May 2023 10 July 2023 20 July 2023 31 August 2023 18 September 2023 17 October 2023 19 December 2023 **Online Form in**	**Email on 12 April 2023** Requested Shell advise which corporations should receive the correspondence. **Email on 26 April 2023** Interest via website from individual with a KLC email address. **Email on 27 April 2023** Requested Shell advise which corporations should receive the correspondence. **Email on 03 May 2023** Confirmation that correspondence was distributed to the following PBCs: Nyangumarta Karajarri Aboriginal Corporation. Karajarri Traditional Lands Association Aboriginal Corporation. Yawuru Aboriginal Corporation. Gogolanyngor Aboriginal Corporation.	**Email on 12 April 2023** Responded with group details. **Email on 26 April 2023** Responded to online form interest with information pack and contact details. **Email on 27 April 2023** Reiterated Shell's committed to consultation and set out communication undertaken to date with Indigenous relevant persons. Reiterated invitation to Traditional Owner Forums. Requested support in encouraging community members to attend either the forum or provide feedback through the alternative channels. Asked for feedback on consultation methodology. **Email on 12 May 2023** Reiterated Shell's committed to consultation and set out communication undertaken to date with First Nations relevant persons.	No objections or claims have been received about activity impacts or risks.	Provided information regarding additional groups that Shell could/should contact.	Shell contacted/ attempted to contact all the groups identified (Section 5.6.4). Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer to Table 5-11 and Table 5-12 for further information supporting this.

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		26 April 2023 **Phone calls** 11 May 2023 x2 12 May 2023 15 May 2023 16 May 2023 18 May 2023 31 August 2023 04 October 2023 -no answer -left message 16 February 2024	Wanjina Wunggurr (Native Title) Aboriginal Corporation. Mayala Inninalang Aboriginal Corporation. Balanggarra Aboriginal Corporation. Miriuwung & Gajerrong #1 (Native Title Prescribed Body Corporate) Aboriginal Corporation. Identified other PBCs below which would have interest: Nyul Nyul PBC Aboriginal Corporation. Nimanburr Aboriginal Corporation. Walalakoo Aboriginal Corporation. Warrwa People Aboriginal Corporation. Bardi & Jawi Niimidiman Aboriginal Corporation. Advised that Nyangumarta Warrarn Aboriginal Corporation is not a KLC client, and their contact person details can be found via this ORIC extract. **Email on 31 August 2031** Advised that details can be found via ORIC. Confirmed email had been forwarded to Wanjina-Wunggurr Native Title Aboriginal Corporation; as detailed on this ORIC extract. Included ORIC extract for: Wilinggin Aboriginal Corporation Wunambal Gaambera Aboriginal Corporation. **Email on 17 October 2023** Confirmed that email will be passed onto the Nimanburr	Reiterated invitation to Traditional Owner Forums. Requested support in encouraging community members to attend either the forum or provide feedback through the alternative channels. Asked for feedback on consultation methodology. **Email on 19 May 2023** Sharing details of Indigenous Forum in Darwin. **Email on 26 May 2023** Requesting assistance from KLC to distribute information to the groups previously contacted. **Email on 10 July 2023** 1. Close out email sent which covered the following: 2. Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. 3. Notified of the management of feedback if any details should be considered sensitive information. 4. Reconfirmed contact details. **Email on 20 July 2023** The EP will be submitted later in the year, in November. Outlined opportunity to meet in Broome. **Email on 31 August 2023** Requested support in reaching out to Wilinggin and Wunambul. **Email on 31 August 2023** Thanked KLC for their help. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			

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ID	Name						
			contact, and they will provide a direct email address when available. In the meantime, requested we continue to contact KLC. Confirmed that emails had been forwarded to both Nyul Nyul PBC AC and Gogolanyngor AC. Advised that the relevant "contact person" is detailed on the ORIC website. **Email on 19 December 2023** Confirmed that previous emails had been passed on. Advised that turnaround times to enquiries can be somewhat timely due to several factors.	**Email on 17 October 2023** Introduction of new Indigenous Participation Advisor at Shell. Request to pass on email to Nimanburr Aboriginal Corporation? **Email on 17 October 2023** Request to meet. Request to pass on emails to: Nyul Nyul PBC Gogolanyngor Aboriginal Corporation. **Email on 19 December 2023** Checking if direct contact details were available for Nimanburr Aboriginal Corporation. Phone call on 16 Febrary 2023 Related to consultation with Nyul Nyul.			
44.	Mayala Inninalang Aboriginal Corporation (MIAC) (incl Mayala 2)	Also consulted via 38 – KLC **Email from Shell** 23 August 2023 18 September 2023 17 October 2023 **In Person** 15 August 2023	No response. Meeting arrangements took place via Walalakoo.	**Meeting Notes from 15 August 2023** Contained in sensitive matters report – summary of key discussion points. Cultural connections with Country Job opportunities Oil spill modelling Cultural awareness training RAP Environmental panel that can be accessed at any point. Issues with consultation and Indigenous values, and resourcing protocol. Shell's commitment to looking at the Social and Cultural Heritage Values and the process Shell took around this. Well integrity and stability, drilling fluid spills and Shell's management plans. Social Impact Assessment **Email on 23 August 2023** Offering to:	No feedback, objections or claims received about activity impacts or risks.	The following relevant matters were raised regarding the activity or their functions, interests, or activities: presence of songlines up the [west Kimberley] coastline and associated cultural heritage sites that are not all registered. important cultural connections with Country particularly to the Reef and King Sound. preferred engagement process to ensure culturally appropriate consultation. Shell incorporated this information into its assessment of potential impacts and processes for engagement, as reflected in the EP – see Measures adopted for detail. Other feedback included interest in investigating a local spill response capacity, for quicker initial response, and a resourcing protocol. Section 9.14 demonstrates that the response timeframes for spills are adequate to ensure the risks to areas of heritage significance are ALARP. Shell has assessed the resourcing protocol as not a relevant matter on the basis that it does not relate to MIACs functions, interests or activities that may be affected by	Description of heritage values in Section 7.4.2 were updated to incorporate information received and updated information considered in risk assessment (e.g., Section 9.14.6.3). Section 7.4.2 notes that a number of the heritage sites in the Planning Area have not been recorded. Consultation included collective engagement with the 3 neighbouring cultural groups and facilitating on-Country meetings wherever requested/practicable (Section 5.6.4). Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer Table 5-11 and Table 5-13 for further information supporting this.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Meet on Country and conduct meetings as appropriate. Discuss a resourcing protocol which compensates for time, travel, expert advice and other costs. Prior to that we will cover meeting costs. **Email on 23 August 2023** Following up issues raised and logistics for next meeting. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings.		the activities. Although one aspect of it relates to funding for consultation, Shell considers that this aspect has been covered reasonable costs for the engagements to date. Nevertheless, Shell has committed to work towards getting an updated resource protocol in place with Mayala to support ongoing consultation (Section 5.8) and to participate in industry collaboration on training of indigenous peoples in spill preparednessTable 5-14. All other issues raised were considered to not be relevant matters. Shell responded to feedback accordingly.	
114.	Northern Land Council (NLC)	31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-12. **Email to Shell** 02 May 2023 21 May 2023 23 May 2023 26 May 2023 12July 2023 **Email from Shell** 12 April 2023 26 April 2023 27 April 2023 08 May 2023 17 May 2023 18 May 2023 23 May 2023	**Email on 02 May 2023** The NLC unable to attend meeting on 10 May 2023, requested materials on the project for the NLC to consider. **Email on 21 May 2023** Meeting arrangements. NLC outlined that they would be particularly interested in the notification & consultation processes if there is a spill, disaster, or other emergency event. **Email on 23 May 2023** Continuing to arrange a face-to-face meeting.	**Email on 17 May 2023** Request to meet with NLC in Darwin. Reminded NLC about a third forum in Darwin on the morning of 1 June (10am – 1.30pm), (at a venue to be advised). Attached factsheets and links to the draft EP and website. **Email on 18 & 23 May 2023** Meeting arrangements. **NLC engagement 26 May 2023** Discussed the Crux Project, EPs and the broader planning area. NLC requested an early-warning procedure explaining how NLC would	No objections or claims received in relation to impacts or risks.	Requested NLC be notified in event of a spill. Requested additional information regarding spill impacts and response. Shell has responded accordingly to this feedback, providing information to NLC that they confirmed was adequate for their needs and including amending spill notification requirements – see Measures adopted for detail.	Table 10-8 includes requirement for NLC to be notified in the event of an emergency spill event which has the potential to impact communities and environments in the Top End. Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-12 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		26 May 2023 29 May 2023 19 June 2023 03 July 2023 10 July 2023 17 July 2023 20 July 2023 27 July 2023 18 September 2023 **In Person** 26 May 2023	**Email on 26 May 2023** Requested Shell provide NLC with a detailed early-warning procedure explaining how NLC would be notified of a worst-case-scenario spill including: Emergency response timeframes. Disaster and spill containment support. Expected environmental impacts from such an event. **Email on 12 July 2023** NLC noted that information provided was comprehensive. In the event of a worst-case-scenario spill, Shell must notify the NLC immediately. In such an event, it is extremely important that Shell provides NLC with emergency response timeframes, identifies expected environmental impacts, and offers disaster and spill containment support.	be notified of a worst-case-scenario spill that could affect communities and environments along the coastline of the Top End, including: • Emergency response timeframes. • Disaster and spill containment support. • Expected environmental impacts from such an event. Shell responded accordingly with information on emergency response and confirming NLC has been added to the list of those who would be notified. **Email on 26 May 2023** Confirmed that specific issues had been passed to the Crux team to respond. Requested that NLC contact us again with any further concerns or issues. Included information about the final Crux forum. **Email on 29 May 2023** Request to forward on email with details of the Darwin drop-in session. **Email on 19 June 2023** Requested email to be forwarded to the following ranger teams: • Wudicupildiyerr Rangers • Garngi Land and Sea Management • Garngi Community Rangers • Kenbi Rangers • Malak Malak Land and Water Management Rangers Requested NLC let us know if there was anyone else, we should contact. **Email on 03 July 2023** Provided links to OPEP and Operational and Scientific Monitoring Plan which covers off request by NLC which include: • Notifications to various authorities and entities in the event of a spill. Shell intends to add a notification requirement to Section 10 of its			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				environment plans which covers the process to notify the NLC of a hydrocarbon spill. • Emergency response timeframes The secondary response measures. Disaster and spill containment supportt – Shell maintains capability across all the resources required to implement a response to a worst-case credible spill. This includes internal personnel trained and ready to participate in a spill response as part of Shells Incident Management Team (IMT); external specialist personnel from agencies that specialise in spill response tasks; and maintenance of and access to spill response equipment. These capability arrangements are described in detail within Attachments 1 and 2 of the OPEP which are summarised. • Expected environmental risks and impacts from a worst-case credible spill are assessed within each Crux Environment Plan. **Email on 10 July 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 20 July 2023** Updated on the submission of the four Crux EPs, and what happens next. Reinforced that Shell is keen to build long term relationships and requested another meeting in Darwin in September/ October. Asked whether there are PBCs, RNTBCs, or Indigenous Ranger groups that NLC supports, who would be interested, to let Shell know or forward email to them.			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Email on 27 July 2023 Noted and documented comments. **Email on 18 September 2023** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
54.	Walalakoo Aboriginal Corporation	Also consulted via 38 KLC **Email to Shell** 27 June 2023 28 June 2023 10 July 2023 17 July 2023 20 July 2023 02 August 2023 03 August 2023 04 August 2023 08 August 2023 09 August 2023 13 May 2024 **Email from Shell** 31 March 2023 12 April 2023 26 April 2023 08 May 2023 19 May 2023 25 May 2023 26 May 2023 28 June 2023 30 June 2023 10 July 2023 17 July 2023 20 July 2023 24 July 2023 25 July 2023 01 August 2023 02 August 2023 03 August 2023 04 August 2023 08 August 2023 09 August 2023 10 August 2023 23 August 2023 18 September 2023 17 October 2023 15 May 2024	**Email on 27 June 2023** Raised that the Walalakoo have strong cultural values and requested a meeting to discuss further. **28 June and 10 July 2023** Logistics for meetings. **17 July 2023** Advised that a letter regarding consultation will be issued by end of the week. **20 July 2023** Letter received outlining request for culturally appropriate consultation. **02, 03, 04, 08 and 09 August 2023** Logistics for meeting, including venue and confirmation of attendees. **Email on 13 May 2024** Letter received outlining consultation requirements.	**Phone call on 27 June 2023** Messages left with both the CEO and EA. **Email on 28, 30 June and 10, 17 July 2023** Meeting logistics **Email on 20 July 2023** Update on four Environment Plans, with two due for submission at the end of the week. Shell is open to receiving questions on these at any time. Outlined importance of ongoing relationships and opportunities for partnership to share knowledge, resources, and skills, provide consultancy on critical cultural heritage matters, and collaborate in providing opportunities. Outlined that Shell would be back in Broome in September/October if there was an opportunity to meet then. **Email on 20 July 2023** Confirming receipt of the letter on consultation. **Email on 24 July 2023** Confirmed Shell would be happy to meet with Walalakoo, Bardi Jawi Niimidiman and Mayala Inninalang PBCs, Outlined that Crux is an entirely offshore project, and Shell's obligation to consult and its desire to do better by building long term, mutually beneficial and supportive relationships. Email on 25 July**, 01, 02, 03,04, 08 August 2023** Meeting logistics **Email on 09 August 2023** Acceptance of invoices. **Email on 10 August 2023** Meeting logistics. **Meeting Notes from 15 August 2023** Contained in sensitive matters report – summary of key discussion points. Cultural connections with Country Job opportunities	No objections or claims received about activity impacts or risks.	The following relevant matters were raised regarding the activity or their functions, interests, or activities: • presence of cultural sites. • important cultural connections with Country. • preferred engagement process to ensure culturally appropriate consultation. Shell incorporated this information into its assessment of potential impacts and processes for engagement, as reflected in the EP - see Measures adopted for detail. Other feedback included interest in investigating a local spill response capacity, for quicker initial response, and a resourcing protocol. Section 9.14 demonstrates that response timeframes for spills are adequate to ensure the risks to areas of heritage significance are ALARP. Shell has assessed the resourcing protocol as not a relevant matter on the basis that it does not relate to WACs functions, interests or activities that may be affected by the activities. Although one aspect of it relates to funding for consultation, Shell considers that this aspect has been covered separately by covering reasonable costs for the engagements to date. Nevertheless, Shell has committed to work towards getting an updated resource protocol in place with WAC to support ongoing consultation (Section 5.8) and to participate in industry collaboration on training of indigenous peoples in spill preparedness. All other issues raised were considered to not be relevant matters. Shell's response to the feedback received is set out here.	Description of heritage values in the EP (eg Section 7.4.2.1.2) updated to incorporate information received and updated information considered in risk assessment (eg Section 9.14.6). Section 9.14.6.3 notes that a number of the heritage sites in the Planning Area have not been recorded. Consultation included collective engagement with the 3 neighbouring cultural groups and facilitating on-Country meetings wherever requested/practicable (Section 5.6.4). Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-12 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		Phone call 27 June 2023 20 October 2023 17 May 2024 **In person** 15 August 2023		Oil spill modelling Cultural awareness training RAP Environmental panel that can be accessed at any point. Issues with consultation and Indigenous values, and resourcing protocol. Shell's commitment to looking at the Social and Cultural Heritage Values and the process Shell took around this. Well integrity and stability, drilling fluid spills and Shell's management plans. Social Impact Assessment **Email on 23 August 2023** Follow up on meeting feedback. Meet on Country – expressed that Shell were happy to arrange meetings in Derby in whatever format was appropriate. Requested guidance on this. Resourcing protocol – happy to discuss Shell's standard resourcing protocol and reach an agreement. Should any consultation be required prior to establishing the resourcing protocol we are open to covering meeting costs. Seeking to understanding cultural values and features which could be impacted by our activities; and Ensuring adequate controls are in place to minimise impacts and risks to these identified cultural features and values. Other relevant topics of interest. **Email on 23 August 2023** Meeting follow up with all groups. **Email on 17 October 2023** Update on four Environment Plans and the consultation for those to aid: our understanding of the existing environment which may be affected by Shell's proposed activities, including the cultural features of that environment.			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				how our activities might impact the existing environment (including its cultural features); and how controls and mitigation measures may be adopted to protect what is important to you. Follow up as we have had no response. Update on submission timeframes. Request for comments before Friday 27 October. Reinforced that relationships beyond Environment Plans are important and that Shell are open to meeting for other areas outside of these Environment Plans. **Email on 15 May 2024** Response to letter received on 13 May 2024. **Phone Call on 17 May 2024** No answer			
55.	Wanjina-Wunggurr Aboriginal Corporation (WWAC)	Consulted via 38 KLC Wanjina-Wunggurr Aboriginal Corporation is the formal RNTBC for the Dambimangari, Uunguu Part A, Uunguu – Area B, Wanjina – Wunggurr Wilinggin Native Title claim, determined between 2004 and 2012. Day to day management of the Determined area is in the hands of three separate Aboriginal Corporations: Dambimangari Aboriginal Corporation (DAC) Wunambul Gaambera Aboriginal Corporation (WGAC) Wilinggin Aboriginal Corporation (WAC)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	Refer to Table 5-11 for further details demonstrating sufficient information, reasonable efforts and a reasonable period have been provided to carry out consultation in preparation of this EP. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.
57.	Wilinggin Aboriginal Corporation (WAC)	31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-12. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 25 May 2023 19 June 2023 30 August 2023 18 September 2023 17 October 2023 **Phone call** 19 June 2023	No response.	**Phone call on 19 June 2023** Described the Crux Project. Highlighted that Shell considers engagement with them a priority and asked how to get information through to the right people. The fire officer provided contact details and names for the CEO and admin. **Email on 30 August 2023** Outlined details of the Crux Project and consultation. The priority is to make sure all the relevant groups have had the	No feedback, objections or claims received.	Not applicable.	Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer to Table 5-11 and Table 5-12 for further information supporting this. Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		31 August 2023 -no answer		opportunity to hear about Crux and be consulted. Attached factsheets and links to the environment plans as well as a map of the planning areas, and links to the website. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings.			
125.	Wunambal Gaambera Aboriginal Corporation (WGAC) (Includes the Uunguu Rangers)	Also consulted via 38 KLC 31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-12. **Email to Shell** 01 Sept 2023 14 Sept 2023 **Email from Shell** 26 April 2023 19 May 2023 25 May 2023 26 May 2023 19 June 2023 28 August 2023 31 August 2023 01 Sept 2023 05 Sept 2023 13 Sept 2023 14 Sept 2023 18 September 2023 19 Sept 2023 02 October 2023 17 October 2023	**Email on 1 September 2023** Email forwarded to General Manager and Healthy Country Manager. **Email on 1 & 14 September 2023** Meeting logistics	**Email on 28 August 2023** Shared details about the Crux Project with potential environmental impacts for Traditional Owner groups who have Sea Country. Following up on message left on the office phone. Shared details on consultation process. Outlined that priority is to make sure all the relevant groups have had the opportunity to hear about Crux and be consulted. Attached factsheets and links to the environment plans as well as a map of the planning areas, and links to the website. Requested opportunity to meet. **Email on 31 August 2023** A further attempt to reach out. Shared details about the Crux Project in relation to the Wanjina coastline.	No objections or claims received in relation to risks or impacts.	Provided advice regarding a source of heritage information and the community's general concern regarding oil spills, which Shell considers to be relevant matters and are appropriately addressed in the EP – see Measures adopted for detail.	Shell updated its environment description of cultural values based on information sources provided by the WGAC representative (see Section 7.4.2). Section 9.14 describes the assessment and management of potential spill risks and demonstrates that they have been reduced to ALARP, with Section 9.14.9 outlining Shell's position that a large-scale hydrocarbon release would be unacceptable. Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer to Table 5-11 and Table 5-12 for further information supporting this.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		Phone call 31 August 2023 -no answer 12 Sept 2023 20 October 2023 x 2 -no answer 25 October 2023 -no answer 26 October 2023 x 2 -no answer -message left **In Person** 15 Sept 2023		Shared details on consultation process. Outlined that we are trying to get a better understanding of what's valuable and important to people in the region. Attached factsheets and links to the environment plans as well as a map of the planning areas, and links to the website. Requested opportunity to meet. **Email 01 September 2023** Finalising meeting arrangements. **Email on 13 September 2023** Follow up from call and email to finalise meeting arrangements. **Email on 13 & 14 September 2023** Finalising meeting arrangements. **15 September 2023 meeting notes** contained in sensitive matters report – summary of key outcomes: WGAC did not have any specific objections to the Crux Project. It was noted that the impact from an oil spill is the biggest concern to community, not just from Crux. No specific cultural values or sensitivities were identified. WGAC made Shell aware of a book published on their heritage with stories passed down by the people. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 19 September 2023** Thanked Wunambal Gaambera for the meeting and outlined timeframes for EP submissions. Shared notes from the meeting and offered an opportunity to amend them. Confirmed we would be in touch to work through logistics to arrange the suggested on-Country meeting with			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Directors at Truscott Airport from mid to late October. **Email on 2 October 2023** Follow up to finalise meeting notes and see if any further information was required. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings. **Phone call on 26 October 2023** Voicemail left asking General Manager of Wunambal Gaambera to return call or email.			
Tier 2							
122.	Balanggarra Aboriginal Corporation	Consulted via 38 KLC **Email from Shell** 07 Sept 2023 18 September 2023 17 October 2023 **Phone call** 20 October 2023	No response.	**Email on 7 September 2023** Shared details of the Crux Project. Outlined that Balanggarra has coastal and Sea Country in the area that could be affected in the case of a spill and attached planning area map. Outlined requirement of consultation Attached factsheets and links to draft EP and website. Requested opportunity to meet. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input.	No feedback, objections or claims received.	Not applicable.	Shell has provided sufficient information, made reasonable efforts to elicit feedback and provided a reasonable period to assess information, seek input from the communal group and provide feedback. Therefore, consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-13 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Detailed how input to an EP helps Shell. Updated on timeframes for EP submission, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings. **Phone call on 20 October 2023** Confirmed that CEO had received correspondence from Shell including factsheets dated 7 September 2023. Confirmed that earlier correspondence regarding Crux Project was also received via KLC.			
81.	Dak Djerat Guwe People (Represented by NLC)	Information initially provided via NLC – see 114. **Email to Shell** 07 Sept 2023 **Email from Shell** 06 Sept 2023 07 Sept 2023 18 September 2023 17 October 2023 **Phone call** 06 Sept 2023	**Email on 7 September 2023** Confirming email and attachments were forwarded to the Applicant for the Dak Djerat Guwe native title claim.	**Phone call on 6 September 2023** Legal representative for Dak Djerat claim. **Email on 6 September 2023** Request to pass on information to the Dak Djerat representatives. If they are interested to discuss further, please liaise with me and we can set up an appropriate meeting that works for both parties. Details of the Crux Project and the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Attached factsheets. Offered opportunity for updates and meetings. **Email on 7 September 2023** Request for the representatives for Dak Djerat Guwe people to get in touch. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023**	No objections or claims have been received about activity impacts or risks.	No relevant matters raised.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Shell has provided sufficient information, made reasonable efforts to elicit feedback and provided a reasonable period to assess information, seek input from the communal group and provide feedback. Therefore, consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-13 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings.			
32.	Djarindjin Aboriginal Corporation (DAC)	31 March 2023 *(Initial email)* refer to Table 5-11. **Email to Shell** 04 April 2023 11 April 2023 26 April 2023 18 May 2023 26 May 2023 20 July 2023 **Email from Shell** 12 April 2023 14 April 2023 26 April 2023 18 May 2023 26 May 2023 20 July 2023 24 July 2023 18 September 2023 **In Person** 19 April 2023 10 May 2023 27 March 2024	**In Person on 10 May 2023** Summary of key points: Discussion around Shell giving something back to communities along the coast in the form of investment in renewable energy, social and community benefit funds, partnerships. Request for Shell to partner on solar lights for airstrip. Shell could be advocate for community to move to renewable energy and address carbon footprint. The Bardi Jawi told Shell about the presence of cultural sites. Feedback on the Forum consultation approach and recommendation for improvements. **Email on 20 July 2023** Meeting arrangements.	**In Person on 19 April 2023** DAC attended the Indigenous Forum in Perth. **In Person on 10 May 2023** Summary of key points: Community benefits activities. Underwater archaeological assessment of project area and the larger planning area. Unplanned hydrocarbon spill controls **Email on 18 May 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 26 May 2023** Close out email wrapping up the consultation: sharing the videos from Forum 1. reminder of the environment panel available. recap on what we're consulting on and the obligation to consult under the regulations. Reconfirmed contact details.	Raised objection/claim about potential for major spills to impact cultural features that other groups across the peninsula are likely to have an interest in. Shell considers the objection to have merit because it provides information about cultural values and features which could be affected in the event of a major spill. The EP has been updated accordingly, refer to measures adopted for further details.	The feedback received around suggestions to improve consultation were mostly adopted, in the form of having face to face meetings where possible and making **Phone call**s where information is available. The suggestion to put an indigenous advisor committee in place to support Shell carrying out consultation on our behalf was considered and deemed not appropriate considering Shell already have experienced support to assist with Indigenous People and Organisation consultation.	Shell has updated the EP description of the environment (e.g. Section 7.4.1) with identified features and values provided by DAC and these have been specifically assessed within the impact and risk assessment in Section 9.14.6. Shell updated the approach to consultation because of the feedback from TO Forum 2 on the 10th May which is reflected in updates made in Section 5.6.4. Shell has provided sufficient information and a reasonable period to assess information provided. Consultation has been carried out in preparation of this EP in accordance with the OPGGS(E) Regulations. Refer Table 5-11 and Table 5-13 for further information supporting this.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Email on 20 July 2023 Updated on four EPs including timeframes for submission. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings. **Email on 24 July 2023** Meeting arrangements. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **In person on 27 March 2024** Status of this EP was discussed under ongoing consultation.			
91.	Jikilaruwu (Bathurst Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
129.	Larrakia Nation Aboriginal Corporation (Includes the Larrakia Rangers)	31 March 2023 *(Initial email)* refer to Table 5-11 and Table 5-13. **Email to Shell** 17 April 2023 25 May 2023 27 July 2023 02 August 2023 08 August 2023 21 August 2023 19 Sept 2023 **Email from Shell** 12 April 2023 22 April 2023 26 April 2023 27 April 2023 03 May 2023 08 May 2023 19 May 2023 25 May 2023 26 May 2023 30 May 2023 20 July 2023	**Email on 17 April 2023** Requested more information on the project and included meeting arrangements. **Email on 25 May 2023** Seeking to understand how Darwin will be impacted by the Crux Project. **Email on 27 July 2023 and 02 August 2023** Meeting arrangements. **Email on 08 August 2023** Attached a copy of their Strategic Plan. **Email on 21 August 2023** Meeting arrangements. **Email on 19 September 2023** Expressing thanks for the meeting.	**Email on 03 May 2023** Broome Forum details shared. **Email on 25 May 2023** Notifying that we have Shell reps in Darwin with availability to meet. **Email on 26 May 2023** Reminder about the Darwin final forum. **Phone call on 30 May 2023** Reminder about the Darwin final forum. **Email on 20 July 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission. Reiterated that relationships beyond EPs are important.	No objections or claims received in relation to impacts or risks.	Provided information that there is an underwater heritage site off Croker Island which was considered to be a relevant matter and the description of environment updated accordingly – see Measures adopted for detail. Also requested Larrakia be notified in event of a major spill, which has been incorporated into Shell's spill notification requirements for the activity – see Measures adopted for detail. All other issues raised are considered not to be relevant matters. Shell's responses to feedback are set out here.	Section 7.4.2 updated to include reference to the i underwater cultural site near Croker Island. Assessment of risks to cultural heritage (Section 9.14.6) amended to specifically identify areas around Croker Island. Table 10-8 includes requirement for Larrakia to be notified in the event of an emergency spill event which has the potential to impact Larrakia Country. Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-13 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		27 July 2023 02 August 2023 08 August 2023 10 August 2023 21 August 2023 31 August 2023 06 Sept 2023 08 Sept 2023 11 Sept 2023 18 September 2023 **Phone call** 30 May 2023 **In Person** 05 Sept 2023		Offered opportunity for updates and meetings. **Emails on 27 July, 02, 08, 21 & 31 August 2023** Meeting arrangements. **In person on 5 September** Summary of key points – full notes contained in email on 11 September. Cultural values and features of the environment. Shell suggested that to help protect that site in the event of a spill Larrakia would be listed in notifications. Agreed this would be CEO's mobile and email. Shell asked about other relevant persons they know which we should consult with. No suggestions were made. Contact details for the Darwin Supply Base Manager are provided with a view to discussing potential commercial arrangements in the future. **Email on 6 September 2023** Follow up on: contact details for Social performance and Shell supply base Darwin details are listed for contact in the event of any incident. **Email on 8 September 2023** Following up with details of the Darwin Supply Base Manager **Email on 11 September 2023** Sharing the meeting notes. Shell has obligations to consult relevant persons in line with NOPSEMA regulations/brochure. Relevant persons have rights to be consulted and to raise issues/objections/claims. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
101.	Malawu (Bathurst Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
102.	Mantiyupwi (Bathurst and Melville Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
104.	Marrikawuyanga (Melville Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
105.	Miriuwung-Gajerrong (Western Australia)	Also consulted via 38 KLC **Email from Shell** 20 June 2023 18 September 2023 **Phone Call** 20 June 2023 04 October 2023	No response.	**Email on 20 June 2023** Introductions and update on EP Consultation. **Phone call 20 June 2023** No answer **Email on 18 September 2023** Provided all relevant persons with final opportunity to comment on the draft EP. **04 October 2023** Spoke to reception and requested a call back.	No feedback, objections or claims received.	Not applicable.	*See footnote
107.	Munupi (Melville Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
119.	Tiwi Land Council (TLC)	05 April 2023 *(Initial email)* refer to Table 5-11 and Table 5-13. **Email to Shell** 14 April 2023 27 April 2023 11 May 2023 12 May 2023 17 May 2023 25 May 2023 11 July 2023 **Email from Shell** 12 April 2023 13 April 2023 14 April 2023 26 April 2023 27 April 2023 08 May 2023 09 May 2023 11 May 2023 12 May 2023 16 May 2023 17 May 2023 24 May 2023 26 May 2023 19 June 2023 10 July 2023 20 July 2023 18 September 2023	**Email on 14 April 2023** Declined invitation to Broome Traditional Owner Forum Advised Tiwi Land Council trying to work out how to accommodate the requests from oil and gas companies to meet with the land council of late since the fallout of the Santos decision. **Email on 27 April 2023** Confirming correct contact details. **Email on 11 May 2023** Meeting arrangements Requesting a summary on the project relevant to Tiwi and any impacts that may affect the Tiwi Islands. Discussed covering the costs of the meeting. **Email on 12 & 17 May 2023** Organising meeting costs and requesting information to be included in the presentation. **Email on 25 May 2023** Shared approximate costs for the meeting.	**Email on 27 April 2023** Meeting arrangements **Email on 09 & 11 May 2023** Meeting arrangements **Email on 12 May 2023** Follow-up request in relation to arranging on-Country in-person consultation. Provided information on Shell's obligations to consult, and roles and responsibilities of relevant persons. Provided further information on the proposed activity. **Email on 16 & 17 May 2023** Meeting arrangements **Email on 24 May 2023** Shared the presentation for the meeting. **In Person on 26 May 2023** Key summary of points. TLC advised important to consult with TLC first before community/clans. Oil spill impacts and how long they would take to reach Tiwi Islands.	No objections or claims received in relation to risks or impacts.	Raised a relevant matter regarding preferred engagement process and materials which was reflected in Shell's approach to consultation (Section 5.6.4). Also requested additional information. Shell provided further information as requested on the proposed activity.	Based on consultation undertaken for preparation of this EP, no additional measures have been adopted. Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-13 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		In Person 26 May 2023	**Email on 11 July 2023** Noted that there aren't cultural issues with Shell Australia's Crux Project because of its immense distance from the Tiwi Islands.	Large volume of vessel movements creating increased risk of collision. Why we are consulting when Crux is so far away. Training opportunities for Tiwi people to manage spill responses. Expressed interest in ongoing collaboration and partnerships. **Email on 26 May 2023** This EP is still being drafting. The daft will be published on the website around August 2023. Shared Crux website. **Email on 19 June 2023** Attaching a document with responses to queries raised in the meeting. Checking in that as a Council, TLC are happy with the depth of consultation that has taken place, and secondly, to gain confidence that the Tiwi clans' groups have all the information they need. Shell is keen to have ensured that all relevant people have been consulted or had access to the Crux development proposal information. Reiterating offer for additional meetings. **Email on 10 July 2023** Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 20 July 2023** Providing an update on where Shell is with the submission of the four Crux Environment Plans			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Updated on timeframes for EP submission. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
530.	Top End Aboriginal Corporation RNTBC	Consulted via 114 NLC **Phone call** 20 June 2023	**Phone call 20 June 2023** Spoke with representative. Advised there was no persons in TEDPBC to speak with as it is a legal entity only and is represented by NLC. Communications with Top End can be directed through NLC but there is no specific representative to whom they will be sent. Board of Top End is constituted of members of NLC Executive.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
123	Wanparta Aboriginal Corporation	31 March 2023 (Initial email) **Email to Shell** 02 August 2023 03 August 2023 04 August 2023 13 August 2023 14 August 2023 21 August 2023 23 August 2023 26 August 2023 **Email from Shell** 26 April 2023 26 May 2023 19 June 2023 02 August 2023 03 August 2023 14 August 2023 16 August 2023 17 August 2023 23 August 2023 18 September 2023 **Phone call**	**Email on 02 August 2023** Suggested a meeting on 16 August 2023. **Email on 03 August 2023** Meeting logistics including request for PowerPoint content. **Email on 04 August 2023** Shared estimate for the meeting with Shell. **Email on 13 and 14 August 2023** Meeting logistics and agenda shared. **Email on 21 and 23 August 2023** Confirming names of those that attended the meeting. **Email on 26 August 2023** Letter issued to Shell. **Summary of letter/meeting response:**	**Phone call 19 June 2023** Spoke to their legal representative and sent through follow up email. **Email on 19 June 2023** Introduced the Crux Project and that Shell are seeking to consult with persons or organisations who may be affected by the Crux activities. Attached factsheets and link to the draft EP, along with a link to the website for more information. Email included contact details and offer to meet. **Email on 02 August** Confirming receipt of email. **Email on 03 August 2023** Meeting logistics and proposed agenda. **Email on 14 August 2023** Sent through a shorter version of the Shell presentation. Discussion around how oil spill modelling is based on different scenarios.	No objections or claims received in relation to risks or impacts.	Provided information regarding the cultural importance of Sea Country, marine life, including totem species, and a healthy marine environment, which Shell considers to be relevant matters and are appropriately addressed in the EP – see measures adopted for detail. The request for further consultation if project parameters change is not considered a relevant matter as it is already addressed within the MOC process described within section 10.	Description of cultural heritage values in the EP describes how Sea Country is valued for Indigenous cultural identity, health and wellbeing, including specific connections of the Ngarla People to certain locations within the Planning Area (e.g. Section 7.4.2) Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5-11 and Table 5-13 for further information.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		19 June 2023 **In Person** 16 August 2023	• Ngarla People have deep spiritual connection to Sea Country. • They also highlighted the importance of totem species - the octopus, stingray, spiny bream fish and kestrel. • The protection and management of marine life plays a significant role in the Ngarla People's practise of lore, culture and customs. • The Ngarla People exercising their native title rights and interests is contingent on a healthy and well managed Sea Country.	Discussion around sea Country and explaining Shells processes around heritage values and Shells work on this. Community funding question asked and explained community funding and programs are around areas of Shell impact for Prelude, including areas of people movement in, Broome and Dampier Peninsula Email on 16 and 17 August 2023 Shared the Crux animation and requested confirmation of who was in attendance at the meeting. **Email on 23 August 2023** Finalised names of attendees. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
531.	Wulirankuwu (Melville Island)	Consulted via 119 TLC	No response.	No response.	No feedback, objections or claims received.	Not applicable.	*See footnote
532.	Wurankuwu (Bathurst Island)	Consulted via 119 TLC	No response.	No response.	No feedback, objections or claims received.	Not applicable.	*See footnote
127.	Yimpinari (Melville Island)	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
Tier 3							
72.	Anindilyakwa Land Council	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 26 May 2023 16 June 2023 (online form submission) 18 September 2023 **Phone call** 16 June 2023 (left messages)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
74.	Arnhem Land Aboriginal Land Trust	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
30.	Bardi Jawi Rangers	Consulted via 38 KLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
602.	Balanggarra Rangers	Consulted via 38 KLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
78.	Bulgul Land and Sea Management Rangers	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
603.	Cobourg Peninsula Sanctuary Land Trust	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
79.	Crocodile Islands Rangers / Maringa Ocean Patrol	31 March 2023 *(Initial email)* refer to Table 5-11.	No response.	**Email on 26 May 2023**	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		Email from Shell 05 April 2023 12 April 2023 26 April 2023 08 May 2023 19 May 2023 26 May 2023 18 September 2023 17 October 2023		Close out email wrapping up the consultation: Sharing the videos from Forum 1. Reminder of the environment panel available. Recap on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Reconfirming contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Recap of meeting in August. Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings.			
80.	Croker Island	Initially provided information via 114 NLC **Email from Shell** 19 June 2023 18 September 2023 17 October 2023 **Phone call** 19 June 2023 (left message)	No response.	**Email on 19 June 2023 (via webform)** Shared details about the Crux project and the 4 EPs. Included link to website. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **Email on 17 October 2023** Reminder of the four environment plans Shell is consulting on and opportunity to input. Recap of meeting in August.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Detailed how input to an EP helps Shell. Updated on timeframes for EP submission of Friday 27 October, after which the EP consultation will be closed. Reiterated that relationships beyond EPs are important. Offered opportunity for updates and meetings.			
82.	Delissaville/Wagait/Larrakia Aboriginal Land Trust	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
85.	Garngi Land and Sea Management / Garngi Community Rangers	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
89.	Gumurr Marthakal Rangers	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 25 May 2023 26 May 2023 16 June 2023 18 September 2023 **Phone call** 16 June 2023 (no contact made)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
58.	Individual Indigenous person-self identified.	27 April 2023 (Initial email via Joombarn-Buru Aboriginal Corporation RP 35) **Email to Shell** 28 April 2023 09 May 2023 14 May 2023 17 May 2023 22 June 2023 08 August 2023 **Email from Shell** 28 April 2023 02 May 2023 12 May 2023 17 May 2023 22 June 2023 26 June 2023 10 July 2023 18 September 2023	**Email on 28 April 2023** Raised issue that the law and culture and ceremonies/men's ceremonies come from the ocean and reefs north of the King Sound. The offshore exploration and actives also could impact on a culturally sensitive reef in the region, as an area traditionally fished and hunted with strong cultural significance. Requested that representative bodies are used for consultation. **Email on 09 May 2023** Advised preferred consultation on Country.	**Email on 28 April 2023** Acknowledged message and affirmed Shell's commitment to understanding impacts of proposed activities so they can be managed to ALARP. Requested opportunity to consult further through phone call or in-person meeting. Encouraged representatives to attend Traditional Owner Forum in Broome. **Email on 02 May 2023** Provided information on Shell's consultation approach. Provided details and information of the efforts Shell has been making to identify relevant persons and alternative means to contact as many individuals as possible.	Raised objection/claim that the activities could affect indigenous people's law, culture and ceremonies/men's ceremonies which come from the ocean including culturally significant sites traditionally fished and hunted. Explained that there are sites that have strong cultural significance. Objection/claim is deemed to have merit as it relates to potential impacts on indigenous cultural features/values. The EP has been updated accordingly – see Measures adopted for detail.	Raised a relevant matter regarding preferred engagement process to ensure culturally appropriate consultation. Shell adjusted its engagement process accordingly.	Consultation included RTNBCs from north of King Sound and facilitating on-Country meetings wherever requested/practicable (Section 5.6.4). The description of cultural heritage values in Section 7.4.2 has been updated with the information provided regarding a culturally sensitive reef and this information considered in the assessment of risks (e.g. Section 9.14.6). Accordingly, consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
			Email on 14 May 2023 Advised to consult with representative bodies about the impacts of the proposed activity. **Email on 17 May 2023** Requested senior men's meeting. **Email on 17 May 2023** Advised travelling at present. **Email on 22 June 2023** Welcoming information about Shell's activities at the Walalakoo board meeting. Included Walalakoo and Joombarn-Buru in the emails. **Email on 08 August 2023** Requested to add Indigenous Social and Economic Impacts to the agenda.	Provided information on Traditional Owner Forums and encouraged attendance. Provided information on alternative communications channels and tools available to provide feedback or ask questions. Requested support in sharing information about the consultation process with their community members. **Email on 12 May 2023** Noting feedback on improving consultation. Shell is open to on-Country consultation. Request for guidance on which PBCs to talk to. Factsheets attached and links to website. **Email on 17 May 2023** Acknowledged individuals do not represent other PBCs. Reiterated Shell's commitment to consultation and understanding tangible and intangible ocean sites. Confirming contact with KLC. Request to meet. **Email on 17 May 2023** Follow up on request for feedback, and reiterated offer of meeting at whatever time and place would be convenient. **Email on 22 June 2023** Follow up on request for feedback, and reiterated offer of meeting at whatever time and place would be convenient. **Email on 26 June 2023** Confirming the consultation approach preferred by the Walalakoo Board including a Crux team addressing the Board, meeting, or providing information (such as factsheets, Crux EPs and other material). **Email on 10 July 2023**			

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Close out email sent which covered the following: Recapped on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Notified of the management of feedback if any details should be considered sensitive information. Reconfirmed contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
35.	Joombarn-Buru Aboriginal Corporation	Email to Shell 28 April 2023 (Refer to RP 58) **Email from Shell** 27 April 2023 02 May 2023 27 June 2023 18 September 2023 **In person** 27 April 2023 26 June 2024	**In person on 27 April 2023** Shell Social Performance Advisor and Joombarn-Buru Executive Officer met to discuss assistance in distributing Indigenous Forum 2 invites in Broome. **Email on 28 April 2023** Shared an email from a couple of prominent Indigenous Leaders in our community with feedback on consultation requirements.	**In person on 27 April 2023** Shell requested assistance in distributing invite to Broome Indigenous Forum 2. Refer to relevant person 58, for the response to the email received on the 28April 2023. **Email on 02 May 2023** Overview of meetings that Shell is holding and encouragement to attend. **Email on 18 September 2023** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B. **In Person on 26 June 2024** Summarised this EP and referenced Shell's ongoing consultation commitments.	.No objections or claims have been received about activity impacts or risks.	Provided information identifying other relevant First Nation contacts which Shell added to its consultation program – see Measures adopted for detail. Raised the potential for major spills to impact cultural features that other groups across the peninsula are likely to have an interest in. Shell considers this a relevant matter because it provides information about cultural values and features which could be affected in the event of a major spill. Indicated interest in social and economic benefits which is not considered to be a relevant matter to the preparation of this EP. This is something that will be progressed separately to this EP. Matter raised regarding Consultation Protocol. This is not deemed to be a relevant matter to the preparation of this EP. JBAC requested copies of accepted Crux EPs and OPP, which have been provided.	Additional persons/organisations identified were incorporated into the consultation undertaken for this EP (Section 5.6.5). Table 10 7 includes requirement for Joombarn Buru to be notified in the event of an emergency spill event which has the potential to impact communities and environments across the peninsula. Consultation in preparation of this EP has been carried out in accordance with the Shell methodology. Refer to Table 5 10 and Table 5 11 for further information.
93.	Kalumburu Aboriginal Corporation	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 26 May 2023 20 June 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		18 September 2023 17 October 2023 **Phone call** 12 October 2023 -no answer					
601.	Kenbi Rangers	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
39.	Kimberley Ranger Network	Consulted via 38 KLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
69.	Kooljaman at Cape Leveque – now closed	04 April 2023 *(Initial email)* refer to Table 5-11. 08 May 2023 (follow up) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
42.	Lombadina Aboriginal Corporation Including Lombadina Accommodation & Tours.	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 04 April 2023 26 April 2023 08 May 2023 19 May 2023 25 May 2023 26 May 2023 20 June 2023 18 September 2023 **Phone call** 20 June 2023	No response.	**Email on 26 May 2023** Close out email wrapping up the consultation: Sharing the videos from Forum 1. Reminder of the environment panel being available. Recap on what Shell is consulting on and the obligation to consult under the regulations. Reconfirming contact details. **Phone call on 20 June 2023** Spoke to Director of LAC who requested further information, which was emailed through. **Email on 20 June 2023** Details of the Crux Project and the four environment plans Shell is consulting on and opportunity to input. Details on consultation. Attached factsheets. Offered opportunity for updates and meetings. **Email on 27 June 2023** Close out email wrapping up the consultation: Sharing the videos from Forum 1. Reminder of the environment panel available.	No feedback, objections or claims received.	Not applicable.	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Recap on what Shell is consulting on and the obligation to consult under OPGGS(E) Regulations. Reconfirming contact details. **Email on 18 September** Provided all relevant persons with final opportunity to comment on the draft EP. Available in Appendix B.			
100.	Malak Malak Land and Water Management Rangers	Consulted via 114 NLC **Email from Shell** 31 March 2023 03 April 2023 26 April 2023 19 May 2023 25 May 2023 26 May 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
108.	Munupi Aboriginal Corporation	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 26 May 2023 19 June 2023 18 September 2023**Phone call** 19 June 2023 (phone number disconnected)	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
48.	Northern Australian Indigenous Land and Sea Management Alliance	03 April 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 26 April 2023 19 May 2023 25 May 2023 26 May 2023 18 September 2023	No response	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
132.	NT Indigenous Business Network	04 April 2023 *(Initial email)* refer to Table 5-11. 08 May 2023 (follow up) 18 September 2023	No response	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
51.	Nyul Nyul PBC Aboriginal Corporation	Also consulted via KLC 38. **Email to Shell** 26 October 2023 16 February 2024 22 February 2024 08 April 2024	**Email on 26 October 2023** Nyul Nyul PBC board requesting a consultation workshop in 2024. **Email on 16 February 2024** Meeting arrangements.	**Email on 27 October 2023** Shell acknowledged meeting request and welcomed opportunity to meet in 2024. Explained consultation requirements and that consultation period was closing today in readiness of submission to NOPSEMA. **Email on 7 November 2023**	No feedback, objections or claims received.	Expressed interest in oil spill training for Nyul Nyul Rangers which is considered to be a relevant matter. This is being progressed via the KLC. Raised cultural features up the coast that were deemed outside of	Additional persons/organisations identified were incorporated into the consultation undertaken for this EP (Section 5.6.5).

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		12 April 2024 29 April 2024 06 May 2024 21 May 2024 24 May 2024 **Email from Shell** 17 October 2023 27 October 2023 07 November 2023 15 February 2024 16 February 2024 19 February 2024 01 March 2024 08 April 2024 15 April 2024 30 April 2024 06 May 2024 08 May 2024 20 May 2024 21 May 2024 23 May 2024 29 May 2024 **Phone call** 16 February 2024 **In Person** 22 February 2024 02 May 2024	**Email on 22 February 2024** Meeting details. **Email on 08 April 2024** Update to contact details. **Email on 12 April 2024 x2** Details of Board meeting. **Email on 29 April 2024** Meeting logistics. **Email on 06 May 2024** Confirming attendees. **Email on 21 May 2024** Providing required details. **Email on 24 May 2024** Advice to use existing networks for the Nyul Nyul rangers oil spill training.	Advised again that consultation was closed for purpose of submission, but processes are in place to address new concerns that may be raised. Reiterated that Shell is willing to meet in the new year. **Email on 15 February 2024** Introductory Email from Shell's new Indigenous Engagement Advisor noting previous request for a meeting and asking for suitable dates. **Email on 16 February 2024 (a few emails on this date)** Finalising meeting details. **Phone call on 16 February 2024** Finalising meeting details. **Email on 19 February 2024** Advising Shell's attendees for Nyul Nyul PBC board meeting. **In Person Meeting on 22 February 2024** Meeting notes included in Sensitive Information Report. **Email on 1 March 2024** Sharing the notes from the meeting. **Email on 08 April 2024** Confirming details received. **Email on 15 and 30 April 2024** Meeting logistics. **In person on 02 May 2024** Meeting notes included in the sensitive matters report. **Email on 06 May 2024** Confirming attendees. **Email on 08 May 2024** Meeting follow up, including progressing the Nyul Nyul rangers for oil spill training. **Email on 20 May 2024** Following up previous email. **Email on 21 May 2024**		the Planning Area of this EP and therefore not a relevant matter.	

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
				Confirming receipt. **Email on 23 May 2024** Making contact regarding Nyul Nyul Rangers oil spill training. **Email on 29 May 2024** Offer to meet**.**			
52.	Pudakul Aboriginal Cultural Tours	04 April 2023 *(Initial email)* refer to Table 5-11. 08 May 2023 (Follow-up email) 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
116.	Saltwater Cultural Tours	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 26 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
117.	Tarntipi Bushcamp	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 26 April 2023 08 May 2023 19 May 2023 26 May 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
118.	Thamurrur Rangers	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 15 May 2023 26 May 2023 19 June 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
120.	Tiwi Marine Rangers	Consulted via 119 TLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
121.	Tiwi Resources Pty Ltd	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 25 May 2023 26 May 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable	*See footnote

Relevant Person		Dates of Correspondence and Follow-Up	Summary of Relevant Person Response	Summary of Shell's Response	Assessment of Merits of Objection or Claim	Relevant and Not Relevant Matters to this EP	Measures Adopted and Justification for Consultation Closed
ID	Name						
		18 September 2023					
126.	Yagbani Aboriginal Corporation	31 March 2023 *(Initial email)* refer to Table 5-11. **Email from Shell** 12 April 2023 26 April 2023 19 May 2023 25 May 2023 26 May 2023 19 June 2023 18 September 2023	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote
599.	Wudicupildiyerr – now closed.	Consulted via 114 NLC	No response.	Not applicable.	No feedback, objections or claims received.	Not applicable.	*See footnote

Footnote.

*In accordance with Shell approach, multiple attempts have been made to contact this relevant person during a reasonable period with no response received to date. Other mechanisms have been used to comply with Shell's requirement to consult with relevant persons on the proposed activity. Relevant persons can provide feedback to Shell via the EP webpage during the implementation of the EP with any new relevant matters assessed in accordance with the EP (Section 5.8). Consultation in the course of preparation of the EP has been completed in accordance with the OPGGS(E) Regulations.

Appendix D Oil Spill Modelling RPS Technical Note

This Appendix contains the Technical Note prepared by RPS on behalf of INPEX. It explains the limitation of the oil spill modelling and is directly relevant to the modelling presented in this EP. Shell has received permission from INPEX and RPS to include this Technical Note.

Appendix B.7 a) Technical note - RPS

Response to Inpex questions on Oil Spill Modelling

The following technical guidance has been prepared by me, Scott Langtry, as a subject matter expert in oil spill modelling as applied to environmental management of oil field operations within the offshore waters of Australia. The details provided constitute my opinions based on specialised knowledge developed through my education, training, study, and experience, including working experience carrying out oil spill modelling for risk assessment and response to real spill incidents over 26 years.

This report has been compiled in response to a request by Inpex Australia to provide answers to the following questions:

1.0 Base Scope

Question	Answer
a) Describe generally the purpose of oil spill modelling.	See addendum, Section 1.0.
b) Develop a report which describes the model conservatism, and how the conservatisms affect model outputs and results, as related to the thresholds presented in (c) and (d) below.	See addendum, Section 2.0 and details below.
c) 10 ppb entrained oil threshold:	
(i) Can you confirm that the 10 ppb entrained threshold, when evaluated through the model, is based on ‘instantaneous exposure”, when the 10 ppb threshold is actually derived from dissolved oil exposure over a time-weighted average?	Yes. The model calculations are analysed for distributions of oil mass in different states (floating, entrained, dissolved, stranded, evaporated) at each model time step. Typically, 15-minute time steps (or less) are used to maximise accuracy of the weathering and transport calculations. Consequently, entrained oil >10 ppb (parts per billion) calculated for durations as short as 15 minutes during any replicate simulation would flag a location as ‘affected’. This flag would only need to occur during 1 of 300 simulations (=0.3% probability of occurrence) for that location to be enclosed by a polygon defining the

	Environment that May Be Affected (EMBA) as defined in the NOPSEMA guideline (2019). A 10 ppb entrained threshold is not based on evidence that 10 ppb of entrained oil droplets (alone) is harmful for either short term (e.g., 15 minutes or for any longer duration (e.g., 48-96 hrs). The NOPSEMA guideline has applied the same threshold for both dissolved and entrained hydrocarbon concentrations as instantaneous exposures. The dissolved threshold concentration was calculated by toxicity studies applying long-term exposures (48-96 hrs of exposure) to the components of oil that can dissolve into water from oil mixtures and no correction for shorter exposure durations has been applied in the NOPSEMA guidelines (see below; part ii). At the outer bounds of the EMBA calculated for a blowout simulation spanning 70 or more days, entrained oil would be present as widely dispersed and insoluble droplets with small diameter (10-50 µm). No insoluble compounds will remain to dissolve into the water to trigger the toxic effects demonstrated by toxicity testing on marine organisms. Direct contact with droplets or consumption of droplets may have influence but risks of influence would depend upon encounter rates, which would depend on the concentration of droplets and the duration that they are present. As an indication of the meaning of the 10 ppb concentration threshold that the NOPSEMA guidelines recommend for entrained oil, this would represent one insoluble droplet suspended in 40,000 L of water for a droplet of 25 µm diameter. It would be necessary to have one million droplets of this size to form a standard drop of oil from an oil dropper (0.05 ml). Consequently, the potential for direct contact by marine biota with a droplet at this threshold concentration when triggered by durations as short as 15 minutes is highly conservative for any consequence through direct contact with droplets.
(ii) Can you describe how the use of instantaneous thresholds in the model may affect the model outputs/geographical areas exposed above threshold?	Instantaneous thresholds have a very large influence upon the geographic extent that is mapped as the EMBA, an influence larger than all other conservative measures applied. Hydrocarbons impose a narcotic effect on organisms through absorption of soluble hydrocarbons from water into their tissue, and it takes longer than 15 minutes for

	harmful soluble compounds to accumulate to levels that impose effect when the concentration of harmful, soluble, hydrocarbons in the water is higher than 10 ppb. Species vary by sensitivity and different oils vary in terms of the toxic components present. The lowest toxic threshold for soluble hydrocarbons (~10 ppb) has been derived as a generic trigger value for potential sublethal influence from a large body of laboratory toxicity testing where exposure has been maintained for 48-96 hrs to ensure saturation of body tissues. A value of ~10 ppb is the lowest value reported for the most sensitive marine species using the water solutions generated from the most toxic oil mixtures. Exponentially higher concentrations are required to achieve equivalent effects over shorter durations. At least 100 times higher concentrations would remain conservative for durations of <1 hr. Instantaneous thresholds treat all areas exposed for a time as short as 15 minutes as if they were exposed constantly for 2 to 4 days (following evidence from toxicity studies). This is very conservative, and reliance on the extent of the EMBA alone obscures information that would be available to show those locations that may be more at risk, such as those locations where longer exposures may occur. Further clarification can be provided.
(iii) Can you comment on how the probability maps/contours generated by the model using instantaneous oil exposure thresholds would be affected, compared to what would occur using time-weighted exposure thresholds?	Comparisons of model calculations for areas that might experience instantaneous exposures (e.g., >10 ppb of entrained oil for 15 minutes) versus time-weighted exposures (e.g., >10 ppb on average over 24, 48 or 96 hours) indicates that the difference depends on the scenario, oil type and component (floating, entrained, dissolved). The outer extent of the EMBA may be reduced to as small as 20% of the surface area (i.e., the surface area enclosed by the EMBA may be reduced by up to 80%) when based on time-weighted exposures. The shape of the EMBA will also typically change to highlight locations where environmental forcing is more likely to direct higher concentrations of spilled material repeatedly or to retain spilled material for longer during a long duration release (e.g., a blowout) – detail that should be relevant to risk assessment, planning and consultation purposes.

	Allowing for as little as 2 subsequent time steps or for 2 records of exceedance at any time during any spill simulation, will result in marked reduction of the geographic area and alter the shape calculated for the EMBA, showing that large parts of the existing EMBA calculations can be due to single, 15-minute, records. Further clarification can be provided.
c) 10 g/m^2 shoreline contact threshold:	
(i) Can you describe how the model calculates oil accumulation volumes on shorelines, in consideration of the modelled shoreline grid-cell/lineal shoreline lengths vs actual/realistic shoreline lengths and the effect this may have on volumes of oil ashore calculated by the model?	Accumulation of oil onto shorelines is calculated as the mass of oil per unit of shoreline area. The coastline at mean sea level is subdivided into fixed, rectangular, grid cells of a defined area described by fixed length and width. For example: • 1 km long x 10 m wide (10,000 m^2 area per cell) for blowouts. • 400 m long x 10 m wide (4,000 m^2 area per cell) for diesel spills. Owing to the grid scale applied, the coastline shape must be simplified in areas of small-scale complexity. Very complex and convoluted shorelines will be represented by a smaller area than reality, adding conservatism by lowering the area used when calculating the mass of oil per unit area. The more complex the coastline the larger the degree of conservatism. If the model calculates that any part of a patch of floating oil contacts any part of a coastline cell, the total mass of oil in that patch is transferred to the coastline cell as a conservative calculation for oil stranding. Any subsequent oil patches that contact that coastline cell will add to the tally in that coastline cell over time. The maximum possible load at any time will be capped at the carrying capacity set for shoreline cells (40 m^3 over 10,000 m^2 for low viscosity oils (condensates and diesel, etc.). Any excess oil will be re-floated and may then accumulate on other coastline cells. Evaporation and degradation are calculated for stranded oil to reduce the tally of oil in a coastline cell over time.

	When all simulations are complete, the highest mass recorded at any time due to inputs versus losses is found for each coastline cell in each simulation. The highest mass from any simulation is divided by the shoreline area of the cell to determine the peak concentration (grams of oil/area in m^2) as the most conservative calculation for the amount of oil that might be present, for clean-up and other considerations. The peak concentration calculated for each shoreline cell among all replicate simulations is compared to thresholds of relevance. Any shoreline cell with peak mass per area > minimum threshold (e.g., 10 g/m^2) during any replicate simulation will be included in the EMBA polygon. Note that: 1. The peak concentration that is calculated will be higher if the surface area available for accumulation is under-represented in the model compared to reality. 2. The peak concentration that is calculated may be, and typically is, higher than the concentration that would be calculated at the end of the simulation, after further weathering is allowed for. 3. No differential is made between oil on the surface and oil that has entered the substrate. Further clarification can be provided.
(ii) Can you describe if the model includes consideration of tidal movements or wetting and drying of intertidal areas, and how this may affect modelled oil concentration outputs, vs what might occur in reality?	The model does not account for wetting and drying of the intertidal zone. Both the coastline position and water level are treated as fixed, and calculations assume a fixed average width of the shoreline interface (10 m wide) is always available for accumulation. One outcome at a very local scale is that the model cannot differentiate between the happenstance of oil arriving when the shoreline extends further seaward (at lower tide, exposing a wider zone) or when it might have shrunk back to a narrower zone (at higher tide). Although the intertidal width will vary over time, in reality, and oil might be spread over varying area, the area allowance is assumed fixed to an average of 10 m wide when calculating the mass accumulated per area. In reality, concentrations of oil would likely vary with the tide in areas with very large tidal ranges and low slope,

	and we have applied a fixed width as an assumed average. One conservatism is that shorelines are assumed to be "sticky" – binding the oil to the shorelines with no re-floating due to subsequent tidal flooding. This assumes oil accumulations would migrate up and down, occupying the same width of the shoreline as the tide varied. The exception is if the carrying capacity of the shoreline is exceeded. For condensates and diesel this would only be allowed in the model if the thickness exceeded 4 mm, allowing for high accumulation capacity (e.g., 32 tons per shoreline cell for a 1 km long x 10 m wide shoreline if the density averaged 800 kg/m^3). Noting that the model domain must cover areas of hundreds of thousands of km^2 for a blowout scenario, the fixed coastline assumptions represent necessary simplifications requiring a conservative approach. Further clarification can be provided.
(iii) Can you confirm if the model continues to calculate oil weathering of stranded oil on a shoreline, specifically evaporation and melting point?	Yes. As stated above (part i), oil weathering continues to apply to oil classed as stranded. Loss of oil mass from coastline cells can occur through three processes: 1. Evaporation. 2. Degradation (representing microbial action and photo-oxidation). 3. Re-floating (if the carrying capacity of the coastline cell is exceeded). The composition of the oil when freshly released at source is represented by the proportion of the whole oil contributed by groups of hydrocarbons, varying by volatility. Composition change is calculated over time through evaporation and dissolution when the oil is floating, and the composition of oil patches is known by the model at the time of stranding. Calculations for variable rates of evaporation, by sub-components, continues for stranded oil until only the non-evaporating residues (boiling point >380 °C) remain. Calculations for evaporation rates are based on wind speed and average ambient temperature (30 °C for the Inpex studies), not elevated temperatures that might occur during daytime on heat-retaining surfaces.

	Calculations for evaporation are, therefore, conservative if evaporating components remain in the stranded oil. If only residues strand, no loss of oil through evaporation will be calculated on shorelines. Degradation is applied to the total mass (regardless of composition) at a fixed rate. A conservative rate of 3% of the mass per day is applied. This rate has been derived from published tests on more complex oil types than diesel or condensate and is considered conservative for condensates in lieu of further research to confirm rates of degradation of both oil types. The model does not calculate for melting point to decide whether the oil is on the substrate (e.g., as solid wax) or in the substrate (e.g., as a melted wax).
(iv) Can you describe if the model takes into consideration the effect of exposed intertidal shoreline temperature (i.e., sand/rock temperature) and the effect this may have on stranded oil including effect on oil melting point and subsequent behaviour of the stranded oil?	Degradation rates do not account for substrate temperature. This will be conservative in settings with high average substrate temperatures because degradation rates do increase at higher temperatures. The same ambient temperature and prevailing wind speeds are used for both floating and stranded oil for calculating evaporation rates. This will be conservative if the oil arrives with volatile content and the real temperatures are higher than assumed (30°C for the Inpex study locations) on average. This would not be conservative if only residues arrive at coastline cells. No calculations are made by the model for the physical state (solid/liquid) of hydrocarbons, or of uptake by sediments. Such considerations would need to be made outside of the model calculations. Further clarification can be provided.

1.1 Supplementary Scope

(a) Can you confirm if there are any other factors which may affect conservatisms within the model?	See addendum.
(b) if Yes, can you please explain these additional factors.	See addendum.

Addendum

1.0 (a) Describe generally the purpose of oil spill modelling.

Modelling of oil fate and transport is useful, and has been applied to multiple purposes:

- Calculating risks of exposure to facilities, personnel, interests of other parties and environmental resources if a spill scenario were to eventuate.
- Guiding preparations for response, including identifying those resources that may need to be defended and what responses may be practical given factors such as the nature of the place at risk and the evolution through weathering of the oil type(s) that might be spilled.
- Forecasting the drift and behaviour of oil slicks ahead of real time to guide response to real spills.
- Forecasting the efficacy of alternative response measures.
- Guidance of environmental monitoring efforts to sense influence or impact.
- Post-spill assessment to inform and quantify social, environmental, or commercial impacts.

The first general application is the basis of EMBA calculations at present, but with the results simplified to calculating the area enclosing all locations where greater than low threshold concentrations might occur instantaneously at very low probabilities.

Other calculations from modelling are available and may be applied as contextual measures. These include:

- Mapping locations at higher probability of contact > instantaneous thresholds.
- Mapping locations at risk of longer durations of contact > instantaneous thresholds.
- Mapping locations at higher probability of contact at > time-integrated thresholds.
- Mapping locations based on potential concentrations (maximums and statistical distributions such as mean and higher percentiles).

1.0 (b) Develop a report which describes the model conservatism, and how the conservatisms affect model outputs and results, as related to the thresholds presented in (c) and (d) below.

General background

In general, oil spill models are a collection of interacting formulae and calculations that have been compiled to best represent current knowledge of processes that affect oil when released into the marine environment.

These processes are complex and interacting, requiring organised formulation to avoid errors and bias.

The formulations are numerical tools that allow comparative testing for different outcomes depending upon the scenario and prevailing conditions, subject to errors and uncertainties in both the inputs and the formulae.

Key processes have been studied to varying degrees over several decades through empirical studies, observations, and laboratory experiments. Some processes and their dependencies are well understood, while others have larger uncertainties and are the subject of ongoing testing and development.

The model formulations allow management of uncertainties through sensitivity allowances and/or conservative calculations or inputs (i.e., arrangements that are more likely to overstate and not understate risks).

Potential sources of conservatism

As a general principle, the ongoing calculation of concentrations over a large number of sequential time steps (e.g., 7,680 contiguous time-steps in an 80-day blowout simulation), with calculations at each time step dependent upon a previous calculation of state, can be expected to lead to magnification of any model errors at the outer distances and durations.

The current NOPSEMA guidance for calculating the EMBA has changed the focus of modelling assessment efforts from identifying locations that are most at risk (typically closer to the source and at risk of contact over shorter elapsed times) to map out only an outer bound of possibilities. One consequence of this is that the EMBA definition is now highly dependent on model capabilities, uncertainties, and compounding of errors in calculations for defining when concentrations will fall below very low concentrations.

The modelling software that I will detail to address model calculations and conservatism is the Spill Impact Model Application Package (SIMAP) that has been applied to most oil spill risk assessments in Australia, including those carried out for INPEX, but considerations will be common to other oil spill models of similar capability.

SIMAP is three-dimensional and is structured as a series of interacting algorithms that consider all known key processes that may affect the transport and weathering of hydrocarbon mixtures:

- Buoyancy (upward vertical transport from subsea).
- Initial spreading due to gravity and surface tension.
- Horizontal transport due to wind and current.
- Spreading (transport in the vertical and horizontal) due to dispersive forces.
- Wave-induced entrainment into the water column (as oil droplets).
- Dissolution (of soluble hydrocarbons) into the water column.
- Vertical dispersion of dissolved hydrocarbons (vertical spreading due to dispersive forces).
- Evaporation to the atmosphere.
- Emulsification (uptake of water into floating oil films).
- Change in viscosity due to change in composition and emulsification.
- Sedimentation (through binding with suspended sediment).
- Shoreline stranding – shoreline specific.
- Re-floating from shorelines (if capacity exceeded).
- Degradation (to component molecules).

The model uses oil composition and physical properties as input, and calculates changes in the mass distribution of the spilled oil over time among six states in response to the release scenario (e.g., onto the water, from subsea blowouts, etc.) and a sequence of environmental conditions:

1. Floating as a film on the water surface.

2. Entrained (at some depth) as oil droplets suspended in the water column.
3. Dissolved (at some depth) in the water column from films or suspended droplets.
4. Evaporated (to the atmosphere).
5. Stranded on a shoreline.
6. Degraded to simpler chemical components (hydrogen, carbons, etc.).

The NOPSEMA guidelines require that the worst-case (or worst plausible case) spill scenario is modelled for a given oilfield operation. For drilling operations into reservoirs where gas/condensates are targeted, that will involve a long-term (>70-day) release of gas and condensate at the highest rate possible through a fully open reservoir.

This scenario will generate the highest potential initial concentrations, both in reality and in the model, and is a conservative starting point.

Key considerations for conservatisms in the modelling are calculations for initial concentrations, the initial distribution of oil mass among the states, and processes that affect reductions in the concentrations of oil in each state over time.

Calculations for gas-condensate releases, more so than for heavier oil types, are very sensitive to model calculations of entrainment rates because these oil mixtures have both very low viscosity (hence will be susceptible to entrainment) and are mostly composed of volatile hydrocarbons (hence will be susceptible to evaporation, if exposed to the atmosphere). Entrainment and dissolution are competing fate pathway to floating and evaporation.

Over-prediction of entrainment rates will reduce the evaporation rate that is calculated (a general loss term for calculation of oil mass that would otherwise be on or in the water, or on shorelines) and leads to higher concentrations of entrained oil being calculated further from the source.

Entrainment is calculated for two processes by the model:

- As droplets released subsea (for blowouts).
- Generated by waves breaking up slicks into droplets and mixing the droplets into the surface layer, or keeping droplets that were entrained by the process above mixed into that layer.

Considerable care is required to calculate the initial droplet-size distributions accurately for subsea blowout scenarios involving highly volatile condensates (as opposed to less volatile mixtures) due to the large influence of droplet-size calculations upon entrainment rates versus evaporation rates. Calculations for oil droplet sizes have been an active area of model development and the modelling currently incorporates the most recent calculations from authoritative sources (SINTEF, TAMOC, etc.) but understatement of droplet sizes remains a risk for overstatement of entrainment rates because most research has involved heavier oil types.

Calculations for entrainment due to wave action in the SIMAP model were updated ~5 years ago to new formulations following a large volume of research conducted for the Deepwater Horizon blowout. The updated formulations increased the sensitivity to wave action, lowering thresholds for wind speed required to generate or maintain entrainment for low viscosity oils.

Sensitivity testing suggests that the allowances may be overly conservative for entrainment rates when applied to highly volatile condensates. In turn, calculations

would likely be conservative for dissolution rates and dissolved hydrocarbon concentrations for these products because faster dissolution is calculated for entrained oil than for slicks.

The model will calculate reduction of oil concentrations for surface and subsurface oil concentrations (entrained and dissolved) due to dispersion, representing the spreading and thinning of patches and plumes over time due to the mixing forces in the ocean.

Contemporary calculations for dispersion are typically set for moderate sea conditions for the scenario setting and not for more energetic conditions that can occur. On average, it is expected that this approach will result in maintenance of higher concentrations over longer distances than might occur in reality. The level of conservatism would vary depending on the frequency of occurrence of windy conditions that would trigger breaking sea waves.

A further level of conservatism for calculation of entrainment (increasing dissolution) versus floating (increasing evaporation) for surface releases of highly volatile condensates is the model time step. Highly volatile condensates with a low residue content will flash off rapidly, in reality, when spread thinly onto the water surface. However, calculation at 15-minute steps, which is a practical rate for long term blowout modelling, may underestimate the evaporation rate that is calculated for such condensates and overestimate the calculation for maintenance of entrained oil concentrations above low thresholds. Evaporation rates are calculated to occur at a slower rate for soluble hydrocarbons that are dissolved in surface-waters than at the surface, which could lead to overstatement of dissolved hydrocarbon concentrations exceeding low thresholds.

Some loss of mass is calculated for entrained oil over time due to dissolution of the soluble compounds. These compounds will typically represent a small proportion of the mass of an oil initially (typically 6-12% for condensates) so there would be only a relatively small influence on reduction of entrained oil concentrations.

It is also noteworthy that the model can calculate when entrained oil droplets have lost all soluble components. However, the NOPSEMA guidelines are applied equally to entrained oil that has remaining soluble components and those that have migrated long distances over long time periods and would have weathered to lose all soluble components. Because the EMBA line defines the widest boundaries, it will be the concentrations of weathered entrained oil that are tested against the NOPSEMA guideline threshold.

Degradation rates are applied to allow for reduction of oil concentrations over time. These rates are derived from literature accounts, and different rates are applied to floating, entrained, dissolved, and stranded oil. All rates are assumed to be conservative for condensates, in particular, because they tend to be composed of simpler hydrocarbons than those oils used to measure degradation rates, which could lead to concentrations being maintained for longer distances and durations than might occur, in reality, in warm tropical and sub-tropical settings. The rate currently applied to the insoluble components of entrained oil is a constant rate of ~8% of the mass per day.

Collectively for these uncertainties, calculations for entrainment mass concentrations and dissolved hydrocarbons will tend to be increasingly conservative over many sequential calculations.

The extremely low threshold set by the NOPSEMA guidelines for entrained oil is interacting with the conservative allowances for entrained concentrations for gas

condensates to dominate calculations for the EMBA for both blowout and surface release scenarios for this oil type. In other words, the extent of the entrained oil contour applied to the EMBA calculation is always larger than for any other component.

A further, potential, consequence of maintaining entrained concentrations for longer, in combination with the low threshold set by the NOPSEMA guidelines for oil contact with shorelines (as opposed to accumulation), is that model calculations for re-floating of oil from an entrained state become more critical. The model only needs to calculate that re-floating has led to a small patch of oil at the surface that is equal to or marginally higher than the low threshold (10 g/m^2 on the surface) from an overstated entrained oil concentration to flag a once-off calculation for shoreline exposure at a location that can be isolated by a long distance from the extent calculated for surface slicks to decrease below threshold concentrations when remaining at surface. One such occurrence among 300 simulations will flag a shoreline location for inclusion in the EMBA at a further distance than is indicated for the persistence of surface slicks above the low threshold. Although entrainment and re-floating are real processes that can occur, it is plausible that model errors are responsible for triggering the flagging of some stranding events judged by the low instantaneous threshold at the outer bounds of the EMBA.

Scott Langtry

Principal Scientist
RPS | MetOcean Science & Technology
Level 3, 500 Hay Street
Subiaco, WA 6008, Australia

T +61 8 9211 1111 **F** +61 8 9211 1122
D +61 8 9211 1149 **M** +61 418 827 754
E scott.langtry@rpsgroup.com

Appendix E Native Title Rights and Interests

The table below provides a summary of the rights and interests held by Indigenous groups with Native Title determinations located within the Planning Area. It is not exhaustive of the relevant Indigenous groups or their rights, rather it is designed to provide an indication of the different rights and interests within the Planning Area.

Table 12-1:Summary of Native Title Rights and Interests

Native Title Holder	Rights
Balanggarra (Combined) (WCD2013/005)	Balanggarra (Combined) concerned recognition of the Balanggarra people's Native Title rights and interest over approximately 26,025 square kilometres of land and sea in the northern Kimberley region of WA. The full description of rights and interests afforded the Balanggarra people through the Balanggarra (combined) Native Title determination is described in Cheinmora v State of Western Australia (No 2) [2013] FCA 768 (7 August 2013). The following is not considered an exhaustive list of the rights and interests of the Balanggarra people. The Balanggarra people have exclusive Native Title rights over some areas within the determination area. Exclusive rights include the right to possession, occupation, use and enjoyment to the exclusion of all others. The Balanggarra people hold non-exclusive rights over sea areas within the Native Title determination area. The nature and extent of the Native Title rights and interests in relation to non-exclusive areas are: (a) the right to enter, travel over and remain on the area; (b) the right to camp on the area including erecting shelters and other structures for that purpose; (c) the right to hunt, fish, gather and use (including by way of sharing or exchange the resources of the area for personal, domestic and communal needs including, but not limited to, cultural or spiritual needs but not for commercial purposes ; (d) the right to light fires for domestic purposes; (e) the right to take and use water from the area; (f) the right to engage in cultural activities on the area including: a. visiting places of cultural or spiritual importance and protecting those places by carrying out lawful activities to preserve their physical or spiritual integrity; b. conducting and participating in ritual; c. holding meetings; and d. passing on knowledge about the physical and spiritual attributes of the determination area and areas of importance on or in the determination area. The are some additional qualifications on Native Title rights and interests within the Balanggarra (combined) determination area. Further information on rights and interests under the Balanggarra (combined) Native Title determination is available at in Cheinmora v State of Western Australia (No 2) [2013] FCA 768 (7 August 2013).
Croker Island (DCD1998/001)	Native Title is held by Aboriginal peoples who are the yuwurrumu members of the Mandilarri-Ildugij, the Mangalara, the Murran, the Gadura-Minaga and the Ngaynjaharr clans (the common law holders). The full description of rights and interests afforded through the Croker Island Native Title determination is described in Yarmirr & Ors v NT of Australia & Ors [1998] FCA 1185 (4 September 1998). Non-exclusive Native Title exists in relation to the sea and sea-bed within the determination area (i.e. the Native Title rights and interests do not confer possession, occupation, use and enjoyment of the sea and sea-bed within the claimed area to the exclusion of all others). Native Title rights and interests held by the common law holders in relation to sea Country are the rights of the common law holders, in accordance with and subject to their traditional laws and customs to have free access to the sea and sea-bed within the claimed area for all or any of the following purposes: (a) to travel through or within the claimed area;

Native Title Holder	Rights
	(b) to fish and hunt for the purpose of satisfying their personal, domestic or non-commercial communal needs including the purpose of observing traditional, cultural, ritual and spiritual laws and customs; (c) to visit and protect places which are of cultural and spiritual importance; (d) to safeguard their cultural and spiritual knowledge (FCA 1185).
Uunguu Part A (WCD2011/001)	Determination: Native title exists in parts of the determination area. It consists of exclusive rights and interests over some portions of the determination area and non-exclusive Native Title rights and interests over others. Native title is held by the Wanjina-Wunggurr community comprising of Wunambal Gaambera, Dambimangari and Willinggin. The Native Title determination recognises that the Wunambal Gaambera (Uunguu) people hold exclusive rights to 90% of their traditional land and islands, and have shared Native Title in the sea. The full description of rights and interests afforded through the Uunguu Part A Native Title determination is described in Goonack v State of Western Australia [2011] FCA 516 (23 May 2011). The Wunambal Gaambera people have a right to possess, use, occupy and enjoy most of the determination area to the exclusion of all others. Those exclusive rights and interests are said to be exercisable for personal, domestic and communal needs but not for commercial purposes. The following section summarises the rights and interests afforded the Wunambal Gaambera people through Native Title determination as described in the extract from the National Native Title Register (determination reference WAD6033/1999). Native Title Holders have the following non-exclusive rights in relation to waters within the Determination Area: (a) the right to enter, travel over and remain on the waters; (b) the right to hunt, fish, gather and use the resources of the waters for personal, domestic and communal needs (including, but not limited to, cultural or spiritual needs) but not for commercial purposes ; and (c) the right to take and use water. Native Title Holders rights in relation to Intertidal Areas within the Determination Area include: (a) the right to enter, travel over and remain on the Intertidal Area; (b) the right to live and camp on the Intertidal Area (including erecting shelters and other structures for those purposes); (c) the right to hunt, fish, gather and use the resources of the Intertidal Area including: (i) sharing and exchanging those resources; and (ii) manufacturing traditional items from those resources, for personal, domestic and communal needs (including, but not limited to cultural or spiritual needs) but not for commercial purposes ; (d) the right to light fires for domestic purposes; (e) the right to take and use water from the Intertidal Area; and (f) the right to engage in cultural activities on the Intertidal Area including: (i) visiting places of cultural or spiritual importance and protecting those places by carrying out lawful activities to preserve their physical or spiritual integrity; (ii) conducting ceremony and ritual; (iii) holding meetings; (iv) participating in cultural practices relating to birth and death, including burial rights; (v) passing on knowledge about the physical and spiritual attributes of the Determination Area and areas of importance on or in the Determination Area; and (vi) maintaining, and protecting from physical harm, places and areas of importance including, for the avoidance of doubt, freshening or repainting images at painting sites.

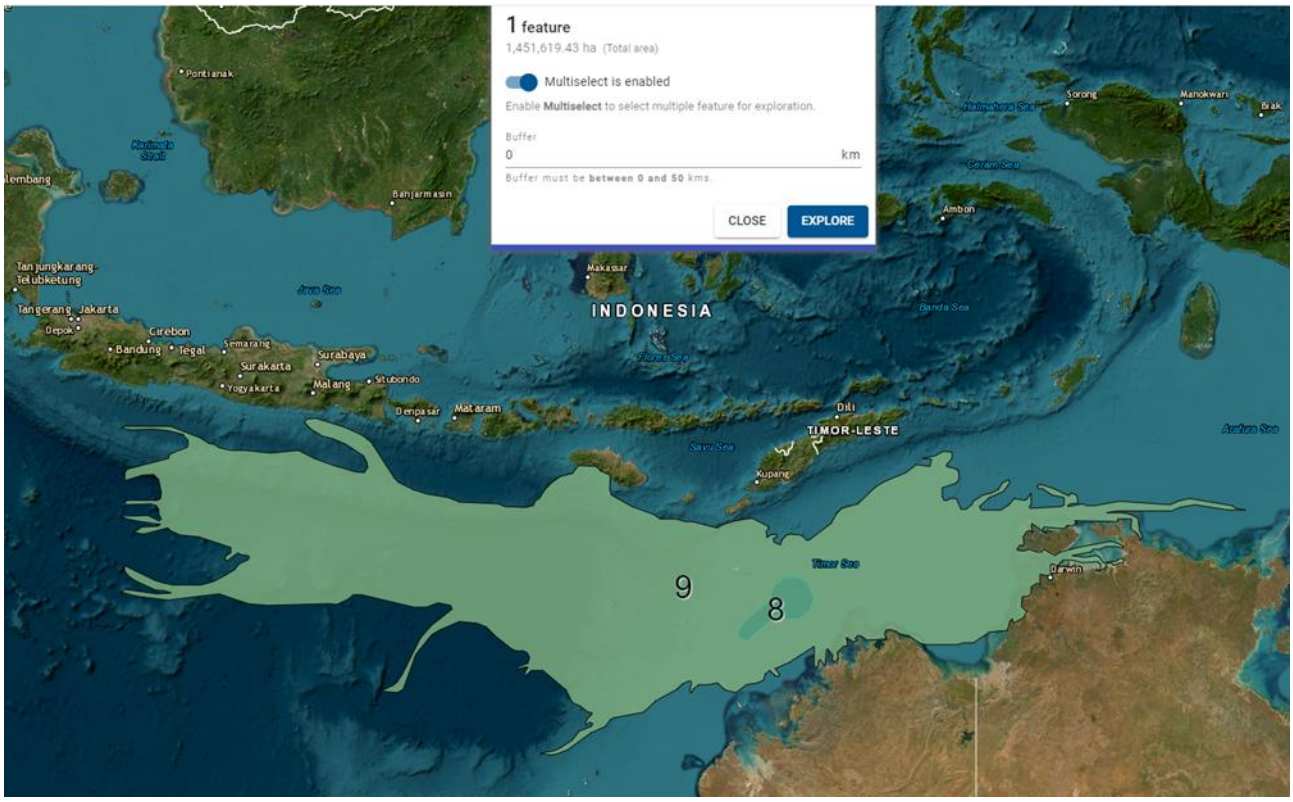
Appendix F EPBC Act Protected Matters Reports

This appendix includes four sperate protected matters reports obtained from the EPBC Protected Matters Search Tool (PMST). The input data for PMST is summarised as follows and an image from the PMST search tool is provided at the start of each report within this Appendix:

- F.1 Protected Matters Report (Planning Area)
- F.2 Protected Matters Report (Activity Area)
- F.3 Protected Matters Report (Light Assessment Area)
- F.4 Protected Matters Report (Noise Assessment Area)

F.1 Protected Matters Report (Planning Area)

Input data:



Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 23-Jan-2024

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	2
Wetlands of International Importance (Ramsar	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	13
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	82
Listed Migratory Species:	86

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	62
Commonwealth Heritage Places:	9
Listed Marine Species:	141
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	18
Habitat Critical to the Survival of Marine Turtles:	5

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	18
Regional Forest Agreements:	None
Nationally Important Wetlands:	8
EPBC Act Referrals:	200
Key Ecological Features (Marine):	10
Biologically Important Areas:	65
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties		[Resource Information]
Name	State	Legal Status
Kakadu National Park	NT	Declared property

National Heritage Places		[Resource Information]
Name	State	Legal Status
Natural		
Kakadu National Park	NT	Listed place
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar Wetlands)	[Resource Information]
Ramsar Site Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Cobourg peninsula	Within Ramsar site
Kakadu national park	Within Ramsar site

Commonwealth Marine Area	[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
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Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Melanodryas cucullata melvillensis		
Tiwi Islands Hooded Robin, Hooded Robin (Tiwi Islands) [67092]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti		
Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus		
Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis		
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Breeding known to occur within area
Pluvialis squatarola		
Grey Plover [865]	Vulnerable	Roosting known to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tyto novaehollandiae kimberli		
Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis		
Tiwi Masked Owl, Tiwi Islands Masked Owl [26049]	Endangered	Species or species habitat known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area
FISH		
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
FROG		
Uperoleia daviesae		
Howard River Toadlet, Davies's Toadlet [85375]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus bellus		
Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Conilurus penicillatus		
Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Isoodon auratus auratus		
Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Mesembriomys gouldii gouldii		
Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Mesembriomys gouldii melvillensis		
Black-footed Tree-rat (Melville Island) [87619]	Vulnerable	Species or species habitat known to occur within area
Petrogale concinna canescens		
Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area
Petrogale concinna monastria		
Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Phascogale pirata		
Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat likely to occur within area
Phascogale tapoatafa kimberleyensis		
Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus		
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Sminthopsis butleri		
Butler's Dunnart [302]	Vulnerable	Species or species habitat known to occur within area
Trichosurus vulpecula arnhemensis		
Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Burmannia championii listed as Burmannia sp. Bathurst Island (R.Fensham 1021)		
[93461]	Endangered (listed as Burmannia sp. Bathurst Island	Species or species habitat likely to occur within area
Elaeocarpus miegei		
[65147]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hoya australis subsp. oramicola a vine [55436]	Vulnerable	Species or species habitat known to occur within area
Mitrella tiwiensis a vine [82029]	Vulnerable	Species or species habitat likely to occur within area
Stylidium ensatum a triggerplant [86366]	Endangered	Species or species habitat known to occur within area
Tarennoidea wallichii [65173]	Endangered	Species or species habitat known to occur within area
Typhonium jonesii a herb [62412]	Endangered	Species or species habitat likely to occur within area
Typhonium mirabile a herb [79227]	Endangered	Species or species habitat likely to occur within area
Xylopia monosperma a shrub [82030]	Endangered	Species or species habitat known to occur within area
REPTILE		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus gurrmul		
Arafura Snake-eyed Skink [83106]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Lucasium occultum		
Yellow-snouted Gecko, Yellow-snouted Ground Gecko [82993]	Endangered	Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Tiliqua scincoides intermedia		
Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area
Varanus mertensi		
Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area
Varanus mitchelli		
Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis		
Australian Humpback Dolphin [87942]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica		
Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa incana Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Attorney-General - Australian Customs Service	
Commonwealth Land - Australian Customs Service [70998]	NT
Attorney-General - Australian Government Solicitor	
Commonwealth Land - Australian Government Solicitor [70450]	NT
Commonwealth Land - Australian Government Solicitor [70332]	NT

Commonwealth Land Name	State
Commonwealth Land - Australian Government Solicitor [70996]	NT
Commonwealth Land - Australian Government Solicitor [70089]	NT
Commonwealth Land - Australian Government Solicitor [70208]	NT
Commonwealth Land - Australian Government Solicitor [70092]	NT
Commonwealth Land - Australian Government Solicitor [71135]	NT
Commonwealth Land - Deputy Crown Solicitor [70333]	NT
Commonwealth Land - Deputy Crown Solicitor [70334]	NT
Commonwealth Land - Deputy Crown Solicitor [70994]	NT
Defence	
Defence - AUSTRALIAN ARMY BAND - DARWIN [70042]	NT
Defence - DARWIN - AP10 RADAR SITE - LEE POINT [70021]	NT
Defence - DARWIN - AP3 RECEIVING STATION - LEE POINT [70044]	NT
Defence - DARWIN RELOCATIONS CENTRE [70045]	NT
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE [70046]	NT
Defence - Esanda Builidng [70048]	NT
Defence - LARRAKEYAH BARRACKS [70061]	NT
Defence - LEANYER BOMBING RANGE [70024]	NT
Defence - LEANYER BOMBING RANGE [70023]	NT
Defence - LEANYER BOMBING RANGE [70022]	NT
Defence - MT GOODWIN RADAR SITE [70063]	NT
Defence - Patrol Boat Base (DARWIN NAVAL BASE) [70041]	NT
Defence - QUAIL ISLAND BOMBING RANGE [70003]	NT
Defence - RAAF BASE DARWIN [70073]	NT
Defence - SHOAL BAY RECEIVING STATION [70037]	NT
Defence - STOKES HILL OIL FUEL INSTALLATION [70035]	NT
Defence - WINNELLIE TWO [70077]	NT
Defence - Defence Housing Authority	
Commonwealth Land - Director of Property Services Defence Estate [70856]	NT

Commonwealth Land Name	State
Commonwealth Land - Director of Property Services Defence Estate [70855]	NT
Environment and Heritage	
Commonwealth Land - Kakadu National Park [70835]	NT
Commonwealth Land - Kakadu National Park [71099]	NT
Commonwealth Land - Kakadu National Park [70850]	NT
Commonwealth Land - Kakadu National Park [71139]	NT
Family and Community Services - Department of Community Services & Health	
Commonwealth Land - Department of Community Services & Health [70720]	NT
Finance and Administration	
Commonwealth Land - Department of Administrative Services [70590]	NT
Commonwealth Land - Department of Administrative Services [70091]	NT
Commonwealth Land - Department of Administrative Services [70210]	NT
Immigration and Multicultural and Indigenous Affairs - Department of Immigration Local Government and Ethnic Affairs	
Commonwealth Land - Department of Immigration Local Government & Ethnic Affairs [70336]	NT
Transport and Regional Services	
Commonwealth Land - Department of Transport & Regional Development [70207]	NT
Unknown	
Commonwealth Land - [52278]	ACI
Commonwealth Land - [71140]	NT
Commonwealth Land - [52277]	ACI
Commonwealth Land - [70205]	NT
Commonwealth Land - [70335]	NT
Commonwealth Land - [70337]	NT
Commonwealth Land - [70338]	NT
Commonwealth Land - [70593]	NT
Commonwealth Land - [70999]	NT
Commonwealth Land - [70591]	NT

Commonwealth Land Name	State
Commonwealth Land - [70203]	NT
Commonwealth Land - [70204]	NT
Commonwealth Land - [70206]	NT
Commonwealth Land - [70993]	NT
Commonwealth Land - [70995]	NT
Commonwealth Land - [70090]	NT
Commonwealth Land - [70447]	NT
Commonwealth Land - [70327]	NT
Commonwealth Land - [70595]	NT
Commonwealth Land - [70594]	NT
Commonwealth Land - [52276]	ACI
Commonwealth Land - [70580]	NT

Commonwealth Heritage Places

[Resource Information]

Name	State	Status
Historic		
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place
Larrakeyah Barracks Sergeants Mess	NT	Listed place
RAAF Base Commanding Officers Residence	NT	Listed place
RAAF Base Precinct	NT	Listed place
RAAF Base Tropical Housing Type 2	NT	Listed place
RAAF Base Tropical Housing Type 3	NT	Listed place
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		

Scientific Name	Threatened Category	Presence Text
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area overfly marine area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Cecropis daurica as Hirundo daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons		
Little Tern [82849]		Breeding known to occur within area
Stiltia isabella		
Australian Pratincole [818]		Roosting known to occur within area overfly marine area
Sula dactylatra		
Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster		
Brown Booby [1022]		Breeding known to occur within area
Sula sula		
Red-footed Booby [1023]		Breeding known to occur within area
Thalasseus bengalensis as Sterna bengalensis		
Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa incana as Heteroscelus incanus		
Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area overfly marine area
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammal		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptile		
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus Dusky Sea Snake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus tenuis Brown-lined Sea Snake, Mjoberg's Sea Snake [1121]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyi Mangrove Sea Snake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Sea Snake [1101]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis coggeri Cogger's Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Sea Snake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis inornatus Plain Sea Snake [1107]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis pacificus Pacific Sea Snake, Large-headed Sea Snake [1112]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis platurus as Pelamis platurus		
Yellow-bellied Sea Snake [93517]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii		
Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweiffei as Enhydrina schistosa		
Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni		
Arafura Smooth Sea Snake, Northern Mangrove Sea Snake [1090]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Breeding known to occur within area

Current Scientific Name	Status	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa sahulensis Australian Humpback Dolphin [87942]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Commonwealth Reserves Terrestrial

[Resource Information]

Name	State	Type
Kakadu	NT	National Park (Commonwealth)

Australian Marine Parks

[Resource Information]

Park Name	Zone & IUCN Categories
Kimberley	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Habitat Protection Zone (IUCN IV)
Arafura	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Christmas Island	National Park Zone (IUCN II)
Kimberley	National Park Zone (IUCN II)
Oceanic Shoals	National Park Zone (IUCN II)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Cartier Island	Sanctuary Zone (IUCN Ia)
Arafura	Special Purpose Zone (IUCN VI)

Park Name	Zone & IUCN Categories
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles

Scientific Name	Behaviour	Presence
Aug - Sep		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Dermochelys coriacea Leatherback Turtle [1768]	Nesting	Known to occur
May - Jul		
Lepidochelys olivacea Olive Ridley Turtle [1767]	Nesting	Known to occur
Nov - May		
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Balanggarra	Indigenous Protected Area	WA
Browse Island	Nature Reserve	WA
Casuarina	Coastal Reserve	NT
Charles Darwin	National Park	NT
Djukbinj	National Park	NT
Garig Gunak Barlu	National Park	NT
Garig Gunak Barlu	Marine Park	NT
Holmes Jungle	Nature Park	NT

Protected Area Name	Reserve Type	State
Lesueur Island	Nature Reserve	WA
Low Rocks	Nature Reserve	WA
Marri-Jabin (Thamurrurr - Stage 1)	Indigenous Protected Area	NT
Mary River	National Park	NT
Niiwalarra Islands	National Park	WA
North Kimberley	Marine Park	WA
Scott Reef	Nature Reserve	WA
Unnamed WA41775	5(1)(h) Reserve	WA
Unnamed WA44677	5(1)(h) Reserve	WA
Uunguu	Indigenous Protected Area	WA

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Ashmore Reef	EXT
Cobourg Peninsula System	NT
Daly-Reynolds Floodplain-Estuary System	NT
Finniss Floodplain and Fog Bay Systems	NT
Kakadu National Park	NT
Murgenella-Cooper Floodplain System	NT
Port Darwin	NT
Shoal Bay - Micket Creek	NT

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Bayview, The Boulevarde, Darwin, NT	2015/7466		Assessment
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Clarence Strait Offshore Tidal Energy Project	2008/4660		Assessment

Title of referral	Reference	Referral Outcome	Assessment Status
Darwin Pipeline Duplication (DPD) Project	2022/09372		Assessment
Darwin Pipeline Duplication DPD Project	2022/9166		Completed
East Arm Marine Industry Park, Darwin, NT	2014/7318		Completed
Northern Endeavour Phase 1 Decommissioning	2022/09327		Post-Approval
Project Crux Cable Lay and Operation	2022/09441		Completed
Project Fitzroy Expansion Offshore Cable Lay	2023/09674		Referral Decision
Tiwi H2 Project	2022/09347		Assessment
Controlled action			
2-D seismic survey Scott Reef	2000/125	Controlled Action	Post-Approval
Andranangoo Creek & Lethbridge Bay mineral sand mining	2005/2155	Controlled Action	Completed
Audacious Oil Field Standalone Development	2001/407	Controlled Action	Completed
Augmentation of the East Point Effluent Rising Main and Extension of East Point Outfall	2009/5113	Controlled Action	Post-Approval
Barramundi Nursery Farm	2005/2378	Controlled Action	Completed
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Browse FLNG Development, Commonwealth Waters	2013/7079	Controlled Action	Post-Approval
Conduct an exploration drilling campaign	2010/5718	Controlled Action	Completed
Darwin to Moomba Gas Pipeline	2001/213	Controlled Action	Completed
Decommissioning of Buffalo Oil Field	2003/984	Controlled Action	Post-Approval
Decommissioning of Challis Oilfield	2003/942	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Blacktip Gas Field	2003/1180	Controlled Action	Post-Approval
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Floating Liquefied Natural Gas facility	2001/533	Controlled Action	Completed
Glyde Point and Middle Arm Peninsula Infrastructure Support	2001/334	Controlled Action	Completed
Glyde Point Industrial Estate	2001/336	Controlled Action	Completed
Glyde Point Industrial Estate and Associated Infrastructure	2004/1506	Controlled Action	Completed
Hardwood Plantation	2001/229	Controlled Action	Post-Approval
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Kilimiraka Mineral Sands and Associated Infrastructure (Bathurst Island), NT	2012/6587	Controlled Action	Assessment Approach
Lee Point Master-planned urban development, Darwin, NT	2015/7591	Controlled Action	Post-Approval
Methanol Plant	2001/195	Controlled Action	Completed
Middle Arm Peninsula Industrial Area Development	2001/339	Controlled Action	Completed
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval
Muirhead Subdivision	2010/5525	Controlled Action	Post-Approval
Operation of 17 Tiger Helicopters at Robertson Barracks	2004/1459	Controlled Action	Post-Approval
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Replacement of the East Point Outfall	2011/6099	Controlled Action	Assessment Approach
Residential subdivision of Lot 9793 (formerly Lots 9774 and 9779) Lee Point Road	2005/2108	Controlled Action	Post-Approval
Shipping Channel Enhancement	2010/5431	Controlled Action	Completed
Snake Bay Barramundi Sea Cage Farm	2005/2150	Controlled Action	Completed
Talisman Saber 2005 Military Exercise	2004/1819	Controlled Action	Post-Approval
Tassie Shoal LNG Project	2003/1067	Controlled Action	Post-Approval
Torosa South Initial Appraisal Drilling	2007/3500	Controlled Action	Completed
Tropical Tidal Testing Centre, Clarence Strait, 50km NE Darwin	2014/7299	Controlled Action	Guidelines Issued
Not controlled action			
2D seismic survey, exploration permit NT/P67	2004/1587	Not Controlled Action	Completed
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
3D marine seismic survey in WA 314P and WA 315P	2004/1927	Not Controlled Action	Completed
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
AEC International Hydrocarbon Well Puffin 6	2000/36	Not Controlled Action	Completed
Andranangoo Mine Site Aircraft Landing Area	2007/3743	Not Controlled Action	Completed
Audacious-3 oil drilling well	2003/1042	Not Controlled Action	Completed
Backpacker-1 Offshore Hydrocarbon Exploration Well	2001/300	Not Controlled Action	Completed
Buffalo In-Fill Production Wells	2001/475	Not Controlled Action	Completed
Channel Island Bridge Pipeline Replacement Project	2020/8672	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Construction and operation of Radar Infrastructure	2004/1406	Not Controlled Action	Completed
Controlled Source Electromagnetic 2D Survey	2009/4980	Not Controlled Action	Completed
Controlled Source Electromagnetic Survey	2010/5434	Not Controlled Action	Completed
Coot-1 hydrocarbon exploration well, Permit Area AC/L2 or AC/L3	2001/296	Not Controlled Action	Completed
Cox Peninsular Remediation Project, NT	2015/7587	Not Controlled Action	Completed
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Darwin Port Maintenance Dredging, Darwin Harbour, NT	2017/8122	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed
Drilling of exploration well Audacious-1 in AC/P17	2000/5	Not Controlled Action	Completed
Drilling of exploration wells, Permit areas WA-301-P to WA-305-P	2002/769	Not Controlled Action	Completed
Drilling of Marina-1 Exploration Well	2007/3586	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Exploration Drilling in AC/P17, AC/P18 and AC/P24	2001/359	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Marine Seismic Survey in WA-239-P	2000/24	Not Controlled Action	Completed
Marine Survey for the Australia-ASEAN Power Link AAPL	2020/8714	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed
Nexus Drilling Program NT-P66	2007/3745	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Project Sea Dragon Stage 1 Hatchery - Gunn Point, NT	2017/8092	Not Controlled Action	Completed
Puffin Oil wells 7, 8 & 9 development	2005/2336	Not Controlled Action	Completed
Residential Complex - Lots 6575 and 6576	2001/163	Not Controlled Action	Completed
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Skua and Swift Oilfields	2006/3195	Not Controlled Action	Completed
Strumbo-1 Gas Exploration Well Permit Area WA-288-P	2002/884	Not Controlled Action	Completed
Waterfront Redevelopment	2003/1256	Not Controlled Action	Completed
Wickham Point Interconnect Gas Pipeline	2008/4309	Not Controlled Action	Completed
Woodside Geotechnical Investigation Sunrise Bank	2000/13	Not Controlled Action	Completed
Not controlled action (particular manner)			
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D or 3D Marine Seismic Survey in Petroleum Permit Area AC/P35	2009/4864	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey - Petroleum Exploration Area NT/P68, Eastern Bonaparte Basin	2006/2922	Not Controlled Action (Particular Manner)	Post-Approval
2 geotechnical surveys - preliminary and final	2006/2886	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2009/4681	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic Survey - Maxima 3D MSS	2006/2945	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey	2006/2729	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, Browse Basin, WA	2009/5048	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, near Scott Reef, Browse Basin	2005/2126	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, petroleum exploration permit AC/P33	2006/2918	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey (NT/P68)	2008/4121	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey (NT/P68)	2006/2980	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic survey of AC/P4, AC/P17 and AC/P24	2006/2857	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey WA-406-P Bonaparte Basin	2007/3904	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Auralandia 3D marine seismic survey	2011/5961	Not Controlled Action (Particular Manner)	Post-Approval
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 3D & 2D Seismic Survey, in NT/P82, Timor Sea	2012/6398	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Basin Seabed Mapping Survey	2009/4951	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval
Caldita 3D Marine Seismic Survey - NT/P61, NT/P69, and acreage release area NT06-5	2006/3142	Not Controlled Action (Particular Manner)	Post-Approval
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Conduct an exploration drilling campaign	2011/5964	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Dillon South-1 Exploration Well Drilling - AC/P4, Territory of Ashmore/Cartier	2013/6849	Not Controlled Action (Particular Manner)	Post-Approval
Dredging the outer shipping channels of Darwin Harbour	2013/6988	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Audacious-5 appraisal well	2008/4327	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Exploration & Appraisal Wells Braveheart-1 & Cornea-3	2009/5160	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of two appraisal wells	2011/5840	Not Controlled Action (Particular Manner)	Post-Approval
Endurance 3D Marine Seismic Data Acquisition Survey	2007/3667	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling in Permit Areas WA-402-P & WA-403-P	2010/5297	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Program - Permit areas - WA-314-P, WA-315-P, WA-398-P.	2008/4064	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Geoscience Australia - Marine survey in Browse Basin to acquire data to assist assessment of CO2 sto	2013/6747	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Gigas 2D Pilot Ocean Bottom Cable Marine Seismic Survey	2007/3839	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Joseph Bonaparte Gulf Seabed mapping survey	2010/5517	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Kraken, Lusca & Asperus 3D Marine Seismic Survey	2013/6730	Not Controlled Action (Particular Manner)	Post-Approval
Malita West 3D Seismic Survey WA-402-P and WA-403-P	2007/3936	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey 2012	2012/6310	Not Controlled Action (Particular Manner)	Post-Approval
Mariner Non-Exclusive 2D Seismic Survey	2011/6172	Not Controlled Action (Particular Manner)	Post-Approval
NT/P77 3D Marine Seismic Survey	2009/4683	Not Controlled Action (Particular Manner)	Post-Approval
NT/P80 2010 2D Marine Seismic Survey	2010/5487	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Canning Multi Client 2D Marine Seismic Survey	2010/5393	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Exploration Drilling Campaign	2011/6222	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Offshore Gas Exploration Drilling Campaign	2012/6384	Not Controlled Action (Particular Manner)	Post-Approval
Outer Canning exploration drilling program off NW coast of WA	2012/6618	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Pilot Appraisal Well - Torosa South 1	2008/3991	Not Controlled Action (Particular Manner)	Post-Approval
Port Melville marine supply base, Melville Island	2015/7510	Not Controlled Action (Particular Manner)	Post-Approval
Removal of Potential Unexploded Ordnance within NAXA	2012/6503	Not Controlled Action (Particular Manner)	Post-Approval
Repsol 3d & 2D Marine Seismic Survey	2012/6658	Not Controlled Action (Particular Manner)	Post-Approval
Rosebud 3D Marine Seismic Survey in WA-30-R and TR/5	2012/6493	Not Controlled Action (Particular Manner)	Post-Approval
Sandalford 3D Seismic Survey	2012/6261	Not Controlled Action (Particular Manner)	Post-Approval
Santos Petrel-7 Offshore Appraisal Drilling Programme (Bonaparte Basin)	2011/5934	Not Controlled Action (Particular Manner)	Post-Approval
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Scott Reef Seismic Research	2006/2647	Not Controlled Action (Particular Manner)	Post-Approval
Searcher bathymetry & geochemical seismic survey, Brawse Basin,Timor Sea,WA	2013/6980	Not Controlled Action (Particular Manner)	Post-Approval
Sonar and Acoustic Trials	2001/345	Not Controlled Action (Particular Manner)	Post-Approval
Songa Venus Drilling and Testing Operations	2009/5122	Not Controlled Action (Particular Manner)	Post-Approval
Songa Venus Drilling Programme, Bonaparte Basin	2009/4990	Not Controlled Action (Particular Manner)	Post-Approval
Sunshine Infill 2D and Mimosa 2D Marine Seismic Surveys	2009/4699	Not Controlled Action (Particular Manner)	Post-Approval
Thoar 3D Marine Seismic Survey	2010/5668	Not Controlled Action (Particular Manner)	Post-Approval
Tiffany 3D Seismic Survey	2010/5339	Not Controlled Action (Particular Manner)	Post-Approval
Torosa-5 Apraisal Well, WA-30-R	2008/4430	Not Controlled Action (Particular Manner)	Post-Approval
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval
Tridacna 3D Ocean Bottom Cable Marine Seismic Survey	2011/5959	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Ursa 3D Marine Seismic Survey	2008/4634	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval
Veritas Voyager 2D Marine Seismic Survey	2009/5151	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Woodside Southern Browse 3D Seismic Survey, WA	2007/3534	Not Controlled Action (Particular Manner)	Post-Approval
Zeemeermin MC3D seismic survey, Browse Basin, Offshore WA	2009/5023	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
3D Seismic Survey (NT/P68)	2006/2949	Referral Decision	Completed
Aurora extension MC3D Marine Seismic Survey	2011/5887	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Experimental Study of Behavioural and Physiological Impact on Fish of Seismic Ex	2006/2625	Referral Decision	Completed
Installation of Telecommunication Facilities	2001/254	Referral Decision	Completed
Phillips Petroleum Wickham Point LNG facility	2001/391	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Pilot Appraisal Well - Torosa South-1	2008/3985	Referral Decision	Completed
Puffin South-West Development of Oil Reserves	2007/3834	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	North-west
Canyons linking the Argo Abyssal Plain with the Scott Plateau	North-west
Carbonate bank and terrace system of the Sahul Shelf	North-west
Carbonate bank and terrace system of the Van Diemen Rise	North
Continental Slope Demersal Fish Communities	North-west
Pinnacles of the Bonaparte Basin	North
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	North-west
Shelf break and slope of the Arafura Shelf	North

Biologically Important Areas

Scientific Name	Behaviour	Presence
Dolphins		
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Breeding	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Breeding likely	Known to occur

Scientific Name	Behaviour	Presence
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Calving	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging (high density prey)	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Resting	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding likely	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Significant habitat	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Significant habitat - unknown behaviour	Likely to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Known to occur
Dugong		

Scientific Name	Behaviour	Presence
Dugong dugon Dugong [28]	Breeding	Known to occur
Dugong dugon Dugong [28]	Calving	Known to occur
Dugong dugon Dugong [28]	Foraging	Known to occur
Dugong dugon Dugong [28]	Foraging (high density seagrass beds)	Known to occur
Dugong dugon Dugong [28]	Nursing	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Likely to occur
Chelonia mydas Green Turtle [1765]	Mating	Likely to occur
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur

Scientific Name	Behaviour	Presence
Chelonia mydas Green Turtle [1765]	Nesting	Likely to occur
Dermochelys coriacea Leatherback Turtle [1768]	Internesting	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Onychoprion anaethetus Bridled Tern [82845]	Breeding	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding (high numbers)	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Thalasseus bergii Crested Tern [83000]	Breeding	Known to occur
Thalasseus bergii Crested Tern [83000]	Breeding (high numbers)	Known to occur
Sharks		

Scientific Name	Behaviour	Presence
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Calving	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Nursing	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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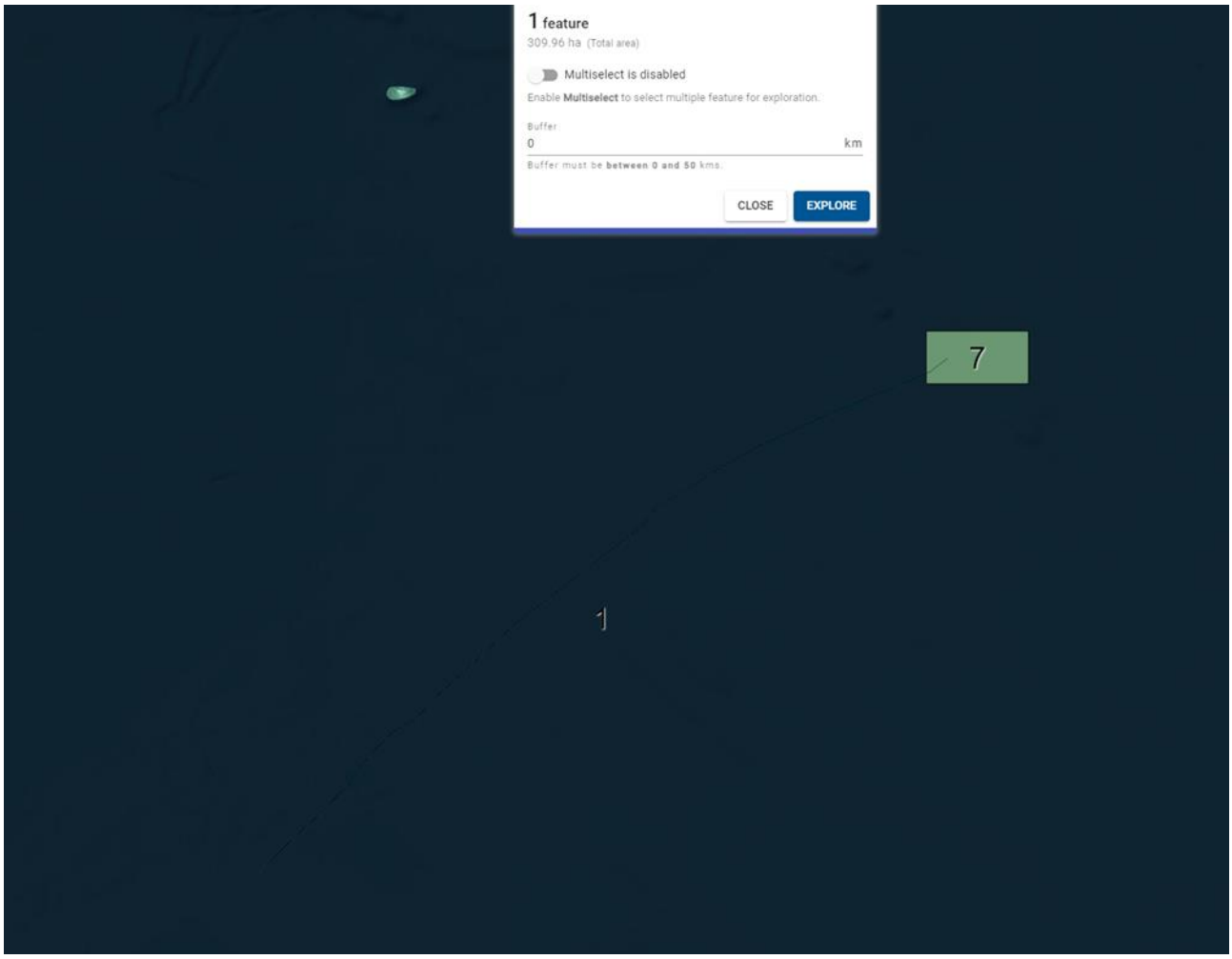
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

F.2 Protected Matters Report (Activity Area)

Input Data:



Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 18-Nov-2024

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	26
Listed Migratory Species:	37

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	70
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	1

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	43
Key Ecological Features (Marine):	2
Biologically Important Areas:	5
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)

Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon lepturus fulvus		
Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis		
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat likely to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Aipysurus apraefrontalis		
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama		
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus		
Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		

Scientific Name	Threatened Category	Presence Text
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Reptile		
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis coggeri Cogger's Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis hardwickii as Lapemis hardwickii		
Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii		
Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli		
MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major		
Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus		
Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii		
Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus		
Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii		
Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweiffei as Enhydrina schistosa		
Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris		
Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Habitat Critical to the Survival of Marine Turtles		[Resource Information]
Scientific Name	Behaviour	Presence
Dec - Jan		
Chelonia mydas		
Green Turtle [1765]	Nesting	Known to occur

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Project Crux Cable Lay and Operation	2022/09441		Completed
Controlled action			
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval
Not controlled action			

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular Manner)	Post-Approval
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region

Name	Region
Ancient coastline at 125 m depth contour	North-west
Continental Slope Demersal Fish Communities	North-west

Biologically Important Areas		[Resource Information]
Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Sharks		
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

F.3 Protected Matters Report (Light Assessment Area)

Input Data:

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 23-Jan-2024

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	25
Listed Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	69
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	1

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	50
Key Ecological Features (Marine):	2
Biologically Important Areas:	6
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name	Buffer Status
Commonwealth Marine Areas (EPBC Act)	In feature area
Commonwealth Marine Areas (EPBC Act)	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Phaethon rubricauda westralis			
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			
Thunnus maccoyii			
Southern Bluefin Tuna [69402]	Conservation Dependent	Breeding known to occur within area	In feature area
MAMMAL			
Balaenoptera borealis			
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Balaenoptera musculus			
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Balaenoptera physalus			
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Aipysurus apraefrontalis			
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Aipysurus foliosquama			
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area	In feature area
Caretta caretta			
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In feature area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In feature area
SHARK			
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area	In feature area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area	In feature area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area	In feature area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area	In feature area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In feature area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area	In feature area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area	In feature area
Migratory Marine Species			
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat may occur within area	In feature area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area	In feature area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area	In feature area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In feature area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area	In feature area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area	In feature area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In feature area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Mobula birostris as Manta birostris			
Giant Manta Ray [90034]		Species or species habitat likely to occur within area	In feature area
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In feature area
Orcinus orca			
Killer Whale, Orca [46]		Species or species habitat may occur within area	In feature area
Physeter macrocephalus			
Sperm Whale [59]		Species or species habitat may occur within area	In feature area
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Pristis zijsron			
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area	In feature area
Rhincodon typus			
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Tursiops aduncus (Arafura/Timor Sea populations)			
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus			
Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anous stolidus			
Common Noddy [825]		Species or species habitat likely to occur within area	In feature area
Anous tenuirostris melanops			
Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris canutus			
Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Calonectris leucomelas			
Streaked Shearwater [1077]		Species or species habitat known to occur within area	In feature area
Fregata ariel			
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In feature area
Fregata minor			
Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area	In feature area
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Papasula abbotti			
Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area	In feature area
Phaethon lepturus			
White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area	In feature area
Sula sula			
Red-footed Booby [1023]		Breeding known to occur within area	In feature area
Fish			
Bhanotia fasciolata			
Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area	In feature area
Campichthys tricarinatus			
Three-keel Pipefish [66192]		Species or species habitat may occur within area	In feature area
Choeroichthys brachysoma			
Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area	In feature area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area	In feature area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area	In feature area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area	In feature area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area	In feature area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area	In feature area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area	In feature area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area	In feature area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area	In feature area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area	In feature area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area	In feature area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area	In feature area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area	In feature area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area	In feature area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area	In feature area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area	In feature area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area	In feature area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area	In feature area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area	In feature area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area	In feature area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area	In feature area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area	In feature area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area	In feature area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area	In feature area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area	In feature area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area	In feature area
Reptile			
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area	In feature area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area	In feature area
Aipysurus fuscus Dusky Sea Snake [1119]		Species or species habitat known to occur within area	In feature area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Aipysurus mosaicus as Aipysurus eydouxii			
Mosaic Sea Snake [87261]		Species or species habitat may occur within area	In feature area
Caretta caretta			
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Emydocephalus annulatus			
Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area	In feature area
Eretmochelys imbricata			
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area	In feature area
Hydrophis coggeri			
Cogger's Sea Snake [25925]		Species or species habitat may occur within area	In feature area
Hydrophis elegans			
Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area	In feature area
Hydrophis hardwickii as Lapemis hardwickii			
Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area	In feature area
Hydrophis kingii as Disteira kingii			
Spectacled Sea Snake [93511]		Species or species habitat may occur within area	In feature area
Hydrophis macdowelli as Hydrophis mcdowelli			
MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area	In feature area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area	In feature area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area	In feature area
Hydrophis platurus as Pelamis platurus Yellow-bellied Sea Snake [93517]		Species or species habitat may occur within area	In feature area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area	In feature area
Hydrophis zweiffei as Enhydrina schistosa Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area	In feature area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In feature area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area	In feature area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area	In feature area

Current Scientific Name	Status	Type of Presence	Buffer Status
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In feature area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area	In feature area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area	In feature area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area	In feature area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area	In feature area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area	In feature area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area	In feature area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area	In feature area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In feature area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area	In feature area

Current Scientific Name	Status	Type of Presence	Buffer Status
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In feature area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area	In feature area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area	In feature area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area	In feature area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area	In feature area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area	In feature area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area	In feature area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area	In feature area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area	In feature area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area	In feature area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area	In feature area

Current Scientific Name	Status	Type of Presence	Buffer Status
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area	In feature area

Habitat Critical to the Survival of Marine Turtles			
Scientific Name	Behaviour	Presence	Buffer Status
Dec - Jan			
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Project Crux Cable Lay and Operation	2022/09441		Completed	In feature area
Controlled action				
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed	In feature area
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed	In feature area
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval	In feature area
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval	In buffer area only
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval	In feature area
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed	In buffer area only
Not controlled action				
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed	In feature area
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed	In feature area
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed	In feature area
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed	In feature area
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed	In feature area
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed	In feature area
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed	In buffer area only
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed	In buffer area only
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed	In feature area
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed	In buffer area only
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action (particular manner)				
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular	Post-Approval	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action (particular manner)				
		Manner)		
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Referral decision				

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Referral decision				
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed	In feature area
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed	In feature area
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed	In feature area

Key Ecological Features

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region	Buffer Status
Ancient coastline at 125 m depth contour	North-west	In feature area
Continental Slope Demersal Fish Communities	North-west	In feature area

Biologically Important Areas

Scientific Name	Behaviour	Presence	Buffer Status
Seabirds			
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur	In feature area
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur	In feature area
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur	In feature area
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur	In buffer area only
Sula sula Red-footed Booby [1023]	Breeding	Known to occur	In feature area
Sharks			
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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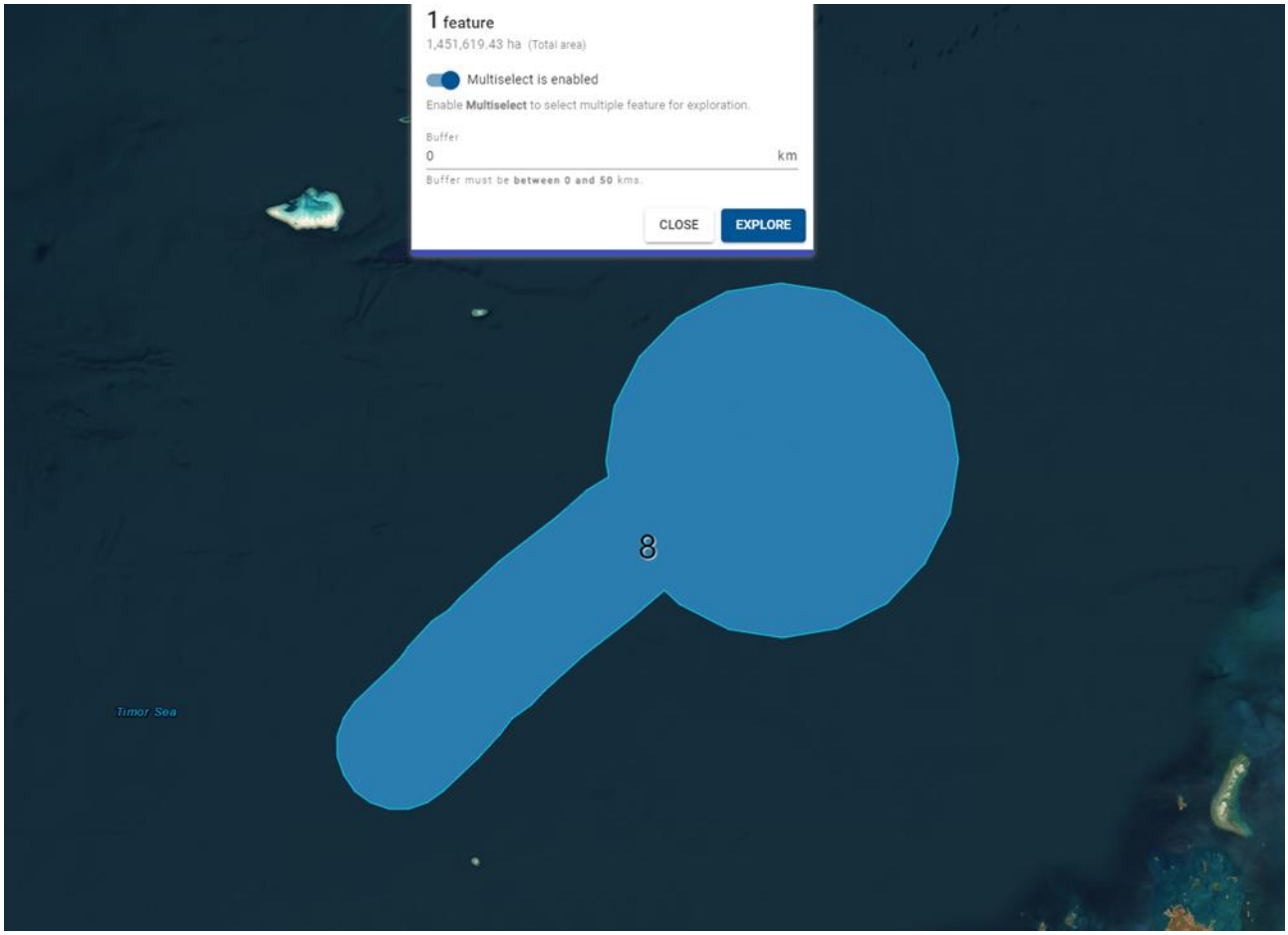
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

F.4 Protected Matters Report (Noise Assessment Area)

Input Data:



Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 23-Jan-2024

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	25
Listed Migratory Species:	37

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	71
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	59
Key Ecological Features (Marine):	3
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)

Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon rubricauda westralis		
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat likely to occur within area
FISH		
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Breeding known to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Aipysurus apraefrontalis		
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama		
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Mobula alfredi as Manta alfredi		
Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris		
Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus		
Sperm Whale [59]		Species or species habitat may occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Papasula abbotti		
Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Species or species habitat likely to occur within area
Sula sula		
Red-footed Booby [1023]		Breeding known to occur within area
Fish		
Bhanotia fasciolata		
Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus		
Three-keel Pipefish [66192]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Reptile		
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus Dusky Sea Snake [1119]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis coggeri Cogger's Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweiffei as Enhydrina schistosa Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris		
Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Project Crux Cable Lay and Operation	2022/09441		Completed
Controlled action			
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed
Not controlled action			
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
AEC International Hydrocarbon Well Puffin 6	2000/36	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Puffin Oil wells 7, 8 & 9 development	2005/2336	Not Controlled Action	Completed
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Skua and Swift Oilfields	2006/3195	Not Controlled Action	Completed
Not controlled action (particular manner)			
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular Manner)	Post-Approval
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Exploration & Appraisal Wells Braveheart-1 & Cornea-3	2009/5160	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to	2014/7223	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Darwin NT		Manner)	
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Searcher bathymetry & geochemical seismic survey, Brawse Basin,Timor Sea,WA	2013/6980	Not Controlled Action (Particular Manner)	Post-Approval
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Puffin South-West Development of Oil Reserves	2007/3834	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region

Name	Region
Ancient coastline at 125 m depth contour	North-west
Carbonate bank and terrace system of the Sahul Shelf	North-west
Continental Slope Demersal Fish Communities	North-west

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix G Acoustic and Animat Modelling

Shell Crux Development

Acoustic and Animat Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

24 May 2023

Submitted to:

Andrew Gowing
Shell Australia Pty Ltd
Contract 4514012227

Authors:

Steven C. Connell
Alina M. Muellenmeister
Emma Ozanich
Matthew W. Koessler
Craig R. McPherson

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The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

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Executive Summary

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Shell Crux development in the northern Browse Basin. The modelling study considers installation of one subsea jacket foundation pile using two possible subsea hammers, vessel operations, and down-the-hole (DTH) drilling operations.

The study predicted ranges to acoustic thresholds that may result in injury to or behavioural disturbance of marine fauna. The corresponding thresholds used in this study represented the best available science for behavioural response or disturbance, temporary threshold shift (TTS), and permanent threshold shift (PTS) or injury depending upon the fauna group. The fauna considered included marine mammals, sea turtles, and fish including fish larvae and eggs.

The modelling methodology applied was to characterise the sound sources and then determine how the sounds propagated at specific locations, considering the environmental properties that influence the propagation of underwater sound. The models considered dynamics of impact pile driving, source levels of vessels, and range-dependent environmental properties. It was assumed that any of the activities could be performed at any time during the year, therefore the most conservative season for the sound speed profile was considered.

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p); zero-to-peak pressure levels (PK, L_{pk}); peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$); and either single-strike (i.e., per-strike) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria and noise sources. In this report, the duration period for SEL accumulation is defined as a 24-hour period over which sound energy is integrated; the level is specified with the abbreviation SEL_{24h}.

SEL_{24h} is a cumulative metric that reflects the dosimetric effect of noise levels within 24 hours, based on the assumption that a receiver (e.g., an animal) is consistently exposed to such noise levels at a fixed position. More realistically, marine animals would not stay in the same location for 24 hours (especially in the absence of location-specific habitat) but rather a shorter period, depending on the animal's behaviour and the source's proximity and movements. Therefore, a reported radius for the SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained at that location for 24 hours.

A more realistic representation of the potential exposures for migrating pygmy blue whales (*Balaenoptera musculus brevicauda*) in the migratory Biologically Important Area (BIA) was undertaken using animal movement modelling ('animat modelling'). Simulations with animats (i.e., simulated animals) restricted to the BIA provide an understanding of how animats will be exposed given the location and environment-specific context in which they are most likely to occur. Scenarios in which the pygmy blue whales are seeded in an unrestricted manner allow for the calculation of exposure range across the entire project area. These ranges may then be interpreted to determine buffer zones around the BIA for different project options and scenarios. The unrestricted seeding approach is informative in cases where there is very little or no overlap between the BIA and the planned operational area, as is the case for this project. The closest distance between the BIA and the operational area is approximately 120 km, however there have been pygmy blue whale detections outside the BIA in this region (C McPherson per comms).

While acoustic modelling inherently assumes static animals, the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) combines modelled sound fields with realistic animal movements to predict how animals might be impacted through sound exposure. JASMINE provides a framework for understanding and predicting sound exposure for species of interest and for calculating ranges to relevant regulatory thresholds. The distribution of distances to the source of simulated animals ('animats') predicted to be exposed to sound levels above relevant thresholds was used to calculate the horizontal distance that includes 95% of the animat distances that exceeded a given effect threshold ($ER_{95\%}$). Within the $ER_{95\%}$, there is generally some proportion of animats that do not exceed the threshold criteria. This occurs for several reasons, including the spatial and temporal characteristics of the sound field and the way in which the animats are exposed to the sound field over time, both vertically and horizontally. The probability that an animat within the $ER_{95\%}$ was exposed above threshold was also computed (P_{exp}) to provide additional context. Due to insufficient density data availability, the modelling results are not related to real-world density estimates for pygmy blue whales within the BIA.

The animat modelling was included in the scope of work to provide context to possible exposures to migrating pygmy blue whales over an entire day. The distances to isopleths associated with the effect thresholds for PTS and TTS, are more realistic than those from the static sound fields as they consider potential animal movements during migration, passing through the operational area. Despite consideration of animats, the ranges to effect thresholds are still greater than visually observable ranges from a static monitoring location.

A summary of the acoustic modelling results for piling operations (Table 1) and vessel and drilling operations (Table 2) are included below. A summary of the animal movement modelling results for the piling operations are provided in Table 3, and Table 4 summarises results for the considered vessel scenario.

Acoustic Modelling - Piling Operations:

One subsea pile with a diameter of 3.5 m was modelled for two subsea hammers (MHU 500T and IHC 800S) at a single location.

Table 1. *Piling Operations:* Maximum (R_{max}) horizontal distances (in km) to relevant thresholds for marine fauna.

Hearing group	Threshold Type	Metric	Threshold	MHU 500T hammer	IHC 800S hammer
				R_{max} (km)	R_{max} (km)
Low frequency cetaceans	PTS [a]	$L_{E,24h}$	183	35.6	19.1
	TTS [a]	$L_{E,24h}$	168	98.1	61.1
High frequency cetaceans	PTS [a]	$L_{E,24h}$	185	0.12	–
	TTS [a]	$L_{E,24h}$	170	2.30	0.13
Very high-frequency cetaceans	PTS [a]	$L_{E,24h}$	155	6.40	1.20
	TTS [a]	$L_{E,24h}$	140	21.6	6.46
Sirenians	PTS [a]	$L_{E,24h}$	226	0.13	–
	TTS [a]	$L_{E,24h}$	220	2.40	0.15
All Marine Mammal Groups	Behavioural Response [b]	L_p	160	21.6	18.5
Fish without swim bladder	Mortality and Potential mortal injury [c]	$L_{E,24h}$	219	0.70	0.21
	Recoverable injury [c]	$L_{E,24h}$	216	0.78	0.26
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	213	0.23	0.13
Fish with swim bladder not involved in hearing	Mortality and Potential mortal injury [c]	$L_{E,24h}$	210	2.37	1.15
	Recoverable injury [c]	$L_{E,24h}$	203	6.40	2.55
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	207	0.70	0.29
Fish with swim bladder involved in hearing	Mortality and Potential mortal injury [c]	$L_{E,24h}$	207	3.47	1.38
	Recoverable injury [c]	$L_{E,24h}$	203	6.40	2.55
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	207	0.70	0.29
Sea turtles	PTS [d]	$L_{E,24h}$	204	4.92	2.24
	TTS [d]	$L_{E,24h}$	189	26.2	16.6
	Behavioural disturbance [e]	L_p	166	11.7	9.97
	Behavioural response [e]	L_p	175	3.85	3.09

L_{pk}= unweighted peak sound pressure level (dB re 1 µPa)
L_p= unweighted root-mean-square sound pressure level (dB re 1 µPa)
L_E= sound exposure level for single strike (dB re 1 µPa^2 s)
$L_{E,24h}$= sound exposure level over 24 hours (dB re 1 µPa^2 s), unweighted for fish and frequency weighted for all other groups
[a] Southall et al. (2019) criteria for marine fauna
[b] NOAA (2019) recommended unweighted behavioural threshold for marine mammals
[c] Popper et al. (2014)
[d] Finneran et al. (2017)
[e] McCauley et al. (2000)

Acoustic Modelling – Vessel and Drilling Operations:

The vessel scenario considered in the modelling were designed to cover the worst-case operation across the project, focusing on the specific scenario with potentially greater effect ranges, and provide context for other operations which were not specifically modelled but which would involve similarly sized and numbers of vessels. The scenarios include:

- Construction activities:
  - Construction vessel in isolation and,
  - Construction vessel with 4 associated support vessels.
- Drilling operations at the Crux platform location:
  - Down-the-hole (DTH) drilling.

Table 2. *Vessel operations*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) and maximum (R_{max}) horizontal distances (in km) and ensonified area (km^2) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds from the most appropriate location for considered sources per scenario.

Site	Description	SPL		TTS, SEL_{24h}	
		R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	Area (km^2)
1	Construction Vessel in isolation	28.4	25.8	6.94	130.3
2	AHT support vessel with 150 MT BP	19.1	17.2	3.85	40.0
3	AHT support vessel with 75 MT BP	11.4	10.5	2.19	13.0
Combined Scenarios					
Scenario 1	Construction Vessel + 3x 150 MT BP + 1x 75 MT BP support vessels	43.1	38.7	13.0	420.7
Drilling					
Drilling	DTH Drilling at Crux Platform	0.94	0.90	0.06	0.015

AHT: Anchor handling tug
MT BP: Megaton bollard pull

Pygmy blue whales – Animat results

- The exposure ranges predicted using animat modelling are significantly more realistic, due to the incorporation of species-specific realistic movements, rather than conservative approach of calculating ranges using the maximum-over-depth sound fields and receivers which are stationary for 24 hours. This is because the exposure ranges account for animats sampling the sound field vertically and horizontally based on species-specific diving and movement parameters.
- In general, exposure ranges from animal movement modelling for PTS and TTS criteria (Southall et al. 2019) are typically shorter than those predicted using acoustic propagation modelling because of the shorter time ('dwell time') to accumulate sound energy of the moving animats.

Considering the pile driving scenarios, the maximum exposure ranges ($ER_{95\%}$) to PTS and TTS thresholds were 19.8 and 56.4 km, respectively, with probabilities of an animat within the $ER_{95\%}$ being exposed above the PTS and TTS thresholds of 75 and 58%, respectively.
The vessel operation scenario resulted in exposure ranges ($ER_{95\%}$) to PTS and TTS of <0.01 and 0.19 km, respectively, with probabilities of an animat within the $ER_{95\%}$ being exposed above the PTS and TTS thresholds of 30 and 79%, respectively.

- Exposure ranges ($ER_{95\%}$) for single exposure metrics, such as the SPL behavioural response criteria, are typically comparable to the predicted acoustic ranges. In this study, exposure ranges are generally very similar or slightly lower than the R_{max} acoustic ranges.
- Both pile driving scenarios resulted in exposures above the SPL behavioural response threshold. The maximum $ER_{95\%}$ to the threshold was 18.0 km with a corresponding probability of an animat within the $ER_{95\%}$ being exposed above the threshold of 72%.
- The vessel operation scenario resulted in exposures above SPL behavioural response threshold with an $ER_{95\%}$ of 36.8 km and a corresponding probability of an animat within the $ER_{95\%}$ being exposed above the threshold of 93%.

Table 3. *Pile Driving:* Summary of animat simulation results for PTS, TTS and SPL behavioural response criteria for pygmy blue whales with unrestricted seeding. Maximum exposure ranges show $ER_{95\%}$ (km) first and probability of exposure of animats travelling within the $ER_{95\%}$ (P_{exp} (%)) in parentheses.

Pile Description	Species	Behavioural re□□□n□e (SPL)[4]	TTS (SEL_{24h})[3]	PTS (SEL_{24h})[3]
		160[2]	168[1]	183[1]
Jacket Foundation Pile	Pygmy blue whale	18.0 (72%)	56.4 (58%)	19.8 (75%)

[1] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[2] SPL (L_p; dB re 1 µPa)
[3] Southall et al. (2019) criteria for marine fauna.
[4] NOAA (2019) recommended unweighted behavioural threshold for marine mammals.

Table 4. *Vessel Operations:* Summary of animat simulation results for PTS, TTS and SPL behavioural response criteria for pygmy blue whales with unrestricted seeding. Maximum exposure ranges show $ER_{95\%}$ (km) first and probability of exposure of animats travelling within the $ER_{95\%}$ (P_{exp} (%)) in parentheses.

Scenario Description	Species	Behavioural re□□□n□e (SPL)[4]	TTS (SEL_{24h})[3]	PTS (SEL_{24h})[3]
		120[2]	179[1]	199[1]
Scenario 1	Pygmy blue whale	36.8 (93%)	0.19 (79%)	<0.01 (30%)

[1] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[2] SPL (L_p; dB re 1 µPa)
[3] Southall et al. (2019) criteria for marine fauna.
[4] NOAA (2019) recommended unweighted behavioural threshold for marine mammals.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Crux development in the northern Browse Basin to assist in understanding the potential acoustic effect on receptors including marine mammals, sea turtles, and fish including fish larvae and eggs.

The modelling study predicted the distances at which underwater sound levels from operations reached noise effect thresholds and criteria. Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance.

The modelling methodology considered underwater acoustic propagation models used in conjunction with the parametrisation specific to modelled sources (source level, frequency content, and source directivity) and range-dependent environmental properties that effect the propagation of underwater sound (e.g., seabed geomorphology). Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), and either single-impulse (i.e., per-strike) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria for either continuous (vessels and drilling) or impulsive (pile driving) noise sources.

The acoustic modelling results were also used as inputs to animal movement modelling simulations to predict the distance at which pygmy blue whales (*Balaenoptera musculus brevicauda*) are expected to be exposed above threshold criteria for permanent threshold shift (PTS), temporary threshold shift (TTS), and may be subject to a behavioural response from activities. Sound exposure distribution estimates are determined by moving large numbers of simulated animals (animats) through a modelled time-evolving sound field, computed using specialised sound source and sound propagation models. This approach provides the most realistic prediction of the maximum expected SPL and SEL for comparison against the relevant thresholds and criteria.

Section 1 outlines the specific details of modelling study. Section 2 details the metrics used to represent underwater acoustic fields and the associated effect criteria considered. Section 3 details the methodology for predicting the source levels and modelling the sound propagation, including source levels and environmental parameters required by the propagation models. Section 4 presents the results, which are then discussed in Section 5.

1.1. Modelling Scenarios

The acoustic modelling study for the Crux development is located in the northern Browse Basin at a location approximately 168 m deep. The study considered the following sound producing activities:

- Impulsive noise from Pile Driving Operations
  - Installing a single subsea jacket foundation pile through impact piling.
- Non-impulsive noise from Vessel and Drilling Operations
  - Construction vessel in isolation,
  - AHT with 150 MT BP in isolation,
  - AHT with 75 MT BP in isolation,
  - Construction vessel with 4 support vessels (3x AHTs with 150 MT BP and 1x AHT with 75 MT BP),
  - Down-the-hole (DTH) drilling of the foundation piles after installation at the Crux platform location.

Figure 1 shows an overview map of the area and the following sections outline the specific details of these activities.

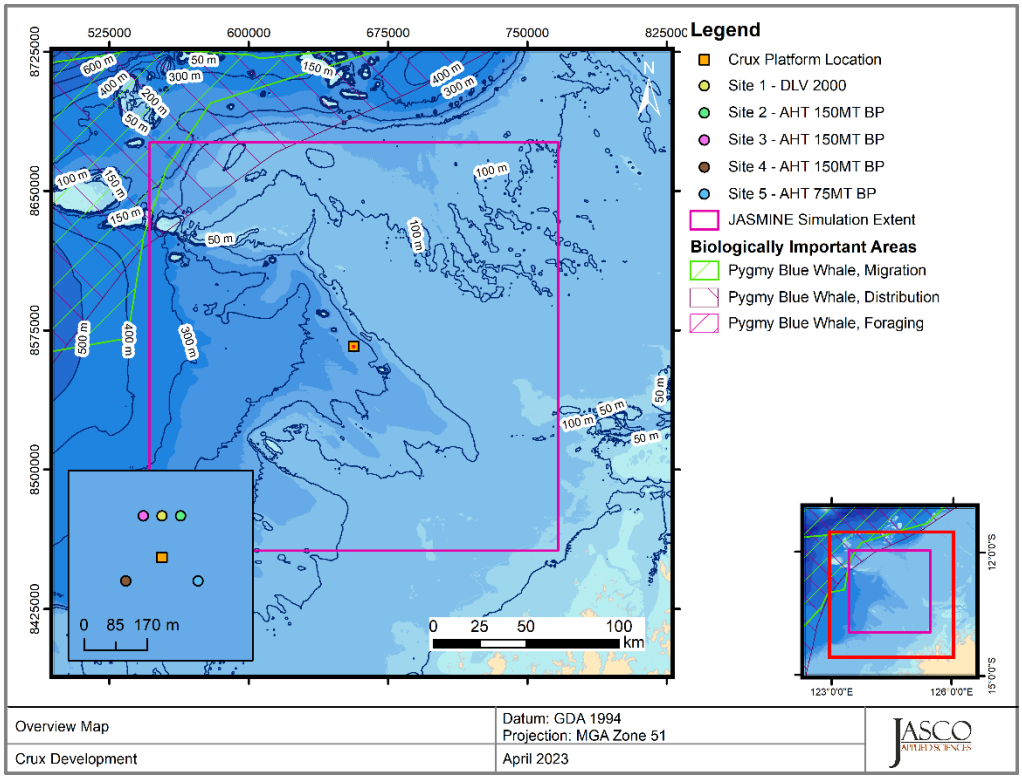

Figure 1. Overview of the modelled sites and features associated with the Crux development.

1.1.1. Pile Driving Operations

Two hammers were considered for modelled as the exact requirements have not been finalised when this study was conducted. JASCO modelled the MHU 500T and IHC 800S impact hammers for use with driving a single foundation pile. The site location for the pile is provided in Table 5 and the general specifications used for modelling underwater noise from impact piling are provided below in Table 6.

Table 5. Modelled pile driving site locations.

Pile Description	Latitude (S)	Longitude (E)	MGA[1] Zone 51 (GDA94[2])		Water Depth (m)
			X (m)	Y (m)	
Jacket Foundation Pile	12° 57' 52.46"	124° 26' 33.21"	656470	8566340	168

[1] Map Grid of Australia (MGA)
[2] Geocentric Datum of Australia 1994

Table 6. Pile specifications for driven cylindrical steel piles.

Pile Description	Dimension			Final penetration depth (m)	Hammers	Helmet Weight (t)
	Length (m)	Diameter (m)	Wall Thickness (mm)			
Jacket Foundation Pile	146.82	3.5	60	120	MHU 500T	30
					IHC 800S	40

1.1.2. Vessel and Drilling Operations

The modelled scenarios for the non-impulsive noise sources are divided into two activities: vessel construction activities and drilling operations at the Crux platform location. The site locations for the sound sources are given in Table 7 and scenarios including combinations of these sound sources are given in Table 9.

Table 7. Modelled site locations and vessel source information.

Site	Vessel	Latitude (S)	Longitude (E)	MGA[1] Zone 51 (GDA94)		Water Depth (m)
				X (m)	Y (m)	
1	*DLV 2000*	12° 57' 48.82"	124° 26' 33.19"	656470	8566452	168
2	AHT 150 MT BP	12° 57' 48.81"	124° 26' 34.84"	656520	8566452	168
3	AHT 150 MT BP	12° 57' 48.83"	124° 26' 31.53"	656420	8566452	167
4	AHT 150 MT BP	12° 57' 54.53"	124° 26' 30.00"	656373	8566277	168
5	AHT 75 MT BP	12° 57' 54.50"	124° 26' 36.44"	656567	8566277	168

[1] Map Grid of Australia (MGA)
AHT: Anchor handling tug
MT BP: Megaton bollard pull

Table 8. Modelled site location for drilling.

Activity	Latitude (S)	Longitude (E)	MGA[1] Zone 51 (GDA94)		Water Depth (m)
			X (m)	Y (m)	
Drilling	12° 57' 52.46"	124° 26' 33.21"	646470	8566340	168

[1] Map Grid of Australia (MGA)

Table 9. Description of modelled scenarios.

Site number	Scenario Label	Vessels	Source(s)	Description
1	Construction Vessel	1	*DLV 2000*	Construction Vessel in isolation
2	AHT 150 MT BP	2	AHT with 150 MT BP	Support vessel with 150 MT BP in isolation
3	AHT 75 MT BP	3	AHT with 75 MT BP	Support vessel with 75 MT BP in isolation
Combined Scenarios				
1	All vessels	1+2+3	*DLV 2000* AHT with 150 MT BP AHT with 75 MT BP	Construction Vessel + 3x 150 MT BP + 1x 75 MT BP support vessels

AHT: Anchor handling tug
MT BP: Megaton bollard pull

2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to first establish exposure criteria (thresholds) for which sound levels may be expected to have a negative effect on animals. Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed SEL–based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), United States National Marine Fisheries Service (NMFS 2018) and Southall et al. (2019). The number of studies that investigate the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

The perceived loudness of sound, especially impulsive noise such as from pile driving, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the pulse rise-time and duration, and the frequency content. Several sound level metrics, such as PK, SPL, and SEL, are commonly used to evaluate noise and its effects on marine life (Appendix A). The period of accumulation associated with SEL is defined, with this report referencing either a “per-strike”, “per-1s” assessment, or over 24 h. For non-impulsive sound sources, such as vessels and DTH drilling, SPL and SEL are the relevant metrics. The acoustic metrics in this report reflect the ISO standard for acoustic terminology, ISO/DIS 18405:2017 (2017).

The following thresholds and guidelines for this study were chosen because they represent the best available science, and sound levels presented in literature for fauna with no defined thresholds:

1. Marine mammals:
    a. Peak pressure levels (PK; L_{pk}) and frequency–weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Southall et al. (2019) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for impulsive and non–impulsive sources.
    b. Marine mammal behavioural thresholds based on the current interim U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) unweighted criterion for marine mammals of 160 dB re 1 µPa (SPL; L_p) and 120 dB re 1 µPa (SPL; L_p) for impulsive and non–impulsive sound sources.
2. Fish, fish eggs, and larvae:
    a. Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
3. Sea turtles:
    a. Frequency–weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of PTS and TTS in turtles for impulsive and non–impulsive sound sources.
    b. Sea turtle behavioural response threshold of 166 dB re 1 µPa (SPL; L_p) (McCauley et al. 2000), along with a sound level associated with behavioural disturbance 175 dB re 1 µPa (SPL; L_p) (McCauley et al. 2000) for impulsive sound sources.

The following sections (Sections 2.1 and 2.2, along with Appendix A.4), expand on the thresholds, guidelines and sound levels for the considered marine fauna.

2.1. Impulsive Noise

Impact pile driving activities have been assessed as an impulsive noise source, consistent with the considered thresholds and guidelines.

2.1.1. Marine Mammals

The criteria applied in this study to assess possible effects of impulsive noise sources on marine mammals are summarised Table 10; cetaceans were identified as the functional hearing group requiring assessment. Details on thresholds related to auditory threshold shifts or hearing loss and behavioural response are provided in Appendix A.3, with frequency weighting explained in detail in Appendix A.4. Of particular note, whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals. The interim criteria from the current U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) has been applied.

Table 10. Acoustic effects of impulsive noise on marine mammals: Unweighted SPL, SEL_{24h}, and PK thresholds.

Hearing group	NOAA (2019)	Southall et al. (2019)			
	Behaviour	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low–Frequency (LF) cetaceans	160	183	219	168	213
High–frequency (HF) cetaceans		185	230	170	224
Very–High–frequency (VHF) cetaceans		155	202	140	196
Sirenians		190	226	175	220

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non–impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

L_p denotes sound pressure level period.

$L_{pk,flat}$ denotes peak sound pressure is flat weighted or unweighted.

L_E denotes cumulative sound exposure over a 24 h period.

2.1.2. Fish, Sea turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Sea Turtles was formed to continue developing noise exposure criteria for fish and sea turtles, work begun by a NOAA panel two years earlier. The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups (Popper et al. 2014). The guidelines define quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death,
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma, and
- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity–based subjective ranges, these effects are not addressed in this report and are included in Table 11 for completeness only. A fish's susceptibility to injury from noise exposure depends on the species and the presence and

possible role of a swim bladder in hearing. Thus, different thresholds were proposed for the following groups: fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Sea turtles, fish eggs, and fish larvae are considered separately.

Impulsive noise from pile driving is assessed in this study based on the relevant effects thresholds from Popper et al. (2014), listed in Table 11. In general, whether an impulsive sound adversely effects fish behaviour depends on the species, the state of the individual exposed, and other factors.

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long–lasting exposures, an exposure evaluation time must be defined. Southall et al. (2007) defines the exposure evaluation time as the greater of 24 h or the duration of the activity. Popper et al. (2014) recommend a standard period of the duration of the activity; however, the publication also includes caveats about considering the actual exposure times if fish move. Integration times in this study for piling have been applied over the time a single pile was driven because only one pile is expected to be driven per day.

Table 11. Criteria for pile driving noise exposure for fish, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	>> 186 dB SEL_{24h}	Pile driving: (N) Moderate (I, F) Low Seismic: (N, I, F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	>> 186 dB SEL_{24h}	Pile driving: (N) Moderate (I, F) Low Seismic: (N, I, F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	Pile driving: (N, I) High (F) Moderate Seismic: (N, I) Low (F) Moderate	(N, I) High (F) Moderate
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	Pile driving: (N) Moderate (I, F) Low Seismic: (N, I, F) Low	(N) Moderate (I, F) Low

Peak sound pressure level dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s.
All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist.
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting that this likely would be conservative for sea turtles). Finneran et al. (2017) in turn presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have greatest sensitivity at low frequencies and are known to have poor auditory sensitivity more generally (Bartol and Ketten 2006, Dow Piniak et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014).

McCauley et al. (2000) observed the behavioural response of caged sea turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the sea turtles increased their swimming activity, and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The Recovery Plan for Marine Turtles in Australia (Department of the Environment and Energy et al. 2017) acknowledges the 166 dB re 1 µPa SPL reported (McCauley et al. 2000) as the level that may result in a behavioural response to marine turtles. The 175 dB re 1 µPa level from McCauley et al. (2000) is recommended as a criterion for behavioural disturbance.; these thresholds are shown in Table 12.

Table 12. Acoustic effects of impulsive noise on sea turtles: Unweighted sound pressure level (SPL), 24-hour sound exposure level (SEL_{24h}), and peak pressure (PK) thresholds.

Effect type	Criterion	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Behavioural response	McCauley et al. (2000)	166	NA	
Behavioural disturbance		175		
PTS onset thresholds[1] (received level)	Finneran et al. (2017)	NA	204	232
TTS onset thresholds[1] (received level)			189	226

[1] Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non–impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

L_p denotes sound pressure level period and has a reference value of 1 µPa.

$L_{pk,flat}$ denotes peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.

L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa²s.

2.2. Non-impulsive Noise

Vessel and drilling operations have been assessed as a non-impulsive noise source, as consistent with the considered thresholds and guidelines.

2.2.1. Marine Mammals

The criteria applied in this study to assess possible effects of non-impulsive noise sources on marine mammals are summarised in Table 13.

Table 13. Criteria for effects of non–impulsive noise exposure, including vessel noise for marine mammals: Unweighted SPL and SEL_{24h} thresholds.

Hearing group	NOAA (2019)	Southall et al. (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)
Low–Frequency (LF) cetaceans	120	199	179
High–frequency (HF) cetaceans		198	178
Very High–frequency (VHF) cetaceans		173	153
Sirenians		206	186

L_p denotes sound pressure level period and has a reference value of 1 µPa.

L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa²·s.

2.2.2. Fish, Sea turtles, Fish Eggs, and Fish Larvae

Non-impulsive noise from vessels is assessed in this study based on the relevant effects thresholds from Popper et al. (2014). The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups (Popper et al. 2014). The guidelines define quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death,
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma, and
- TTS.

Table 14 lists the relevant effects thresholds from Popper et al. (2014) for vessel operational noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing. Finneran et al. (2017) presented revised thresholds for turtle injury, considering frequency weighted SEL, which have been applied in this study for vessels (Table 15).

Table 14. Criteria for non–impulsive (vessels and drilling operational noise) noise exposure for fish, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(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) 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

Sound pressure level dB re 1 µPa.
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Table 15. Acoustic effects of non–impulsive noise on sea turtles, weighted SEL_{24h}, Finneran et al. (2017).

PTS onset thresholds (received level)	TTS onset thresholds (received level)
220	200

3. Methods

This section describes the methods used to characterise acoustic sources (driven piles, vessel, and drilling noise), as well as the acoustic propagation models and considered frequency ranges for the estimation of acoustic field extents.

3.1. Parameter Overview

The specifications of the modelled sources and the environmental parameters used in the propagation models are described in detail in Appendix D. An analysis of seasonal sound speed profiles indicates that July is the month most conducive to sound propagation; as such, it selected to as part of a conservative approach to estimate distances to received sound level thresholds (Appendix D.1.2).

One geological profile was considered during the modelling (Appendix D.1.3). Within the vicinity of the Crux development site the geology is mainly characterised by unconsolidated sediment interspersed with some cemented layers.

3.2. Pile Driving

The pile driving scenarios are based on pile drivability assessments provided by Shell. To predict the acoustic field from the pile driving, JASCO's Pile Driving Source Model (PDSM; Appendix B) was used in conjunction with JASCO's Full Waveform Range-dependent Acoustic Model (FWRAM, Appendix C.3) at frequencies from 10 Hz to 1024 Hz. In addition, an empirical extrapolation was applied to these results to extend the frequency range up to 25 kHz.

The SEL_{24h} predictions were determined through the summation of energy across the entire pile driving operation, accounting for the per-strike sound fields modelled for three phases representing different penetration depths below the seafloor.

The hammer penetration values used in this underwater acoustic modelling study was developed in considering the driveability study provided by the Shell. This study estimated the number of strikes and applied hammer energy per metre of the pile drive. The provided driveability study also indicated that that the total number of specified strikes to drive the pile to completion may be larger than what is required in-situ, hence indicating that some conservativism has been incorporated into the design. The driveability data were then used to inform the pre-strike modelling and accumulated SEL modelling presented below in Sections 3.2.1 and 3.2.2.

3.2.1. Per-strike Modelling

For impact pile driving, time-domain representations of the pressure signals generated in the water are required for calculating sound pressure level (SPL), sound exposure level (SEL), and peak sound pressure level (PK). Appendix A.1 describes the sound level metrics in further detail. The following steps describe the general approach applied in this study to model noise emissions from impact pile driving activities:

1. Piles driven into the seabed by impact pile driving were characterised as vertically distributed sound-radiating sources. This characterisation strongly depends on the rate and extent of pile penetration, pile dimensions, and pile driving equipment.
2. The sound propagation models applied in this study were used to predict how sound propagates from the pile into the water column as a function of range, depth, and azimuthal direction. Sound propagation depends on several conditions including the frequency content of the sound, the

bathymetry, the sound speed in the water column, and seabed geoacoustics (i.e. seabed geology). Appendix D.1 describes environmental properties such as bathymetry, sound speed profile, and geoacoustics.

3. The modelled sound field was used to compute received levels over a grid of receiver locations from which distances to criteria thresholds and maps of ensonified areas have been generated.

To model sound level from impact pile driving of cylindrical piles, PDSM (Appendix B.1), a physical model of pile vibration and near-field sound radiation (MacGillivray 2014), was used in conjunction with the GRLWEAP 2010 wave equation model (GRLWEAP, Pile Dynamics 2010). Figure 2 shows the time history of the hammer force at the top of the pile that was predicted by GRLWEAP.

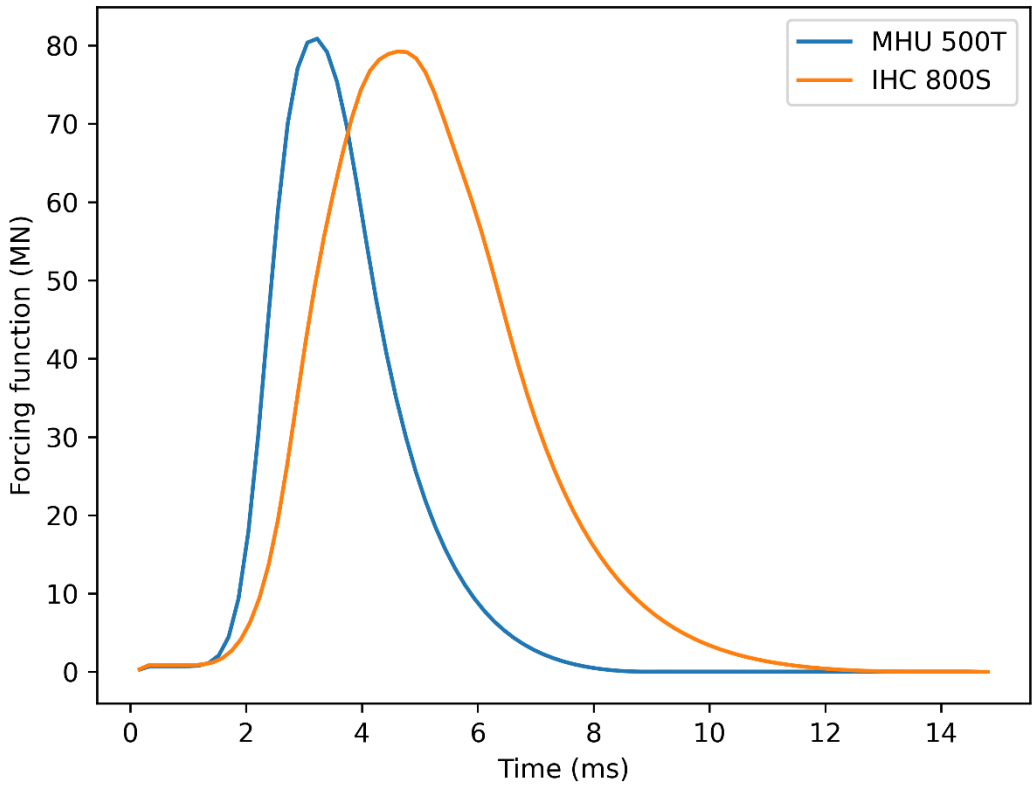

Figure 2. Force (in meganewtons) at the top of the pile corresponding to impact pile driving using the MHU 500T and the IHC 800S impact hammers for the foundation pile, computed using the GRLWEAP 2010 wave equation model.

The forcing function (Figure 2) were used by the PDSM to obtain equivalent pile driving signatures for a vertical array of discrete point sources (Appendix B). These represent the pile as an acoustic source and account for parameters (pile type, material, size, and length), the pile driving equipment, and approximate pile penetration rate. The amplitude and phase of the point sources along the pile are computed so they collectively mimic the time-frequency characteristics of the acoustic wave at the pile wall that results from a hammer strike at the top of the pile. This approach accurately estimates spectral levels within the band 10–1000 Hz, where most of the energy from impact pile driving is concentrated.

Time-domain Full Waveform Range-dependent model (FWRAM; Appendix C.3) calculates sound propagation from physically distributed impulsive sources and is valid at all distances. In the present study, received sound levels were calculated using FWRAM along transects at 72 azimuths out to 100 km from the source. Decidecade band levels higher than 1000 Hz were extrapolated up to 25 kHz using a 20 dB/decade decay rate to match acoustic measurements of impact pile driving of similarly-sized piles (Illingworth & Rodkin 2007, Matuschek and Betke 2009).

Receiver depths were chosen to span the entire water column over the modelled area, from 0 to 350 m, with a depth increment that increases with depth. To produce maps of received sound level distributions and to calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each modelled easting and northing position within the considered region. The radial grids of maximum-over-depth levels were then resampled (by linear triangulation) to produce a regular Cartesian grid with a cell size of 20 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields (Appendix D.1).

3.2.2. Accumulated SEL Modelling for Pile Driving

The modelling approach outlined in Section 3.2.1 provides per-strike SEL for three stages of pile driving (i.e., three penetration depths). Because a single pile is predicted to be driven per day and the piling noise level far exceeds any background, the corresponding sound exposure level can be denoted as SEL_{24h} even though the effective period of accumulation is the estimated time for fully driving a single pile.

The accumulated SEL over a single pile, or the SEL_{24h}, depends on the total number of strikes to drive the pile to completion. As such, the number of strikes per modelled penetration depth and required to fully install the pile were based upon the provided driveability data. Total driving time was estimated assuming continuous piling at a rate of approximately 38 strikes/minute for both the MHU 500T and the IHC 800S hammers. The SEL_{24h} was computed by adjusting the single-strike SEL by $10*\log_{10}(N)$, where N is the total number of strikes within a 24 hour period. A summary of the total number of strikes per penetration depth and over the entire pile is provided in Table 16.

Table 16. Total number of strikes and driving time. Strikes were broken down into stages corresponding to the three modelled penetrations for the MHU 500T and IHC 800S hammers. Pile specifications are shown in Table 6.

Pile Type	Hammer	Full penetration depth (m)	Modelled penetration depth (m)	Penetration range for accumulated SEL (m)	Number of strikes	Average Penetration rate (mm/strike)	Total number of strikes	Time for full penetration (hr)
Jacket Foundation Pile	MHU 500T	120	33.5	16.2-50.6	3486	9.87	14576	6.39
			68.0	50.6-85.4	2716	12.81		
			102.5	85.4-119.8	8374	4.11		
Jacket Foundation Pile	IHC 800S	120	33.5	16.2-50.6	1803	19.08	6516	2.86
			68.0	50.6-85.4	1521	22.88		
			102.5	85.4-119.8	3192	10.78		

3.3. Vessel Operations

JASCO's Marine Operations Noise Model (MONM-BELLHOP; Appendix C.1) was used to predict the non-impulsive acoustic field at decidecade frequencies between 10 Hz to 25 kHz for all vessels.

For all vessels, the sound pressure level (SPL) modelling results were converted to SEL by the duration of the measurement, as appropriate for a continuous noise source. As SEL was assessed over 24 h, the conversion from SPL was obtained by increasing the levels by $10*\log_{10}(T)$, where T is 86,400 (the number of seconds in 24 h).

3.3.1. Vessel Radiated Noise

Underwater sound that radiates from vessels is produced mainly by propeller and thruster cavitation, with a smaller fraction of noise produced by sound transmitted through the hull, such as by engines,

gearing, and other mechanical systems. Sound levels tend to be the highest when thrusters are used to position the vessel and when the vessel is transiting at high speeds. A vessel's sound signature depends on the vessel's size, power output, propulsion system (e.g., conventional propellers vs. Voith Schneider propulsion), and the design characteristics of the given system (e.g., blade shape and size). A vessel produces broadband acoustic energy with most of the energy emitted below a few kilohertz. Sound from onboard machinery, particularly sound below 200 Hz, dominates the sound spectrum before cavitation begins (Spence et al. 2007). The spectra for the vessels considered in this study are shown in Figure 3.

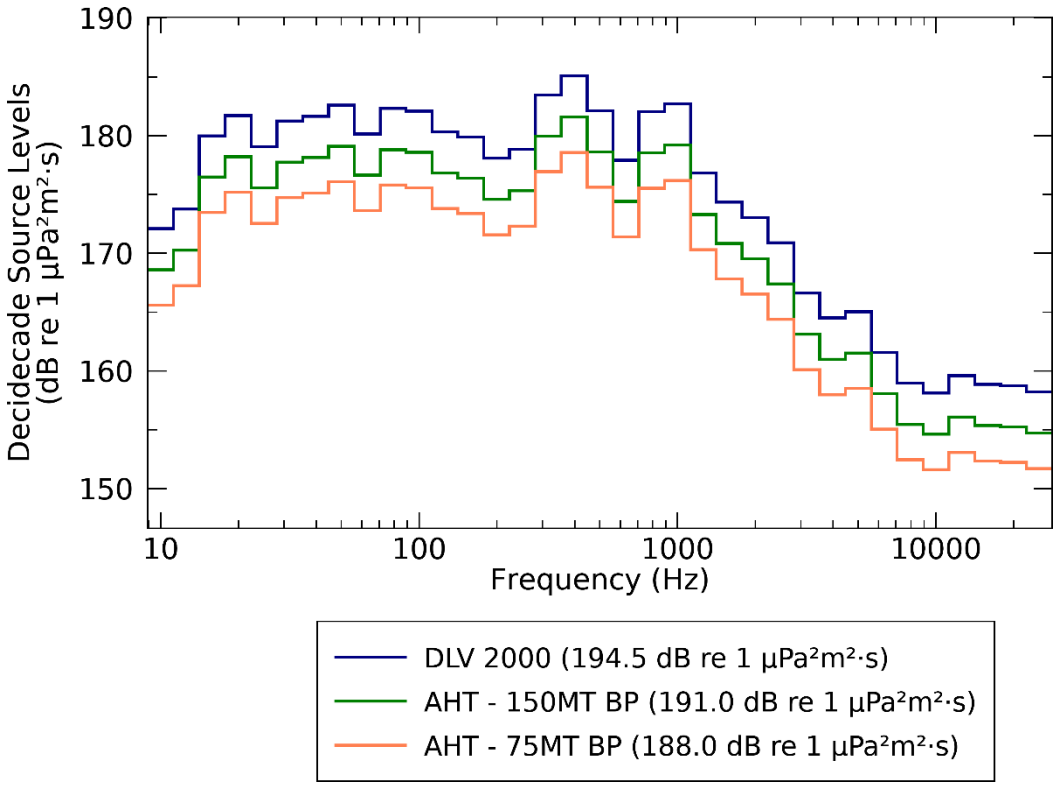

Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the *DLV 2000* and AHT vessels.

3.3.1.1. *DLV 2000*

The *DLV 2000* is a DP Class 3 derrick lay vessel that is planned for use in the construction operations considered in this study (Figure 4). It has a length of 184 m, a width of 38.6 m, and a draft of 7.9 m. While in operation, it will be positioned by thrusters under DP. As such, the underwater noise emitted from the *DLV 2000* is expected to originate primarily from cavitation in the thrusters whilst under DP.

Figure 4. *DLV 2000* – the construction vessel considered (McDermott 2018).

Thruster noise from the DLV 2000 was modelled as a point source at a source depth of 5.5 m (0.7 x draft). The DLV 2000 has 25,500 kW of propulsion installed. The spectra for this vessel were based off a surrogate vessel with similar specifications, the Siem Sapphire (McPherson et al. 2021), and scaled based on the difference in installed thruster power. The vessel can be represented by a combined, estimated broadband energy source level (ESL) of 194.5 dB re 1 μPa^{2}m^{2}s.

3.3.1.2. Anchor Handling Tugs (AHTs)

3.3.1.2.1. AHTs (*TDW Pacific Centurion* and *Posh Antares*)

At this stage, the exact vessel specifications for all vessels as well as the precise operational scenarios are not known for all the AHTs. There are two classes of vessels that are considered, three vessels with a bollard pull of 150 MT and one with a bollard pull of 75 MT. The 150 MT BP vessel will be similar to the *TDW Pacific Centurion,* and the 75 MT BP vessel is similar to the *Posh Antares*. As such, estimates of the source levels for the AHT operations were based on these vessels. The general specification of these vessels is that they have an overall length, beam, and draft of 86.0, 19.9, and 7.3 m for 150 MT BP vessel and 50.7, 13.8, and 4.5 m for the 75 MT BP vessel respectively.

Thruster noise from the AHTs was modelled as a point source at a source depth of 5.1 or 3.2 m (0.7 x draft) for the 150 MT BP or 75 MT BP AHTs respectively. The monopole source levels (MSLs) were based on a measured surrogate AHTS vessel, *Siem Sapphire* (McPherson et al. 2021) and were scaled based on their bollard pull. This gives an estimated broadband energy source level (ESL) of 191.0 or 188.0 dB re 1 μPa^{2}m^{2}s for the 150 MT BP or 75 MT BP AHTs respectively.

Figure 5. Photo of the Anchor Handling Tug vessels the *TDW Pacific Centurion* (left) (Tidewater 2021) and the *Posh Antares* (right) (Posh).

3.4. Drilling Operations

Down-the-hole (DTH) pile drilling is a percussive rotating drilling technique appropriate for hard rock or cemented horizons within sub-bottom formations. The proxy source levels for DTH were adapted from Guan et al. (2022) and were measured in Ketchikan, Alaska using a 0.84 m diameter drill bit. DTH pile drilling contains both impulsive and non-impulsive components to the sound. No clear definition exists for when a sound source is considered impulsive vs non-impulsive; however Guan et al. (2022) suggest that the DTH drilling is better characterised as non-impulsive noise, which is adopted here.

To determine source level, the received levels given in Guan et al. (2022) at 10 m were backpropagated to 1 m using a $20\log(r)$ spherical spreading loss since the measurement location was in the near-field region. In this region, there is little interaction with the seabed with loss almost entirely due to the geometric spreading associated with direct path between source and receiver.

Most acoustic energy from DTH drilling was outputted between 40 Hz and 500 Hz. For modelling purposes in this study, the noise produced from DTH activities was considered to be a point source located mid water column. This gives an estimated broadband energy source level (ESL) of 170.1 dB

re 1 μPa²m²s and Figure 6 presents the spectrum that was used for modelling. This was derived from spectral plots presented in Guan et al. (2022).

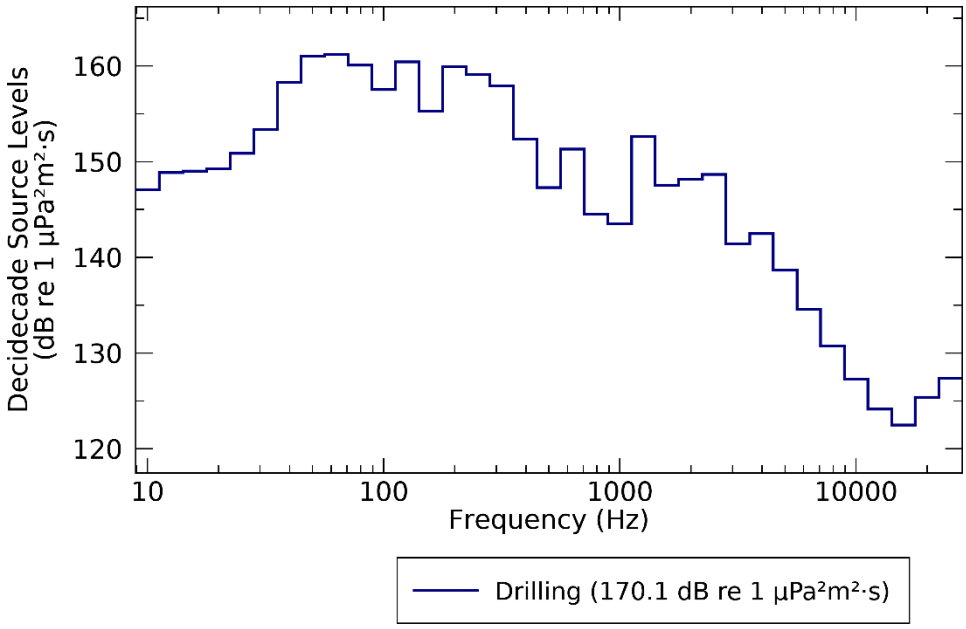

Figure 6. Energy source level (ESL) spectra (in decidecade frequency-band) for the DTH drilling.

3.5. Animal Movement and Exposure Modelling

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to predict the exposure of animats to sound arising from pile driving scenarios (Section 1.1.1) and one vessel scenario (Section 1.1.2). JASMINE integrates the predicted sound field with biologically meaningful movement rules for each marine mammal species (pygmy blue whales for the current analysis) that results in an exposure history for each animat in the model. An overview of the exposure modelling process using JASMINE is shown in Figure 7.

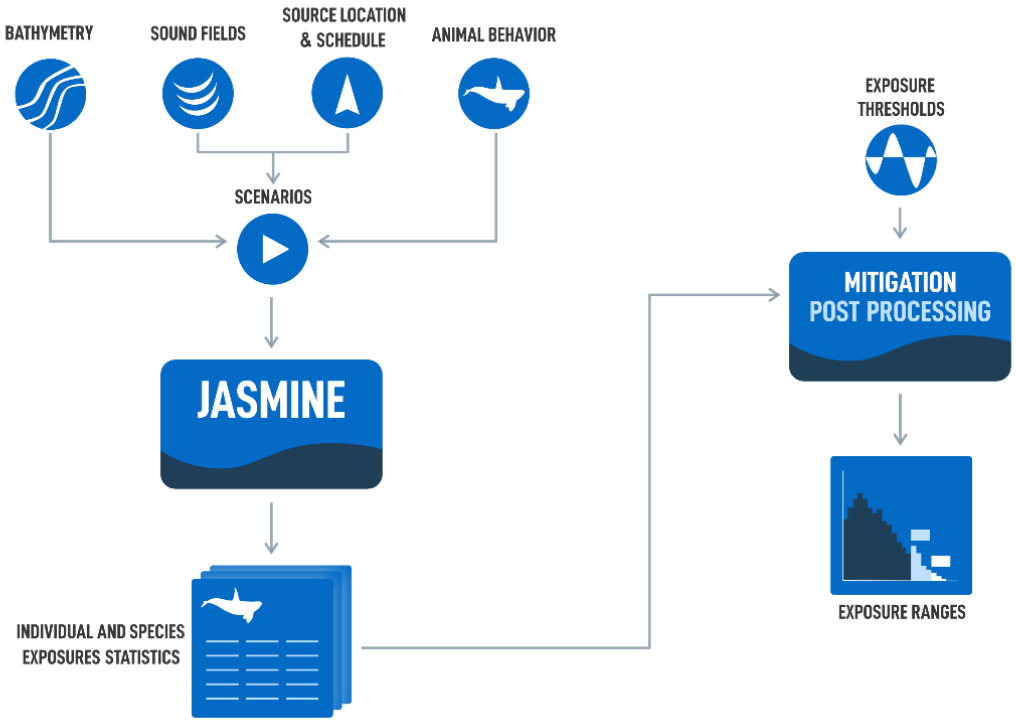

Figure 7. Exposure modelling process overview.

In JASMINE, the sound received by the animats is determined by the proposed activities. As illustrated in Figure 8, animats are programmed to behave like the marine animals that may be present in an area. The parameters used for forecasting realistic behaviours (e.g., diving and foraging depth, swim speed, surface times) are determined and interpreted from marine mammal studies (e.g., tagging studies) where available, or reasonably extrapolated from related or comparable species. For cumulative metrics, an individual animat's sound exposure levels are summed over a 24 h duration to determine its total received energy, and then compared to the relevant threshold criteria. For single-exposure metrics, the maximum exposure is evaluated against threshold criteria for each 24 h period. For additional information on JASMINE, see Appendix E.

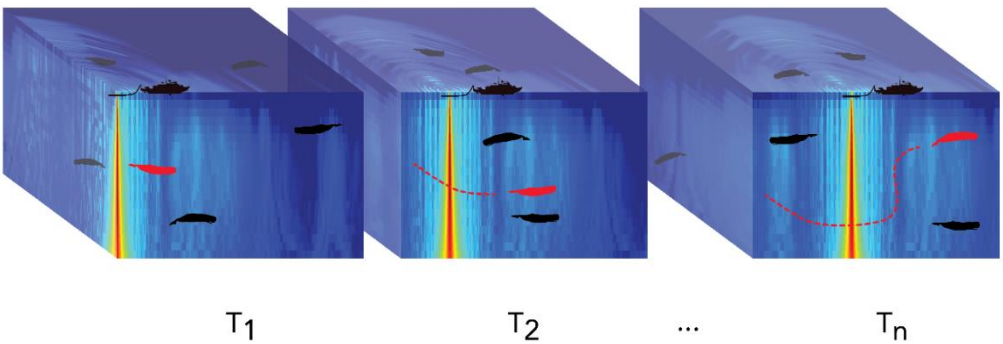

Figure 8. Depiction of animats in a moving sound field. Example animat (red) shown moving with each time step (T_n). The acoustic exposure of each animat is determined by where it is in the sound field, and its exposure history is accumulated as the simulation steps through time.

The exposure criteria for impulsive and non-impulsive sounds (described in Sections 2.1 and 2.2) were used to determine the number of animats that exceeded thresholds. To generate statistically reliable probability density functions, model simulations were run with animat sampling densities of

4 animats/km^2. Due to insufficient density data availability, the modelling results are not related to real-world density estimates for pygmy blue whales within the BIA. To evaluate PTS, TTS and behavioural response, exposure results were obtained using detailed behavioural information for migrating pygmy blue whales (described in Section 3.5.2). The simulation was run for a representative period of 24 h to coincide with the acoustic modelling effort. Animal movements and exposures were modelled for the MHU 500T and IHC 800S impacts hammer for use with driving a single pile (Table 6) as well as for the combined vessel scenario (Table 9). Both scenarios were run for migrating pygmy blue whales; however, due to the large distance between the pygmy blue whale migratory BIA and the pile location, only unrestricted animat seeding was considered.

Figure 9 shows an example animat track (generated for information purposes only and not related to the results presented in this report) with associated received levels from a stationary point source. The top panel displays the animat track relative to the point source, and the bottom panel displays the accumulation of SEL_{24h} for TTS and PTS criteria. At approximately 50 seconds, the animat is exposed so that the TTS threshold is exceeded, and at approximately 700 seconds the animat is exposed so that the PTS threshold is exceeded.

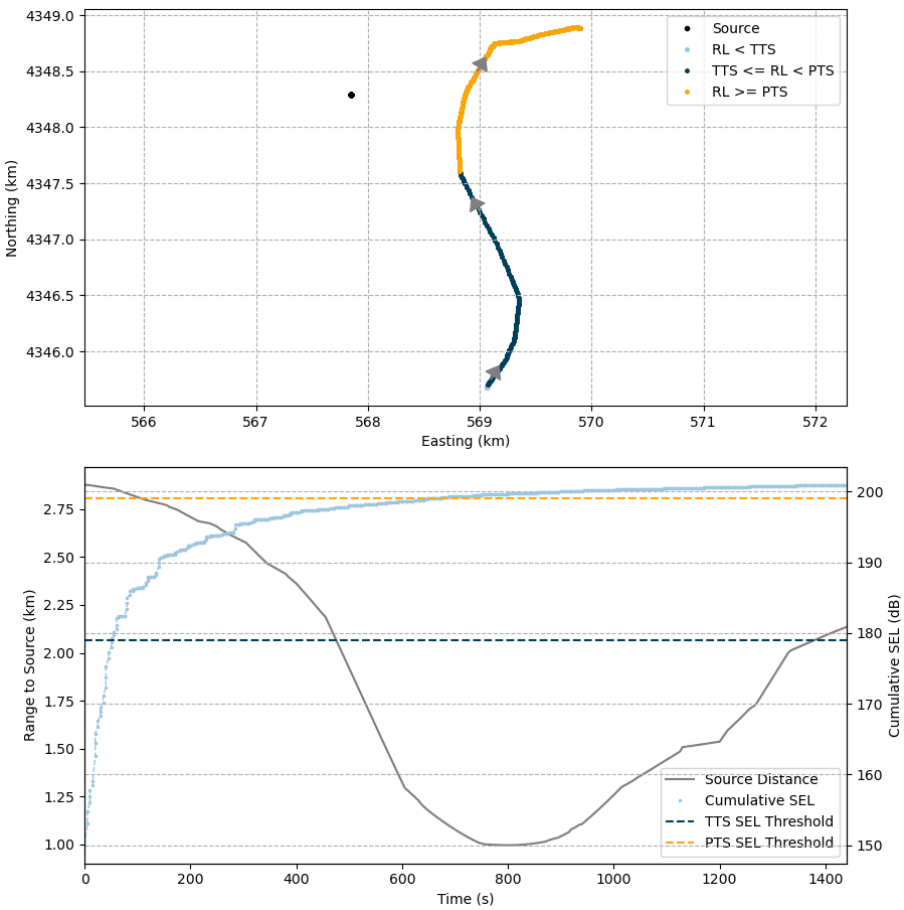

Figure 9. Animat track from an example simulation showing northward movement over a 1400 s duration. The upper panel shows a plan view of both a stationary point source and a foraging animat. Animat steps are coloured to indicate whether the accumulated sound energy at that point has exceeded either TTS or PTS threshold criteria. The lower panel shows horizontal distance in kilometres to the source (grey line; left y-axis) and cumulative 24-h SEL ($L_{E,24h}$, dB re 1 μPa²·s; right y-axis) as a function of time. Note that this example does not use data from the current study.

3.5.1. Exposure-based Radial Distance Estimation

The results from the animal movement and exposure modelling provided a way to estimate radial distances to effect thresholds. The distance to the closest point of approach (CPA) for each of the animats was recorded. The $ER_{95\%}$ (95% Exposure Range) is the horizontal distance that includes 95% of the animat CPAs that exceeded a given effect threshold (Figure 10). Within the $ER_{95\%}$, there is generally some proportion of animats that do not exceed threshold criteria. This occurs for several reasons, including the spatial and temporal characteristics of the sound field and the way in which animats sample the sound field over time, both vertically and horizontally. The sound field varies as a function of range, depth, and azimuth based on a variety of factors such as bathymetry, sound speed profile, and geoacoustic parameters. The way the animats sample the sound field depends upon species-typical swimming and diving characteristics (e.g., swim speed, dive depth, surface intervals, and reversals). Furthermore, even within a particular species definition, these characteristics vary with behavioral state (e.g., feeding, migrating). As this results in some animats not exceeding threshold criteria even within the $ER_{95\%}$, the probability that an animat within that distance was exposed above threshold within the $ER_{95\%}$ was also computed (P_{exp}) to provide additional context.

Acoustic ranges are reported for both $R_{95\%}$ and R_{max}, however, exposure ranges are reported for $ER_{95\%}$ only since, statistically, ER_{max} is not defined. JASMINE is a Monte Carlo simulation, and the results are probabilistic in nature. This is in contrast with acoustic modelling, where there is a specific maximum isopleth range for a given source/environment setup.

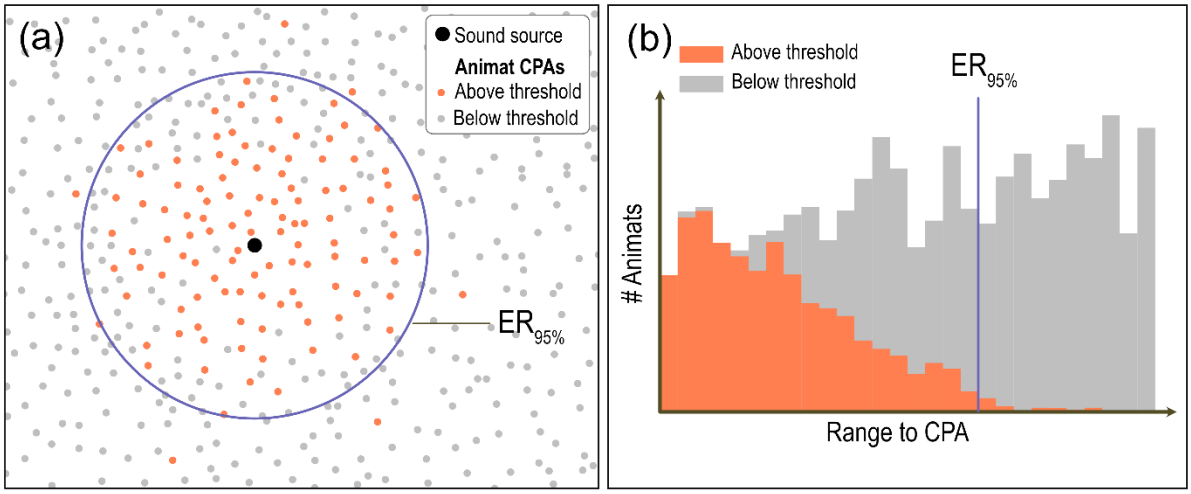

Figure 10. Example distribution of animat closest points of approach (CPAs). Panel (a) shows the horizontal distribution of animats near a sound source. Panel (b) shows the distribution of distances to animat CPAs. The 95% exposure range ($ER_{95\%}$) is indicated in both panels.

3.5.2. Pygmy Blue Whale Behaviour

The Crux development is located approximately 120 km from the migration BIA for pygmy blue whales, therefore migratory behaviour was the only behavioural profile considered. Based on JASCO's experience of monitoring pygmy blue whales in this region, southbound migrating animals pass through the development area before moving in the direction of the foraging BIA near Scott Reef.

Detailed information on pygmy blue whales was derived from a range of sources that used multi-sensor tags to record fine-scale dive and movement behaviour (Owen et al. 2016, Möller et al. 2020). Where information was unavailable for pygmy blue whales, parameters were derived from blue whale (*B. musculus*) tagging data (Goldbogen et al. 2011).

Multi-sensor tags typically record the depth of an animal along with various movement parameters such as swim speed and their body's orientation. Owen et al. (2016) equipped a sub-adult pygmy blue whale with a multi-sensor tag off Western Australia. They identified dives for their tagged animal as migratory, feeding, or exploratory (i.e., no lunges recorded which would indicate feeding). Pygmy blue whales in the simulation area are presumed to be migrating, and so feeding was not included in the model. Exploratory dives were considered to be part of migratory behaviour, and so the two dive types were modelled together such that the animats were migrating 95% of the time and engaged in exploratory dives 5% of the time (Owen et al. 2016). Using data from Owen et al. (2016), the approximate length of a bout of exploratory dives could be determined, as well as the average (± SD) depth of this dive type. The analysis of the dive data showed that the depth of migratory dives was highly consistent over time and unrelated to local bathymetry. The mean depth of migratory dives was 14 ± 4 m while the mean maximum depth of exploratory dives was 107 ± 81 m (23–320 m range).

The behaviour of migrating pygmy blue whales was modelled to reflect animats transiting through the modelling area on a 230° track for the southward. This represents the animals migrating along the west coast of Australia from Indonesia (Double et al. 2014, DoE (AU) 2015-2025). The speed of travel for migratory behaviour (1.17 ± 0.60 m/s) and exploratory dives (0.88 ± 0.14 m/s) were calculated from data presented in Möller et al. (2020).

4. Results

The results below are split into three sections for pile driving (Section 4.1), vessel operations (Section 4.2), and drilling operations (Section 4.3). For the results and tables presented below where a dash is used in place of a horizontal distance, these thresholds may or may not be reached due to the discreetly sampled radial increments of the modelled sound fields. A dash therefore is an indication that effect levels for the associated metric may only be reached within a very close proximity to a given source.

4.1. Pile Driving

The maximum-over-depth sound fields for the modelled pile driving scenarios are presented below in two formats: as tables of distances to sound levels (Section 4.1.1) and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels (Section 4.1.3).

4.1.1. Received Levels at 10 m

Since piles are distributed and directional sources, they cannot be accurately approximated by a point source with corresponding source levels. It is possible to compare the maximum modelled levels at short distances from the piles. Figure 11 (MHU 500T) and Figure 12 (IHC 800S) show the decidecade–band levels for the receiver with the highest SEL at a horizontal range of 10 m, for each of the three modelled penetration depths. The levels above 1000 Hz were extrapolated using a 20 dB/decade decay rate to match acoustic measurements of impact pile driving of similarly sized piles (Illingworth & Rodkin 2007, Matuschek and Betke 2009). The modelled results at a distance of 10 m are included to provide results comparable to other pile driving reports and literature, such as Illingworth & Rodkin (2007), and Denes et al. (2016).

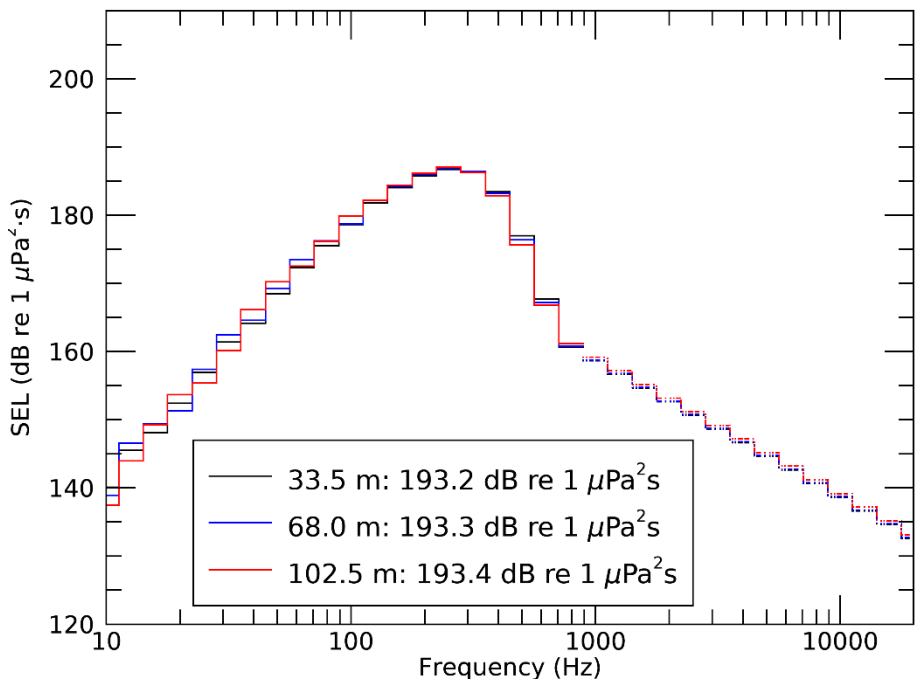

Figure 11. Decidecade–band levels for the receiver with highest SEL at 10 m horizontal range for impact pile driving using the MHU 500T hammer at three penetration depths, after high–frequency extrapolation (dashes indicate extrapolated portion of the spectrum above 1000 Hz). Legend items indicate the modelled pile penetration and the broadband SEL in dB re 1 μPa²·s.

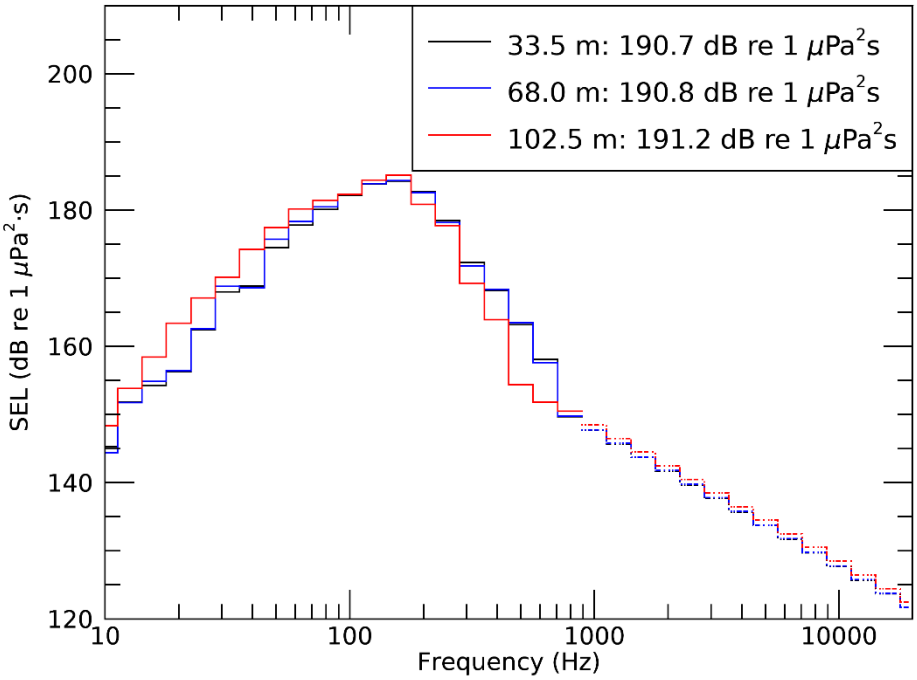

Figure 12. Decidecade–band levels for the receiver with highest SEL at 10 m horizontal range for impact pile driving using the IHC 800S hammer at three penetration depths, after high–frequency extrapolation (dashes indicate extrapolated portion of the spectrum above 1000 Hz). Legend items indicate the modelled pile penetration and the broadband SEL in dB re 1 μPa²·s.

4.1.2. Tabulated Results

This section presents the per-strike sound fields in terms of maximum-over-depth SPL, SEL, and PK. The different metrics are presented for the following reasons:

- SPL sound fields (Table 17) were used to determine the distances to marine mammal and turtle behavioural thresholds (see Section 2.1).
- Per-pulse SEL sound fields (Table 18) are used as inputs into the 24 h SEL scenario.
- PK metrics within the water column (Tables 19 and 20) are relevant to thresholds and guidelines for marine mammals, sea turtles, fish, fish eggs and larvae (see Section 2.1).

Frequency-weighted SEL_{24h} sound fields were used to estimate the maximum distance and area to injury and TTS to marine mammal and turtle PTS and TTS thresholds (listed in Table 21), and to estimate maximum distance and the area to injury and TTS guidelines for fish (Table 22).

Table 17. *Pile Driving Scenarios: modelled maximum–over–depth per–strike SPL isopleths*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the pile for each hammer and for each penetration depth.

SPL (Lp; dB re 1 µPa)	M□n□□ile □ith MHU 500T hammer						M□n□□ile □ith IHC 800S hammer					
	Penetration depth (m)						Penetration depth (m)					
	33.5		68.0		102.5		33.5		68.0		102.5	
	$R_{□a□}$ (km)	$R_{95\%}$ (km)	$R_{□a□}$ (km)	$R_{95\%}$ (km)	$R_{□a□}$ (km)	$R_{95\%}$ (km)	$R_{□a□}$ (km)	$R_{95\%}$ (km)	$R_{□a□}$ (km)	$R_{95\%}$ (km)	$R_{□a□}$ (km)	$R_{95\%}$ (km)
200	0.03	0.03	0.03	0.03	0.06	0.06	–	–	–	–	0.02	0.02
190	0.31	0.29	0.30	0.28	0.24	0.22	0.28	0.27	0.21	0.21	0.15	0.14
180	2.34	2.16	1.75	1.68	1.25	1.16	1.61	1.34	1.28	1.23	0.72	0.69
175[1]	3.85	3.33	3.43	3.04	2.42	2.13	3.09	2.73	2.40	2.24	1.45	1.37
170	9.86	6.31	6.35	5.46	4.83	4.20	5.82	5.21	4.89	4.27	3.08	2.92
166[2]	11.7	9.64	10.2	8.38	9.95	6.63	9.97	7.92	7.80	6.64	5.26	4.83
160[3]	21.6	16.8	18.8	15.0	16.7	12.0	18.5	13.7	14.7	11.7	10.4	8.76
150	40.6	31.9	37.1	30.2	34.1	26.5	33.6	27.4	29.3	24.9	25.1	20.8
140	69.4	56.1	63.0	54.2	68.0	53.1	59.1	50.5	56.0	47.5	68.1	50.9
130	>100	/	>100	/	>100	/	>100	/	>100	/	>100	/

[1] Threshold for turtle behavioural disturbance from impulsive noise (McCauley et al. 2000).
[2] Threshold for turtle behavioural response to impulsive noise (McCauley et al. 2000).
[3] Marine mammal behavioural threshold for impulsive sound sources (NOAA 2019).
A slash indicates that $R_{95\%}$ radius to threshold is not reported when the R_{max} was greater than the modelling extent (100 km).

Table 18. *Pile Driving Scenarios: modelled maximum–over–depth per–strike SEL isopleths*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the pile for each hammer and for each penetration depth.

Per–strike SEL (L_E; dB re 1 µPa²·s)	MHU 500T						IHC 800S					
	Penetration depth (m)						Penetration depth (m)					
	33.5		68.0		102.5		33.5		68.0		102.5	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
190	0.03	0.03	0.03	0.03	0.07	0.07	0.02	0.02	0.02	0.02	0.06	0.06
180	0.72	0.70	0.36	0.34	0.26	0.26	0.29	0.28	0.22	0.22	0.17	0.16
170	2.42	2.26	2.21	1.78	1.31	1.24	1.81	1.73	1.35	1.29	0.76	0.74
160	10.1	7.92	9.91	7.19	6.70	5.53	9.83	6.80	6.45	5.84	4.39	4.02
150	26.1	22.1	24.1	21.0	21.4	18.3	22.2	19.9	20.1	18.0	16.6	14.3
140	53.5	45.0	51.5	43.8	46.1	40.5	48.4	40.9	44.5	38.6	39.5	33.9
130	98.6	79.3	96.3	79.2	92.1	76.3	89.8	74.2	87.2	72.7	79.3	68.3

Table 19. *Pile Driving Scenarios, MHU 500T hammer*: Maximum (R_{max}) horizontal distances (in km) from the piling location to modelled maximum-over-depth peak pressure level (PK) thresholds based on Southall et al. (2019) for marine mammals, and Popper et al. (2014) for fish and Finneran et al. (2017) for sea turtles.

Hearing group	PK threshold (L_{pk}; dB re 1 µPa)	MHU 500T hammer		
		Penetration Depth (m)		
		33.5	68.0	102.5
		R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS				
LF cetaceans	219	0.03	0.03	0.06
HF cetaceans	230	–	–	–
VHF cetaceans	202	1.33	1.26	0.73
Sirenians	226	–	–	–
Sea turtles	232	–	–	–
TTS				
LF cetaceans	213	0.23	0.18	0.13
HF cetaceans	224	–	–	–
VHF cetaceans	196	3.21	2.37	1.78
Sirenians	220	0.03	0.03	0.02
Sea turtles	226	–	–	–
Fish				
Fish I (also applied to sharks)	213	0.23	0.18	0.13
Fish II, III Fish eggs, and larvae	207	0.70	0.44	0.32

Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.
A dash indicates the threshold is not reached within the limits of the modelling resolution (20 m).

Table 20. *Pile Driving Scenarios, IHC 800S hammer*: Maximum (R_{max}) horizontal distances (in km) from the piling location to modelled maximum-over-depth peak pressure level (PK) thresholds based on Southall et al. (2019) for marine mammals, and Popper et al. (2014) for fish and Finneran et al. (2017) for sea turtles.

Hearing group	PK threshold (L_{pk}; dB re 1 µPa)	IHC 800S hammer		
		Penetration Depth (m)		
		33.5	68.0	102.5
		R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS				
LF cetaceans	219	–	–	–
HF cetaceans	230	–	–	–
VHF cetaceans	202	0.76	0.68	0.31
Sirenians	226	–	–	–
Sea turtles	232	–	–	–
TTS				
LF cetaceans	213	0.07	0.13	0.09
HF cetaceans	224	–	–	–
VHF cetaceans	196	1.82	1.32	0.99
Sirenians	220	–	–	–
Sea turtles	226	–	–	–
Fish				
Fish I (also applied to sharks)	213	0.07	0.13	0.09
Fish II, III Fish eggs, and larvae	207	0.29	0.22	0.16

Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.
A dash indicates the threshold is not reached within the limits of the modelling resolution (20 m).

Table 21. *Pile Driving Scenarios:* Maximum-over-depth distances (in km) to frequency-weighted 24 h sound exposure level (SEL_{24h}) based PTS and TTS for marine mammals (Southall et al. 2019) and sea turtles (Finneran et al. 2017) considering the driving of the entire pile.

Fauna group	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	MHU 500T		IHC 800S	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS					
LF cetaceans	183	35.6	2137	19.1	797
HF cetaceans	185	0.12	0.04	–	–
VHF cetaceans	155	6.40	60.3	1.20	1.66
Sirenians	190	0.13	0.05	–	–
Sea turtles	204	4.92	57.7	2.24	11.6
TTS					
LF cetaceans	168	98.1	12992	61.1	5577
HF cetaceans	170	2.30	7.02	0.13	0.06
VHF cetaceans	140	21.6	754	6.46	69.7
Sirenians	175	2.40	9.25	0.15	0.07
Sea turtles	189	26.2	1320	16.6	589

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 22. *Pile Driving Scenarios*: Distances to 24 h sound exposure level (SEL_{24h}) based fish criteria in the water column.

Marine fauna group	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	MHU 500T		IHC 800S	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
Mortality and potential mortal injury					
Fish I	219	0.70	0.80	0.21	0.14
Fish II, fish eggs and fish larvae	210	2.37	11.6	1.15	2.12
Fish III	207	3.47	29.2	1.38	5.83
Recoverable injury					
Fish I	216	0.78	1.87	0.26	0.21
Fish II, III	203	6.40	91.0	2.55	18.4
Temporary threshold shift (TTS)					
Fish I, II, III	186	35.1	2163	23.5	1125

Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.

4.1.3. Sound field figures

Maps of the per strike sound fields are presented as maximum-over-depth sound level contour maps in Figures 13–18 and as vertical slice plots in Figures 19–30 for selected azimuths. Accumulated SEL_{24h} maps are shown in Figures 31–34 for marine mammals, sea turtles, and fish.

4.1.3.1. SPL Sound level contour maps

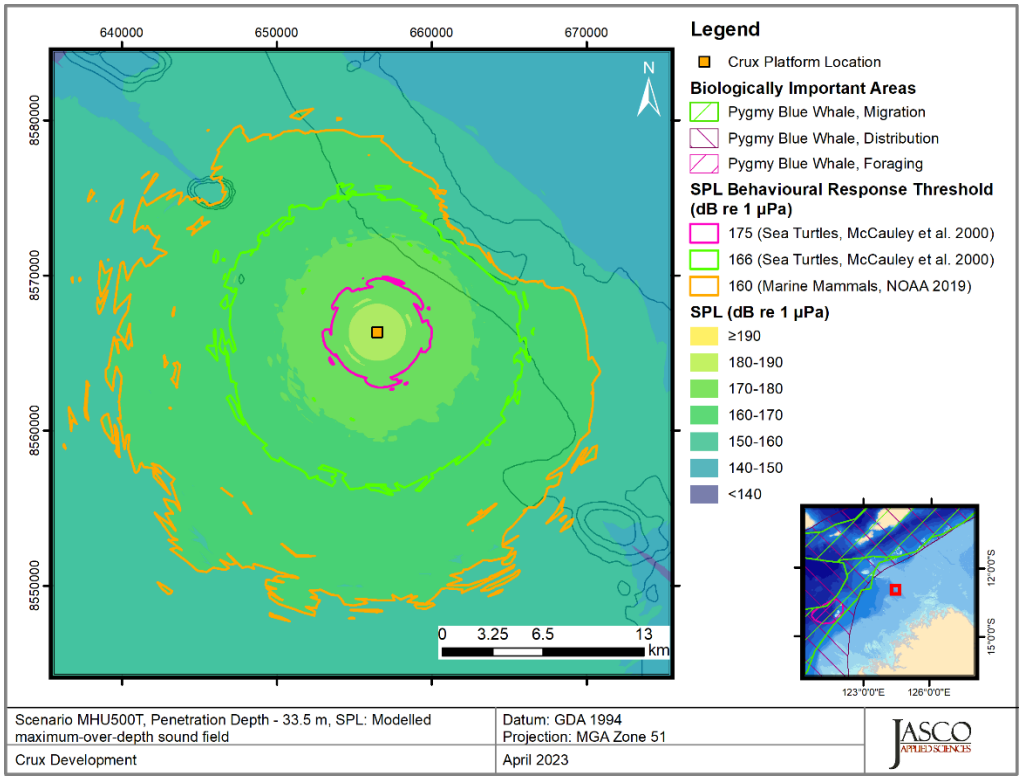

Figure 13. MHU 500T, *Pile penetration depth* – 33.5 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

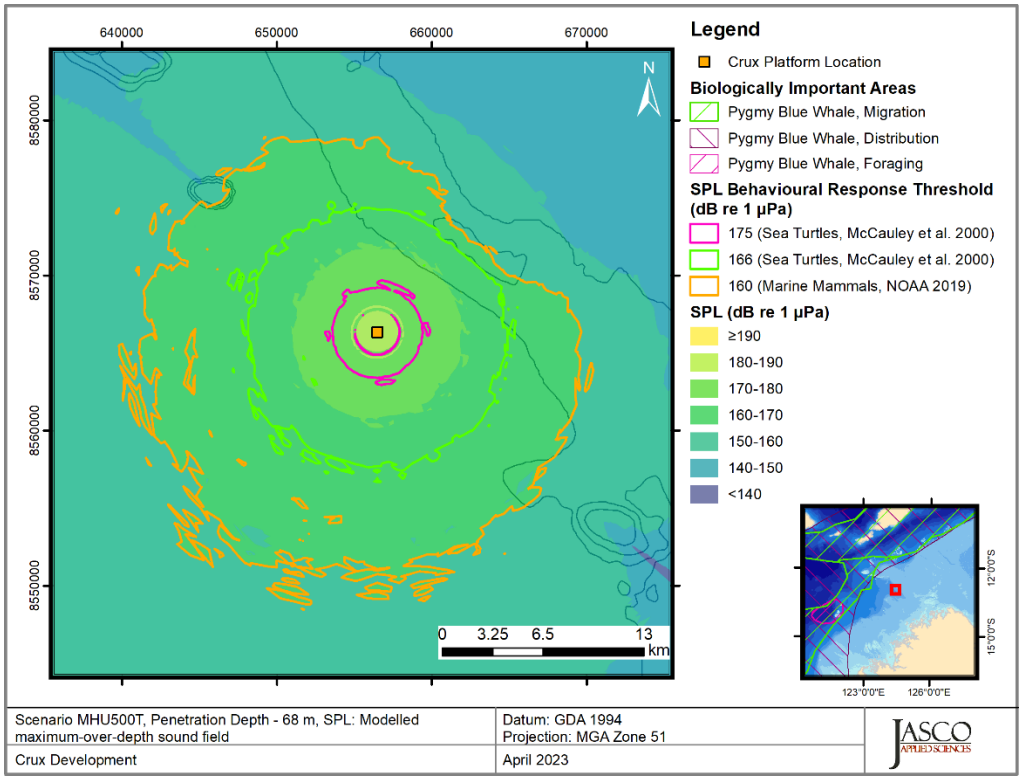

Figure 14. MHU 500T, *Pile penetration depth* – 68.0 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

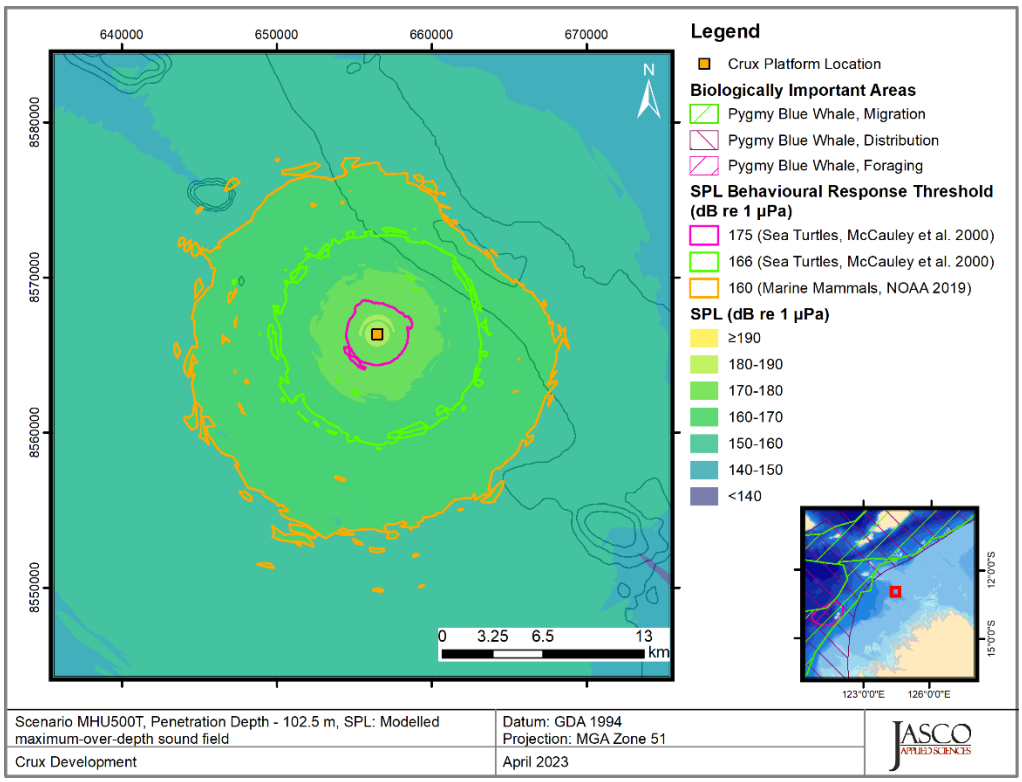

Figure 15. MHU 500T, *Pile penetration depth* – 102.5 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

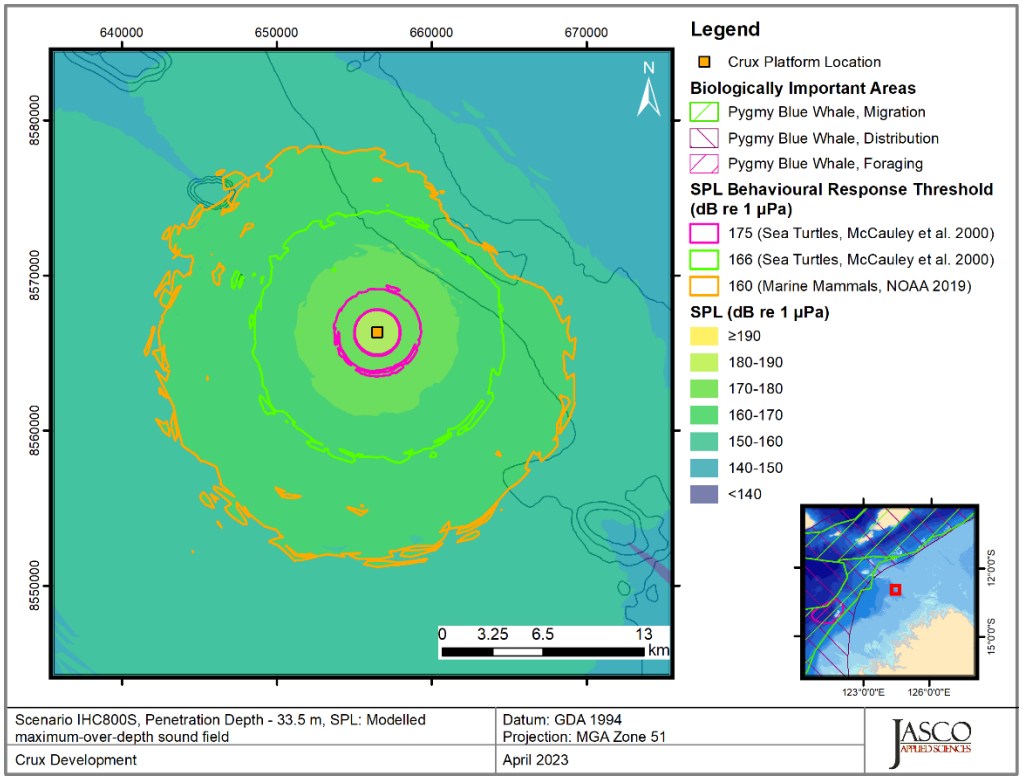

Figure 16. IHC 800S, *Pile penetration depth* – 33.5 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

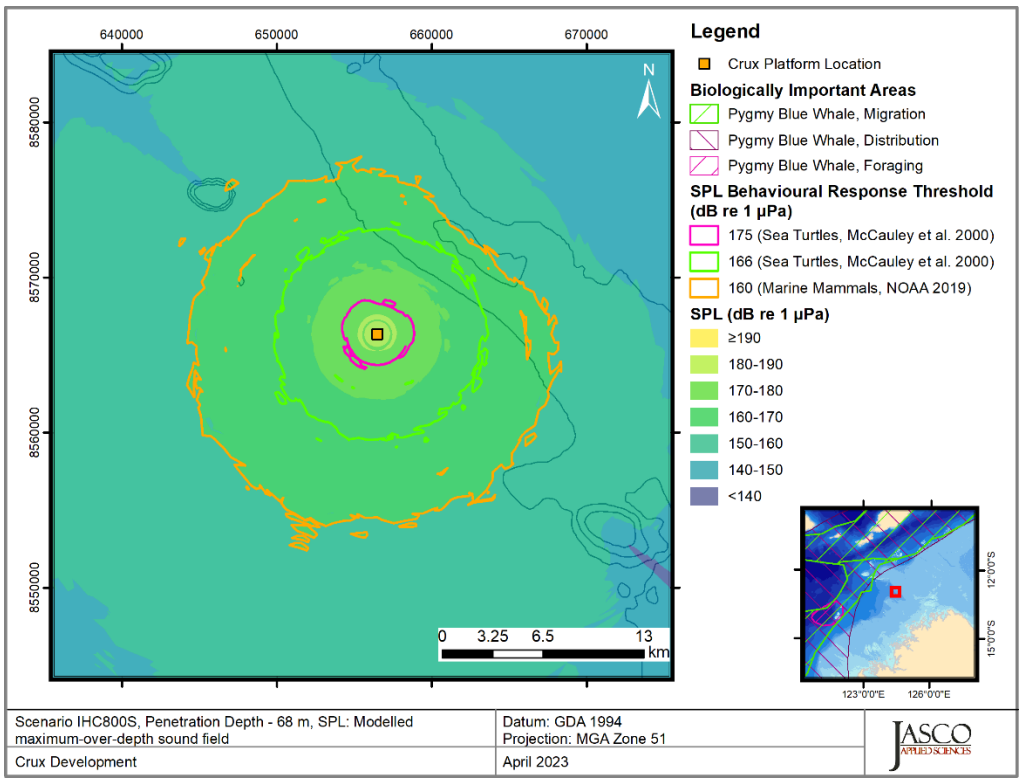

Figure 17. IHC 800S, *Pile penetration depth* – 68.0 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

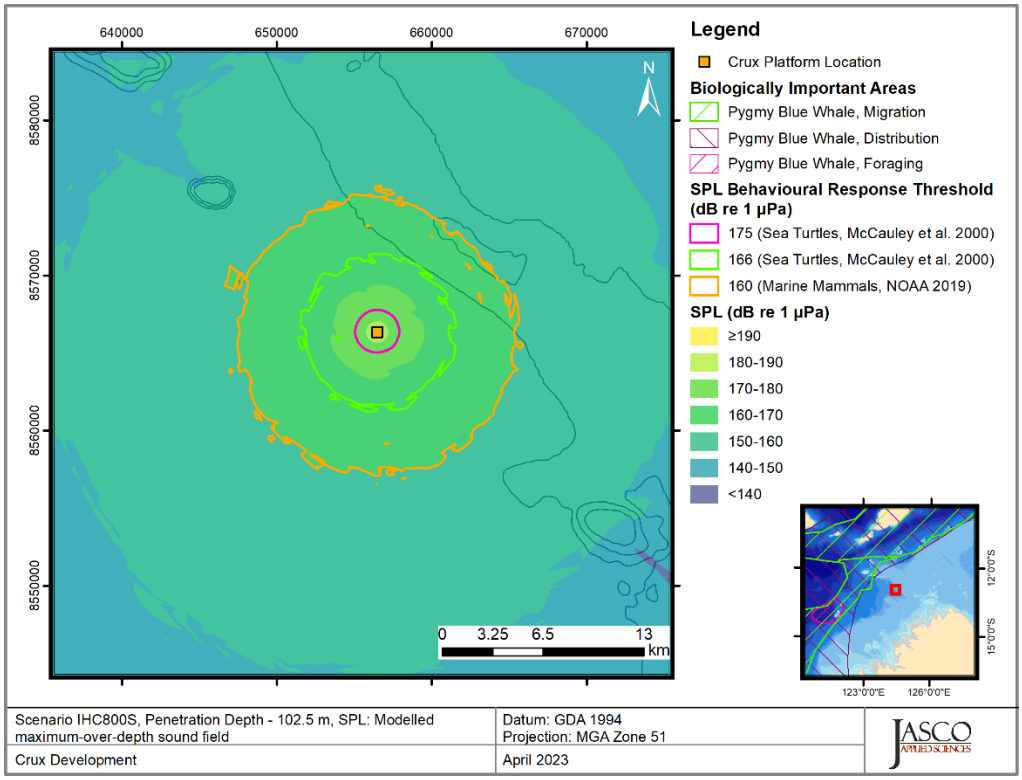

Figure 18. IHC 800S, *Pile penetration depth* – 102.5 m, SPL: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

4.1.3.2. SPL Per-strike Vertical Slice Plots

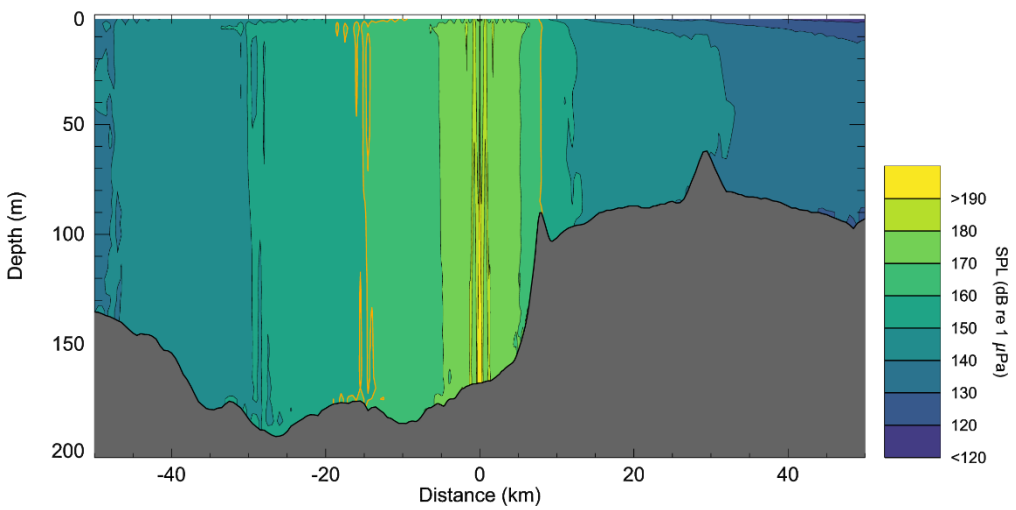

Figure 19. MHU 500T, *Pile penetration depth* – 33.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

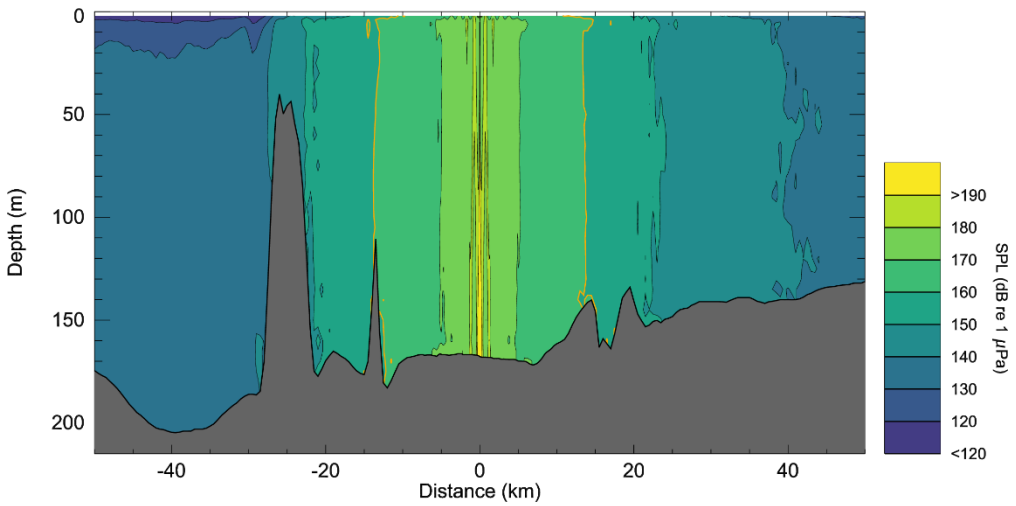

Figure 20. MHU 500T, *Pile penetration depth* – 33.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

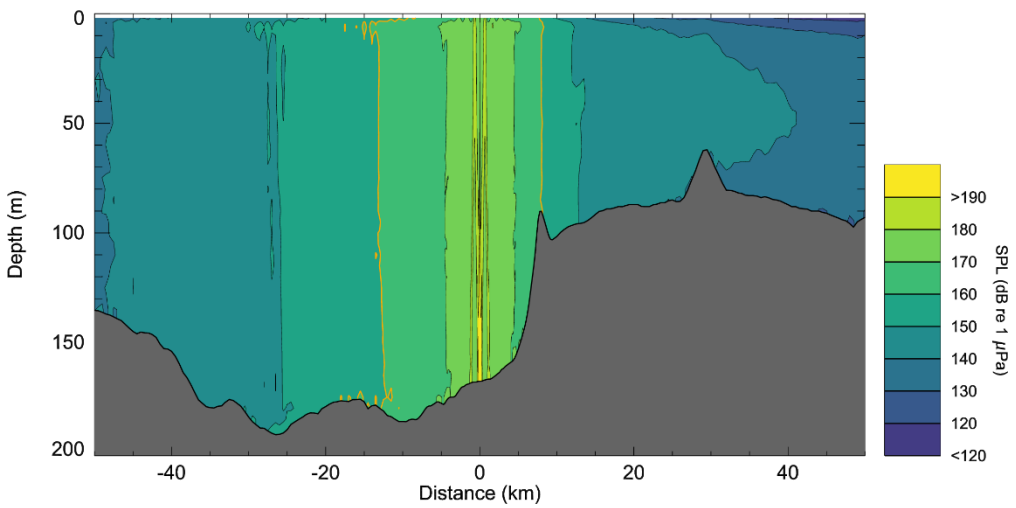

Figure 21. MHU 500T, *Pile penetration depth* – 68.0 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

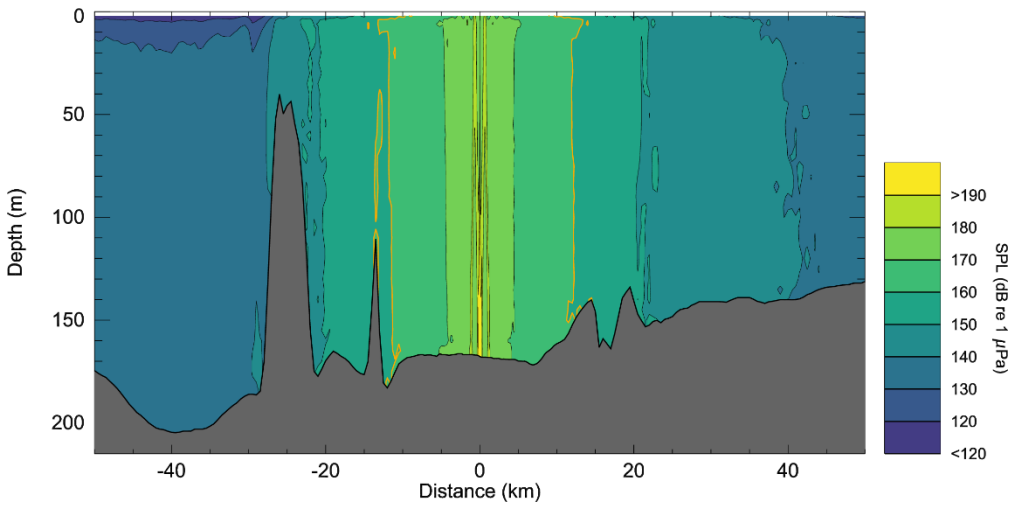

Figure 22. MHU 500T, *Pile penetration depth* – 68.0 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

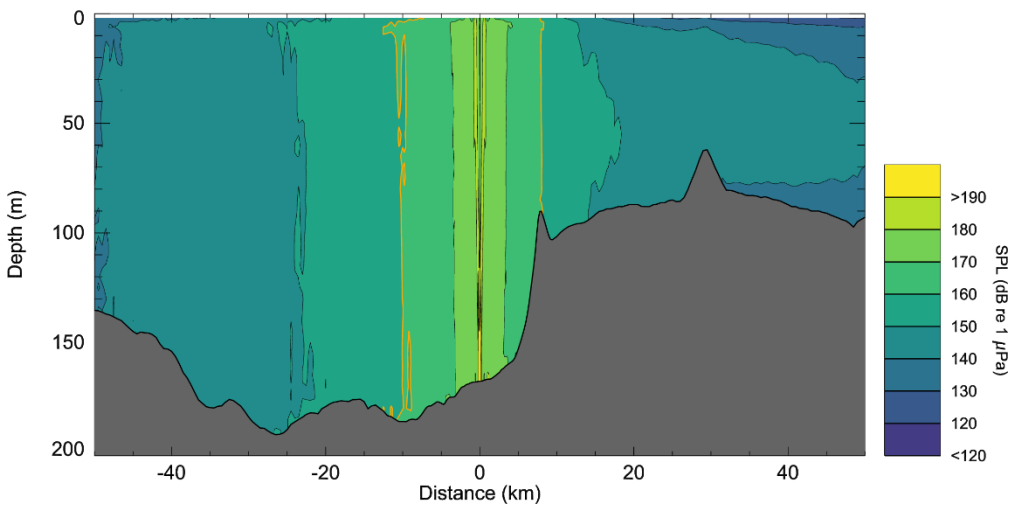

Figure 23. MHU 500T, *Pile penetration depth* – 102.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

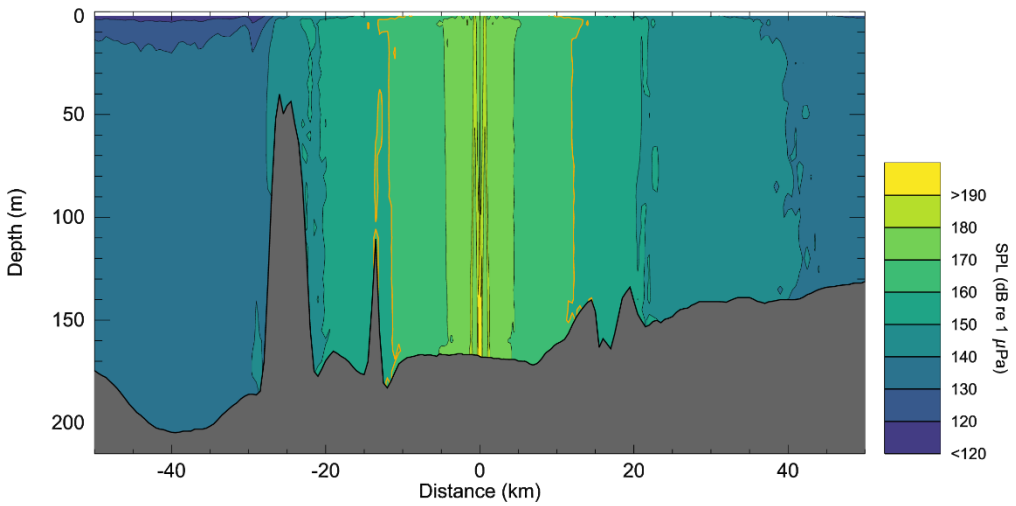

Figure 24. MHU 500T, *Pile penetration depth* – 102.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

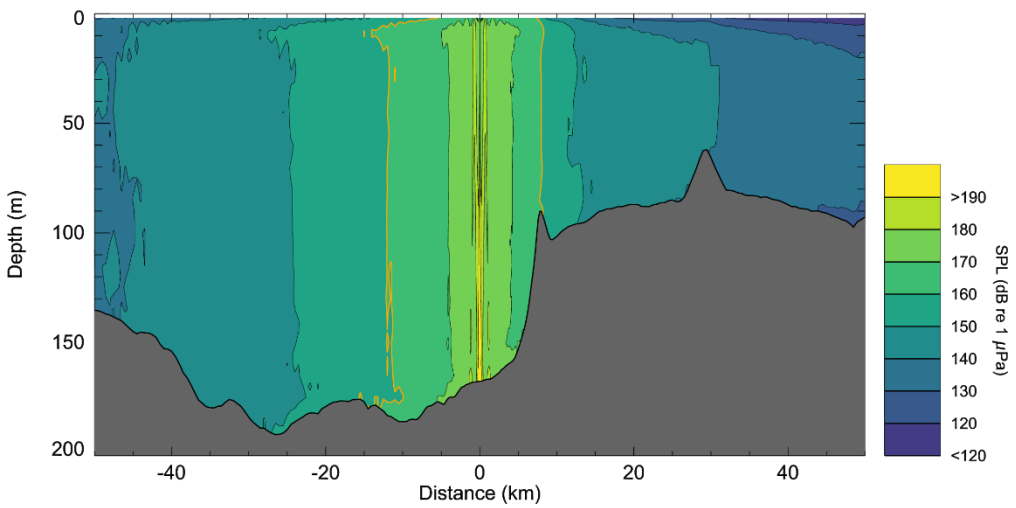

Figure 25. IHC 800S, *Pile penetration depth* – 33.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

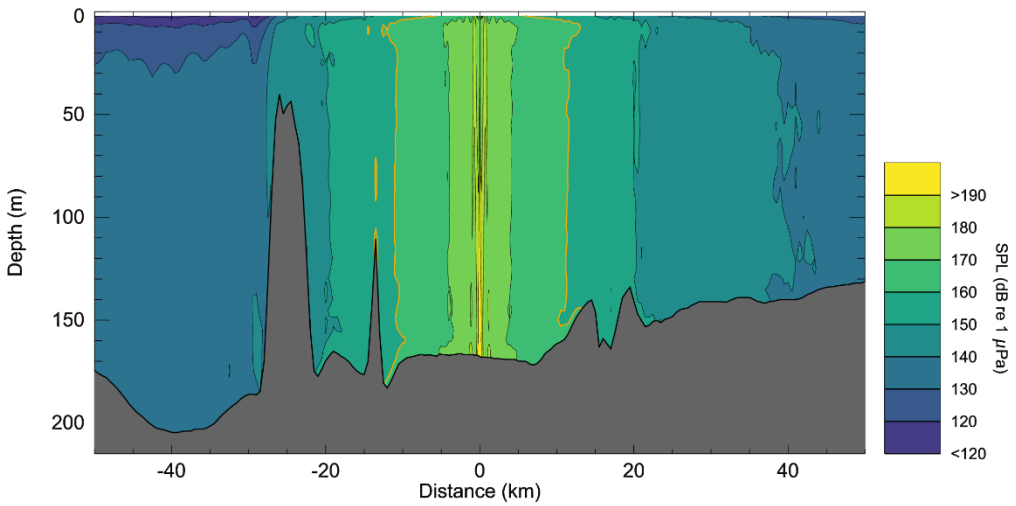

Figure 26. IHC 800S, *Pile penetration depth* – 33.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

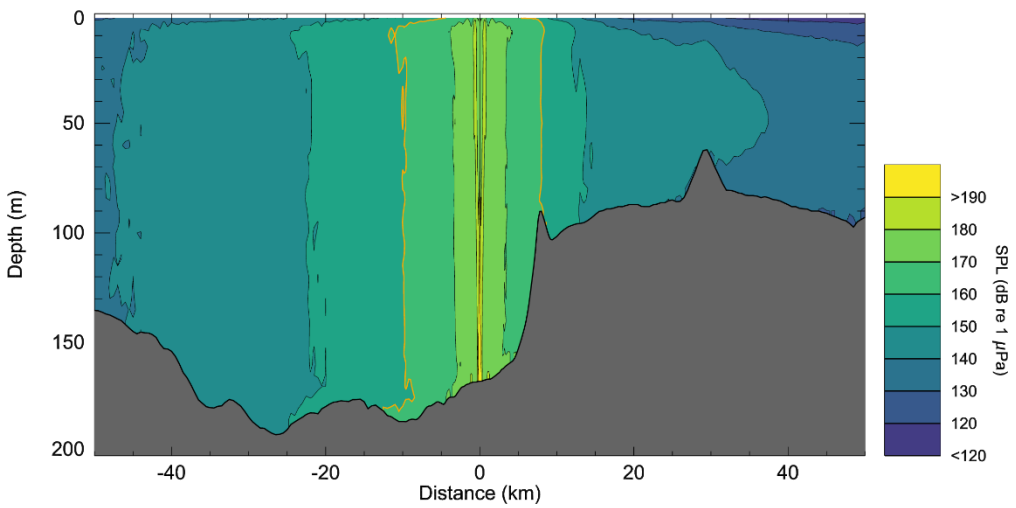

Figure 27. IHC 800S, *Pile penetration depth* – 68.0 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

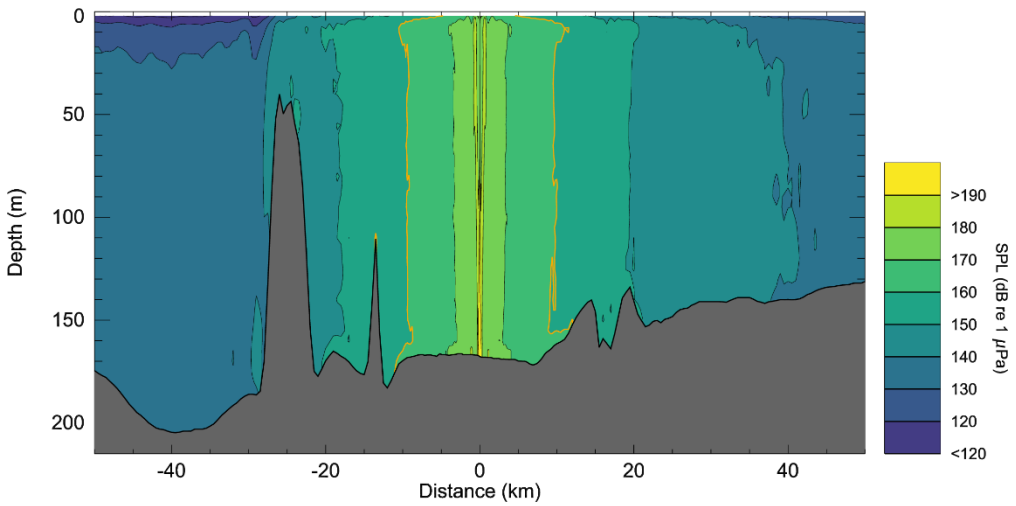

Figure 28. IHC 800S, *Pile penetration depth* – 68.0 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

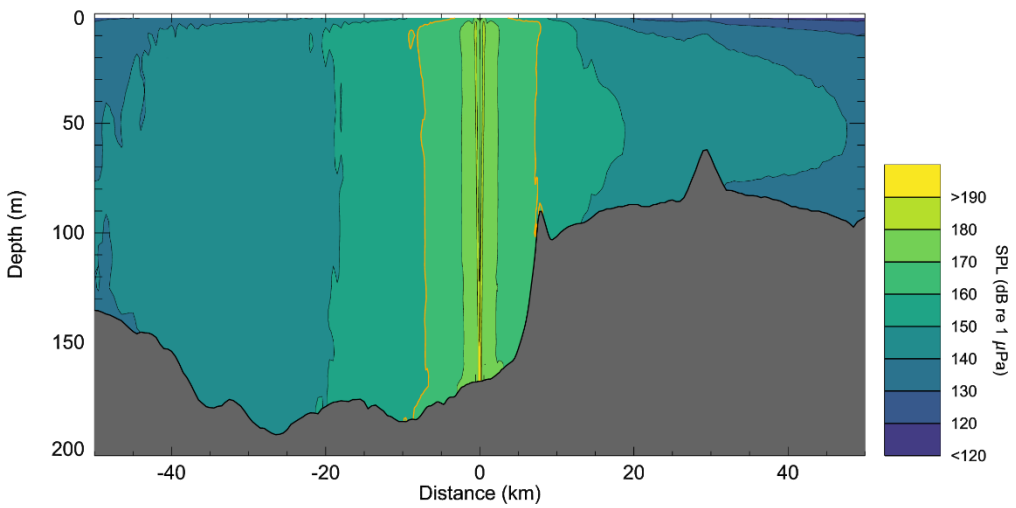

Figure 29. IHC 800S, *Pile penetration depth* – 102.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 45°/225° transect.

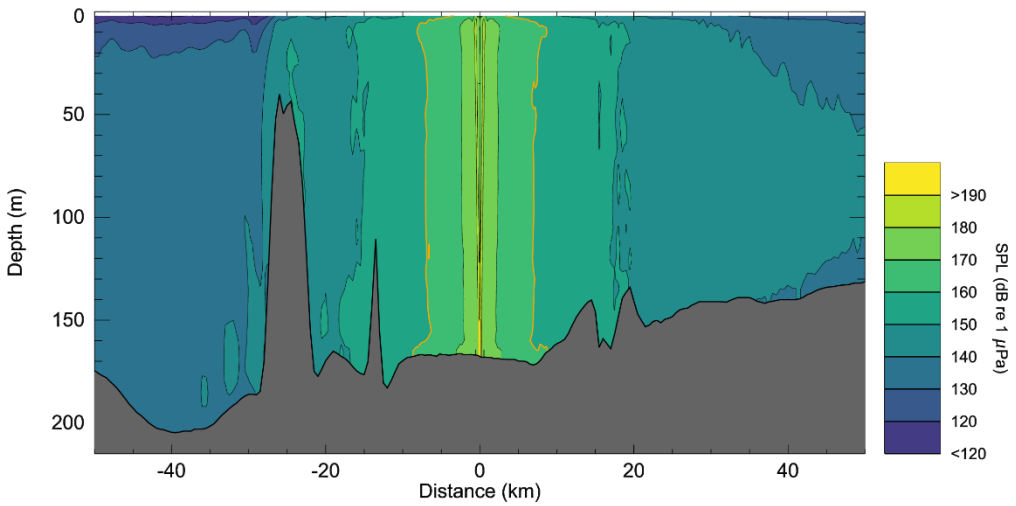

Figure 30. IHC 800S, *Pile penetration depth* – 102.5 m, SPL: Vertical slice plot showing variations with depth and distance from the pile for the third penetration depth, with the isopleth for marine mammal behavioural response threshold highlighted in orange. The seabed is shown as dark grey, and cross sections are along the 135°/315° transect.

4.1.3.3. Accumulated SEL_{24h} Sound level contour maps

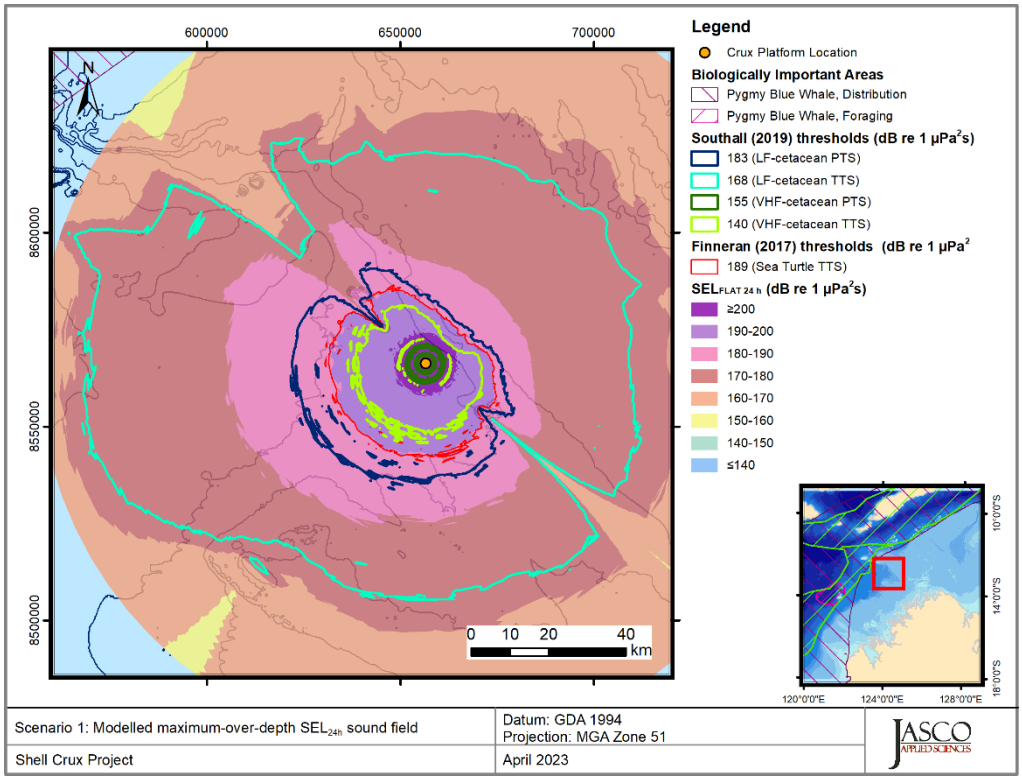

Figure 31. MHU 500T, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for marine mammals and sea turtles. Thresholds omitted here were not reached or not large enough to display graphically. Refer to Table 21 for threshold distances.

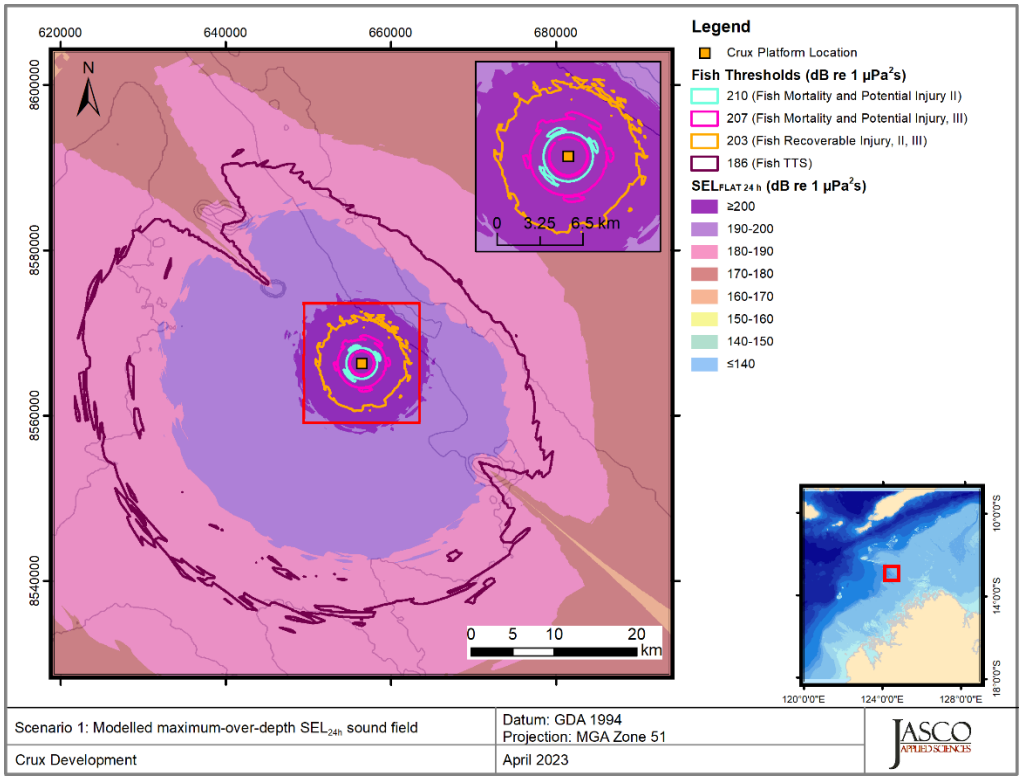

Figure 32. MHU 500T, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths relevant to fish injury and TTS. Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing. Refer to Table 22 for threshold distances.

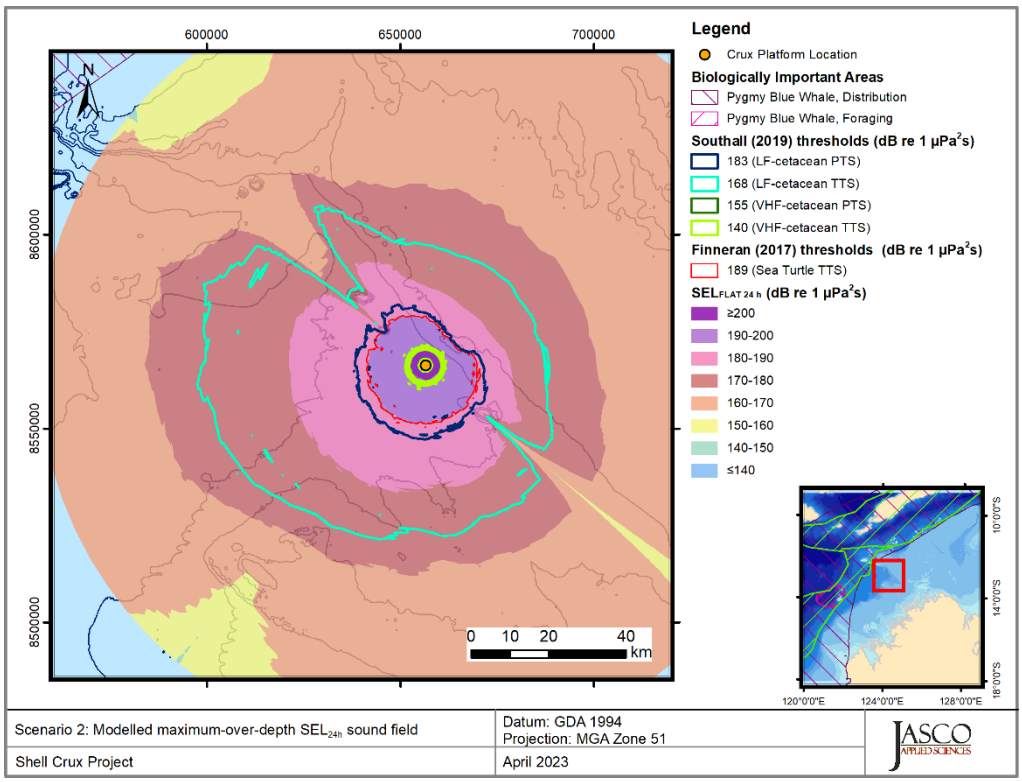

Figure 33. IHC 800S, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for marine mammals and sea turtles. Thresholds omitted here were not reached or not large enough to display graphically. Refer to Table 21 for threshold distances.

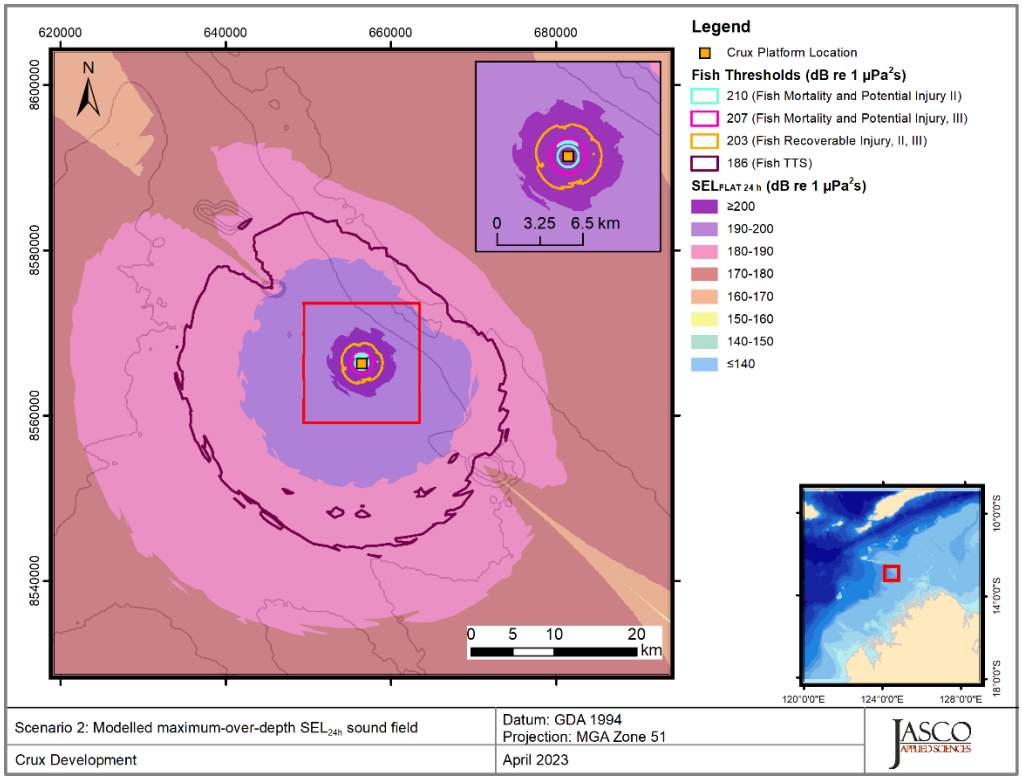

Figure 34. IHC 800S, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths relevant to fish injury and TTS. Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing. Refer to Table 22 for threshold distances.

4.1.4. Animal Movement Exposure Ranges

A summary of radial distances to exposure thresholds for migrating pygmy blue whales, along with probability of exposure are included below. Results include $ER_{95\%}$ exposure ranges calculated for the 160 dB re 1 µPa behavioural response threshold and SEL_{24h} thresholds for both TTS and PTS, and the probability of an animat being exposed above the threshold within the $ER_{95\%}$.

Exposure ranges for TTS and PTS PK thresholds were not included in the exposure analysis since acoustic modelling predicted ranges of less than 200 m for PTS and TTS PK (Tables 19 and 20). For the per-pulse PK metric, the exceedance distances are small and close enough to the source such that only minor differences are expected between acoustic and animat exposure predictions.

Table 23. Summary of animat simulation results for pygmy blue whales with animats not restricted to the BIA. The 95th percentile exposures ranges ($ER_{95\%}$) in km and probability of animats being exposed above threshold within the $ER_{95\%}$ (P_{exp} (%)) are provided. Dashes indicate no animats were exposed above threshold.

Threshold	Pygmy blue whales, southbound migration			
	MHU 500T		IHC 800S	
Description	$R_{95\%}$ (km)	P_{exp} (%)	$R_{95\%}$ (km)	P_{exp} (%)
PTS (SEL_{24h})[1]	19.8	75	9.10	73
TTS (SEL_{24h})[2]	56.4	58	33.8	70
Behavioural response (SPL)[3]	18.0	72	13.7	77

[1] LF-weighted SEL_{24h} (183 dB re 1 µPa²·s) (Southall et al.)
[2] LF-weighted SEL_{24h} (168 dB re 1 µPa²·s) (Southall et al.)
[3] SPL (160 dB re 1 µPa) (NOAA (2019))

Figures 35 and 36 show histograms of CPA ranges to SEL_{24h} PTS, TTS, and the behavioural response threshold for both pile driving scenarios, with results in Table 23.

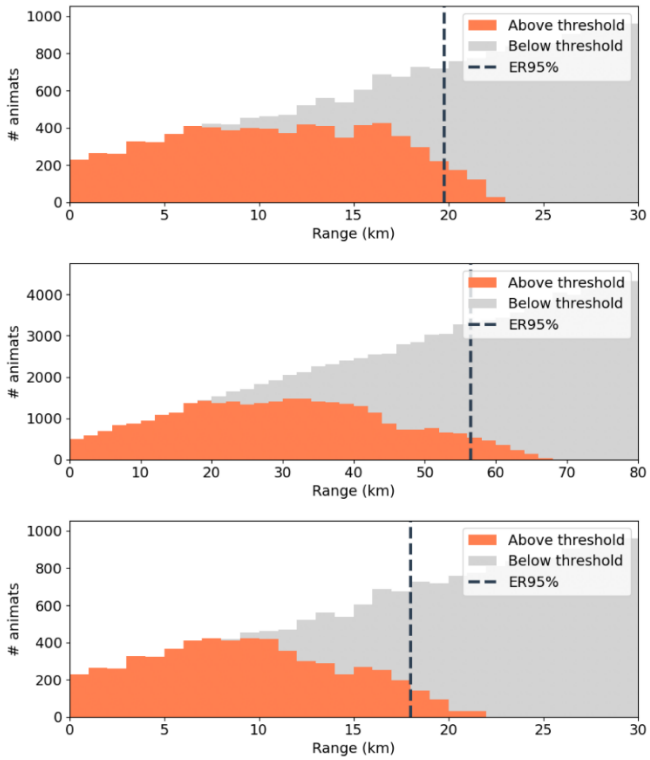

Figure 35. *MHU 500T, South-bound migrating animats, unrestricted seeding*: CPA range histogram for animats, SEL_{24h} PTS threshold (top panel), SEL_{24h} TTS threshold (middle panel, please note the adjusted maximum range on the x-axis), SPL behavioural threshold (bottom panel). Bar colours indicate whether the animats exceeded the threshold.

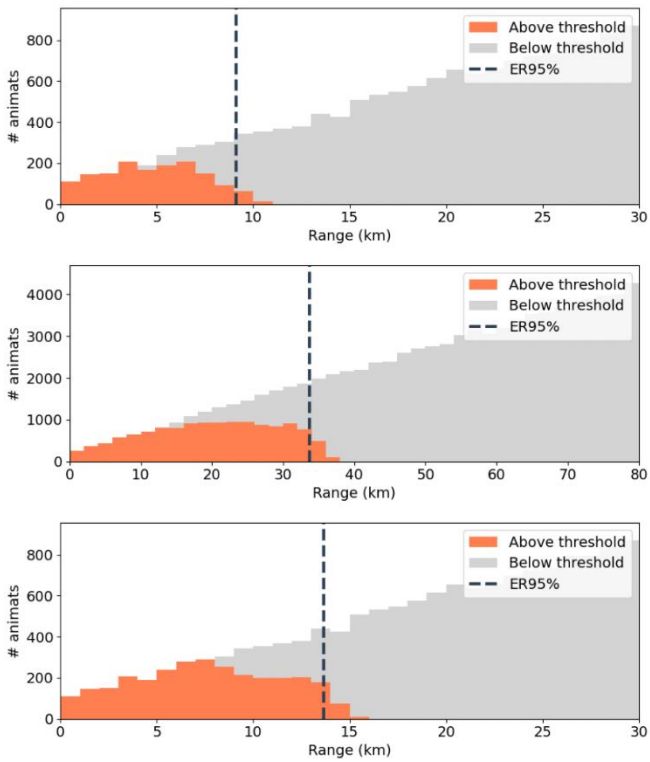

Figure 36. *IHC 800S, South-bound migrating animats, unrestricted seeding*: CPA range histogram for animats, SEL_{24h} PTS threshold (top panel), SEL_{24h} TTS threshold (middle panel, please note the adjusted maximum range on the x-axis), SPL behavioural threshold (bottom panel). Bar colours indicate whether the animats exceeded the threshold.

4.2. Vessel Operations

The maximum-over-depth sound fields for the modelled vessel scenarios are presented below in two formats: as tables of distances to sound levels (Section 4.2.1) and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels (Section 4.2.2).

For the results below, the distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely envelopes multiple sources, the centroid was used. When several closed isopleths exist, the most dominant source was used.

4.2.1. Tabulated Results

Table 24 presents the maximum and 95% distances (defined in Appendix D.1) to SPL isopleths and thresholds for all scenarios (Tables 7 and 9). Table 25 presents the maximum distances to frequency weighted SEL_{24h} thresholds, as well as total ensonified area.

Table 24. *Vessel scenarios*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL). A dash indicates the threshold is not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 9.

SPL ($L_{\square}$; dB re 1 µPa)	Vessel 1: *DLV 2000*		Vessel 2: *TDW Pacific Centurion*		Vessel 3: *Posh Antares*		Scenario 1: ll Vessels	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	0.04	0.04
170[a]	0.02	0.02	–	–	–	–	0.08	0.08
160	0.06	0.06	0.05	0.05	0.03	0.03	0.19	0.16
158[b]	0.08	0.08	0.05	0.05	0.03	0.03	0.2	0.18
150	0.22	0.22	0.14	0.14	0.09	0.09	0.61	0.58
140	1.37	1.31	0.82	0.79	0.56	0.54	2.91	2.69
130	8.32	7.38	4.65	4.12	2.51	2.29	14.1	12.7
120[c]	28.4	25.8	19.1	17.2	11.4	10.5	43.1	38.7
110	80.4	67.8	55.6	48.6	36.2	32.6	>100	\

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019).
A slash indicates that $R_{95\%}$ is not reported when the R_{max} is greater than the maximum modelling extent.

Table 25. *Vessel Scenarios:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km²). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 9.

Hearing group	Frequency-weighted SEL24h threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Vessel 1: *DLV 2000*		Vessel 2: *TDW Pacific Centurion*		Vessel 3: *Posh Antares*		Scenario 1: All Vessels	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS									
LF cetaceans	199	0.19	0.11	0.12	0.05	0.09	0.02	0.46	0.43
HF cetaceans	198	–	–	–	–	–	–	0.06	/
VHF cetaceans	173	0.12	0.05	0.07	0.02	0.06	0.01	0.31	0.16
Sirenians	206	–	–	–	–	–	–	0.06	/
Sea Turtles	220	–	–	–	–	–	–	0.06	/
TTS									
LF cetaceans	179	6.94	130	3.85	40.0	2.19	13.0	13.0	421
HF cetaceans	178	0.10	0.03	0.06	0.01	0.05	0.01	0.27	0.11
VHF cetaceans	153	1.83	10.3	1.28	5.11	1.11	3.32	3.20	30.6
Sirenians	186	0.08	0.02	0.05	0.01	0.03	/	0.25	0.08
Sea Turtles	200	0.15	0.07	0.09	0.03	0.06	0.01	0.39	0.27

A slash indicates that the area is less than an area associated with the modelled resolution (0.0013 km²).

4.2.2. Sound field maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields are presented in Figures 37–40 and Figure 41, respectively.

4.2.2.1. SPL Sound level contour maps

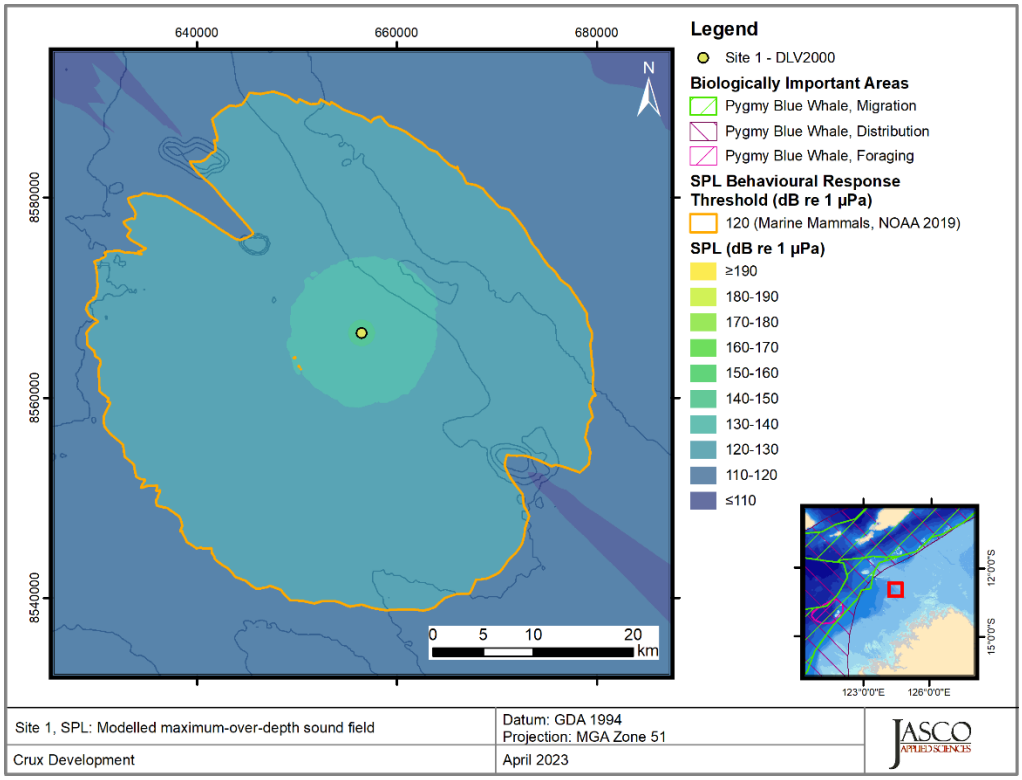

Figure 37. *Site 1, Construction vessel, DLV 2000 under DP in isolation, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleth for behavioural response threshold for marine mammals.

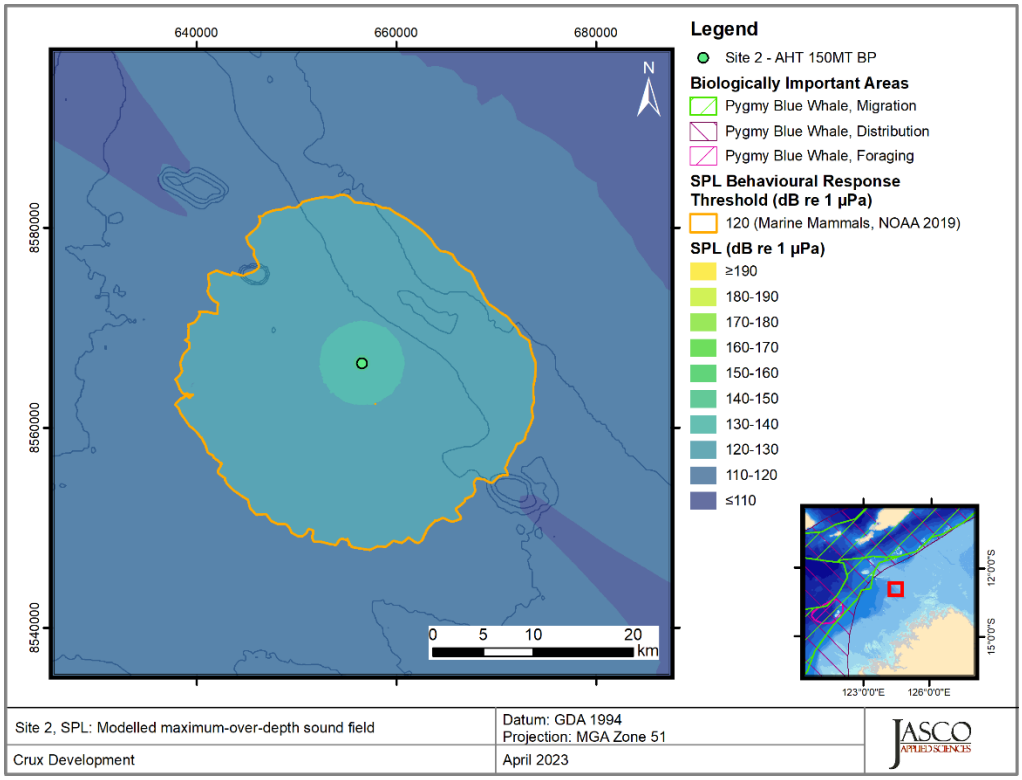

Figure 38. *Site 2, AHT with 150 MT BP in isolation, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

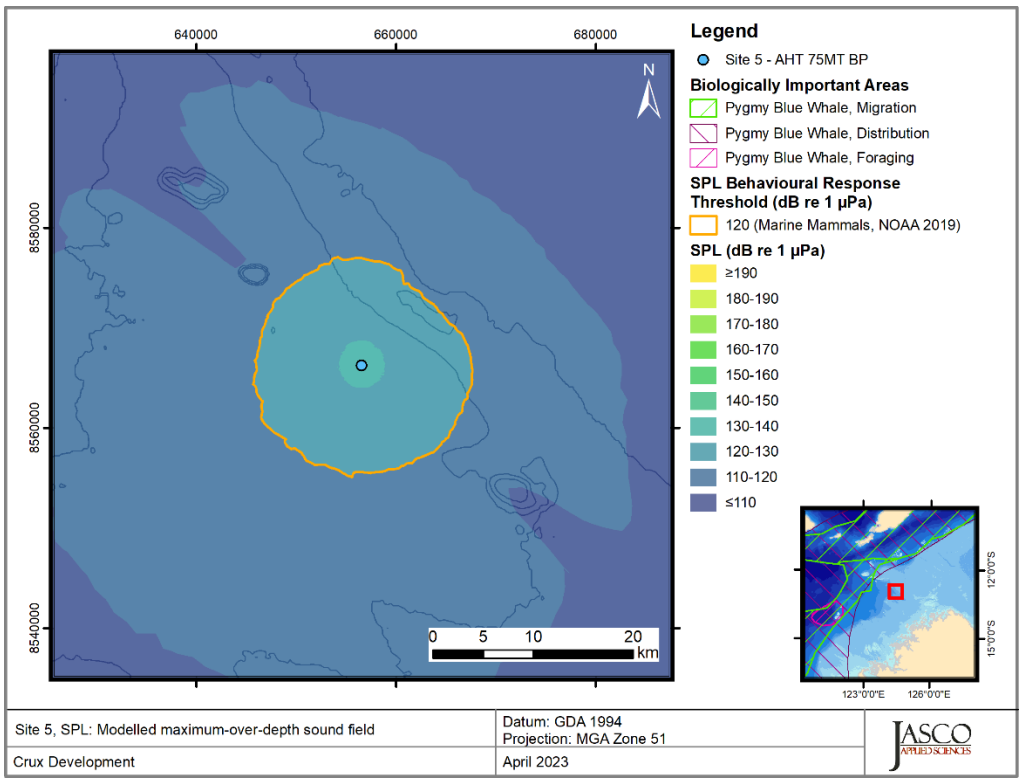

Figure 39. *Site 5, AHT with 75 MT BP in isolation, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

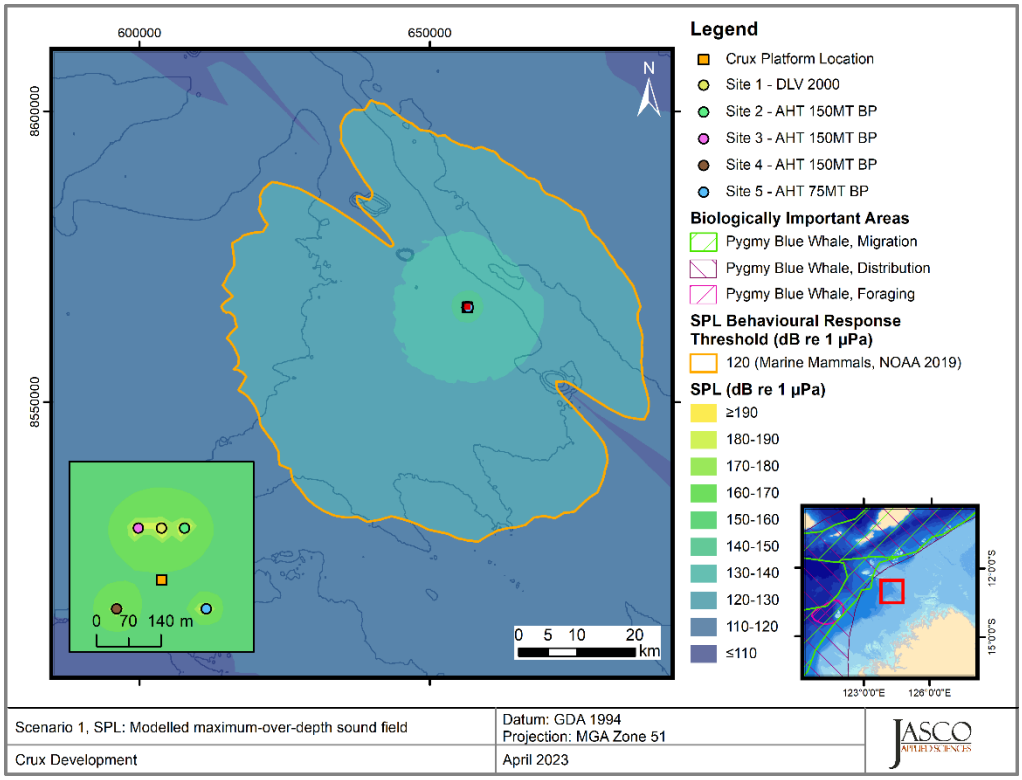

Figure 40. *Scenario 1, all vessels, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural thresholds for marine mammals and sea turtles.

4.2.2.2. Accumulated SEL_{24h} Sound Level Contour Maps

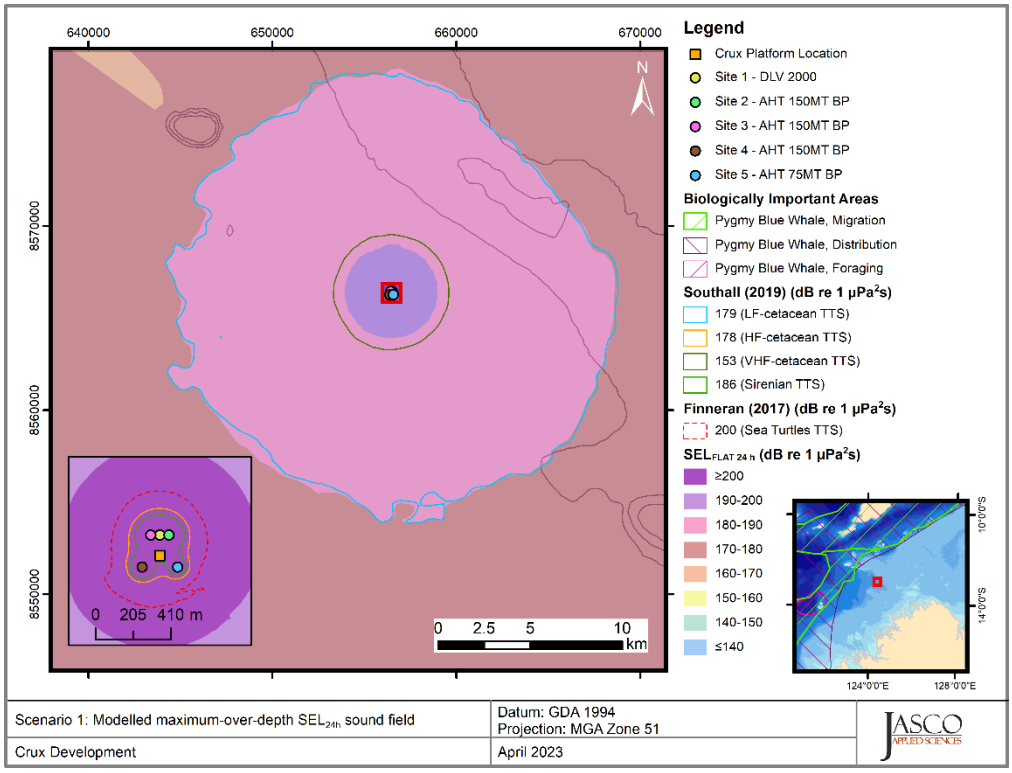

Figure 41. *Scenario 1*, *all vessels:* sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for cetaceans and sea turtles. Thresholds omitted here were not reached or not large enough to display graphically. Refer to Table 25 for threshold distances.

4.2.3. Animal Movement Exposure Ranges

A summary of radial distances to exposure thresholds for migrating pygmy blue whales, along with probability of exposure are included below. Results include $ER_{95\%}$ exposure ranges calculated for the 120 dB re 1 µPa behavioural response threshold and SEL_{24h} thresholds for both TTS and PTS, and the probability of an animat being exposed above the threshold within the $ER_{95\%}$.

Table 26. Summary of animat simulation results for pygmy blue whales with animats not restricted to the BIA. The 95th percentile exposures ranges ($ER_{95\%}$) in km and probability of animats being exposed above threshold within the $ER_{95\%}$ (P_{exp} (%)) are provided. Dashes indicate no animats were exposed above threshold.

Threshold	Pygmy blue whales, southbound migration	
	Scenario 3	
Description	$R_{95\%}$ (km)	P_{exp} (%)
PTS (SEL_{24h})[1]	<0.01	30
TTS (SEL_{24h})[2]	0.19	79
Behavioural response (SPL)[3]	36.8	93

[1] LF-weighted SEL_{24h} (199 dB re 1 µPa²·s) (Southall et al.)
[2] LF-weighted SEL_{24h} (179 dB re 1 µPa²·s) (Southall et al.)
[3] SPL (120 dB re 1 µPa) (NOAA (2019))

Figure 42 shows histograms of CPA ranges to SEL_{24h} PTS, TTS, and the behavioural response threshold for Scenario 3, with results in Table 26.

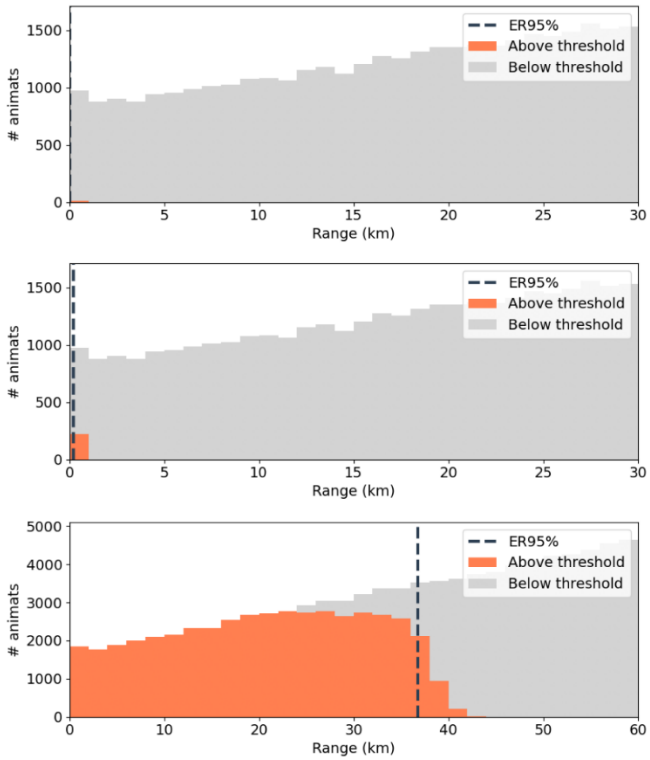

Figure 42. *All vessels, South-bound migrating animats, unrestricted seeding*: CPA range histogram for animats, SEL_{24h} PTS threshold (top panel), SEL_{24h} TTS threshold (middle panel), SPL behavioural threshold (bottom panel, please note the adjusted maximum range on the x-axis). Bar colours indicate whether the animats exceeded the threshold.

4.3. Drilling Operations

The maximum-over-depth sound fields for the modelled drilling scenarios are presented below in two formats: as tables of distances to sound levels (Section 4.3.1) and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels (Section 4.3.2).

4.3.1. Tabulated Results

Table 27 presents the maximum and 95% distances (defined in Appendix D.1) to SPL isopleths and thresholds for all scenarios (Tables 7 and 9). Table 28 presents the maximum distances to frequency weighted SEL_{24h} thresholds, as well as total ensonified area.

Table 27. *Drilling scenario (DTH)*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL). A dash indicates the threshold is not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 9.

SPL (L□; dB re 1 µPa)	Drilling Operations	
	R_{max} (km)	$R_{95\%}$ (km)
180	–	–
170[a]	–	–
160	–	–
158[b]	–	–
150	–	–
140	0.03	0.03
130	0.13	0.13
120[c]	0.94	0.90
110	5.61	5.08

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to non-impulsive noise (NOAA 2019).

Table 28. *Drilling Scenario (DTH):* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 9.

Hearing group	Frequency-weighted SEL24h threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Drilling Operations	
		R_{max} (km)	Area (km^2)
PTS			
LF cetaceans	199	–	–
HF cetaceans	198	–	–
VHF cetaceans	173	–	–
Sirenians	206	–	–
Sea Turtles	220	–	–
TTS			
LF cetaceans	179	0.06	0.015
HF cetaceans	178	–	–
VHF cetaceans	153	0.03	0.004
Sirenians	186	–	–
Sea Turtles	200	–	–

4.3.2. Sound field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields are presented in Figure 40 and Figure 41, respectively.

4.3.2.1. SPL Sound level contour maps

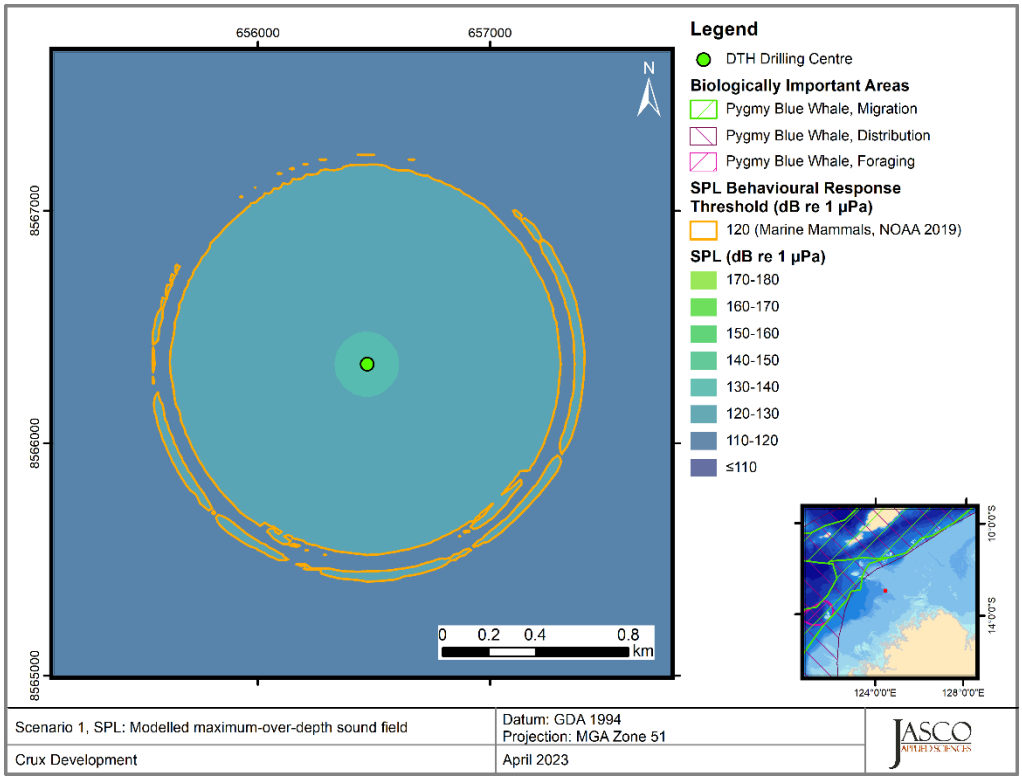

Figure 43. *Scenario 1, DTH pile drilling, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleth for behavioural response threshold for marine mammals.

4.3.2.2. Accumulated SEL_{24h} Sound level contour maps

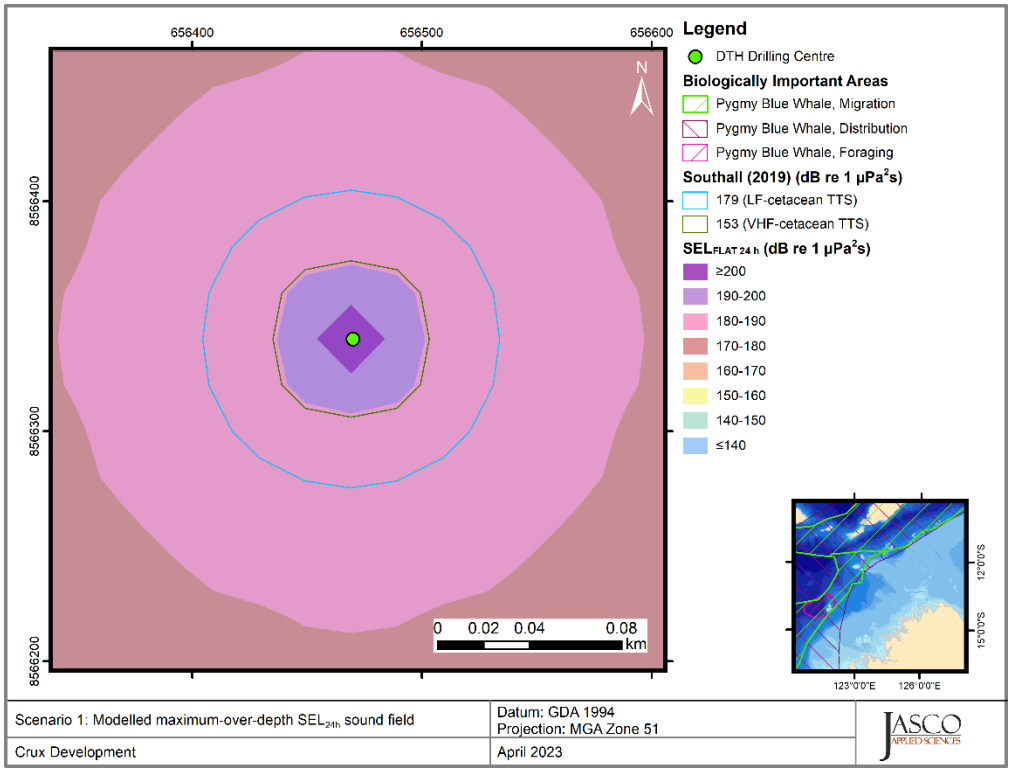

Figure 44. *Scenario 1*, *DTH pile drilling:* sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for cetaceans and sea turtles. Thresholds omitted here were not reached or not large enough to display graphically. Refer to Table 28 for threshold distances.

5. Discussion and Conclusion

The modelling study predicted underwater sound levels associated with key activities for the planned Crux development. The underwater sound field was modelled for a variety of sound sources including pile driving, vessel and drilling operations. An analysis of seasonal sound speed profiles indicates that July is the month most conducive to sound propagation; as such, it selected to as part of a conservative approach to estimate distances to received sound level thresholds (Appendix D.1.2). Modelling also accounted for site-specific bathymetric variations (Appendix D.1.1) and local geoacoustic properties (Appendix D.1.3).

Most acoustic energy from the sound sources considered is output at lower frequencies, in the tens to hundreds of hertz. For pile driving, the sound produced was axially symmetric while vessel and drilling operations was isotropic (although influenced by the presence of the shoals and other bathymetric features).

The sound speed profile was primarily downwards refracting, apart from a moderate surface duct. The profile had a minimum sound speed at approximately 1490 m/s near the deepest areas of the modelled region. The surface duct (found at ≤100 m deep) in the profiles shown in Appendix D.1.2 has a greater influence on shallower sound sources (e.g., vessels) than it does the sub-sea piling activities. Inversely, sound emitted by deeper sources is not subject to the propagation effect of the surface duct, but rather the down-sloping bathymetry in the offshore direction causes the energy to be trapped at deeper depths, in line with the bathymetry.

The modelled scenarios were located in water depths of approximately 165 m. The bathymetry within modelled area varied gradually; however, a few shoals were present. The water depths generally increase to the northwest of the survey area as the continental shelf transitions into a deeper water slope environment. The maximum-over-depth sound footprint maps and vertical slice plots (Sections 4.1.3, 4.2.2, and 4.3.2) assist in demonstrating the influence of the bathymetry, sound speed profile and seabed composition on the sound field. The high reflectivity of the seabed and the increasing slope towards deeper waters lead to longer distances to isopleths towards the northwest.

In some cases, the isopleths had several contours (e.g., the sound field map, Figure 14, and its corresponding vertical slice profile, Figure 22). This can occur as a result of the reflection of the sound field off the seafloor, creating additional rings around the initial isopleth. The first isopleth is generally axially symmetric since it spreads freely in the water column without the influence of the bathymetry, while the subsequent isopleths become more complex due to reflection between the sound field and the seabed and the surface.

Submerged geomorphological structures—known as shallow shoals or seamounts—can block the propagation of acoustic energy. This can be observed in the footprint maps and cross-sections in Sections 4.1.3 and 4.2.2. The steep bathymetric gradient (relative to the water depth) serves to strip propagating sound energy from the water column and enhance transmission into the seabed, resulting in an increase in energy loss as sound propagates upslope. The rate of loss is primarily dependent on the magnitude of the water depth change, the bathymetric gradient and the geoacoustic properties of the seabed (Jensen et al. 2011). These parameters have been incorporated into the acoustic models to provide a realistic estimate of the levels received with the shallow water near the shoals.

5.1. Pile Driving

This study predicted underwater sound levels associated with impact driving of subsea jacket foundation piles for the Crux platform. The pile driving scenarios are based on the most relevant pile designs and installation approaches approved by Shell.

For the subsea jacket foundation piles, the underwater sound field was modelled for a 146.82 m long pile, with a 3.5 m diameter with 60 mm wall thickness. The jacket foundation pile will be driven a total of 120 m into the seabed. The broadband sound energy at 10 m for each penetration depth ranged from 190.7 to 193.4 dB re 1 $\mu Pa^2 \cdot s$ with the peak sound energy concentrated in the frequency range 100 to 400 Hz (Figures 11 and 12), with levels from the pile at the 102.5 m penetration depth having the highest energy.

The IHC 800S hammer operating at 95% efficiency imparts more energy to the pile than the MHU 500T operating at 80% efficiency. A heavier helmet (also referred to as an anvil) was used for the IHC 800S, the heavier helmet weight resulted in a lengthening of the forcing function and reduced the peak force applied to the top of the pile. The corresponding outcome was lower ranges for SPL criteria, for the IHC 800S. Moreover, due to the higher efficiency, it takes a smaller number of strikes and takes less time to install the pile which, in this case, resulted in lower ranges to SEL_{24h} criteria for the IHC 800S as well.

Noise emissions from pile driving were considered to be axially symmetric. As such, variations in noise propagation characteristics between azimuths are attributed to the bathymetry alone. When the hammer strikes the pile, noise propagates into the water as a downward Mach cone (see Appendix B-1). A portion of the energy from the strike is also reflected at the pile bottom, generating an upward Mach cone. This cycle of downward propagation, reflection, and upward propagation occurs multiple times per strike. At close range from the pile, noise levels are determined by the summation of Mach cones, which might add constructively (i.e., their summation results in a total wave with higher amplitude than the original ones) or destructively (i.e., wavefronts can cancel each other, resulting in lower amplitudes). The way in which Mach cones combine with each other is strongly dependent on their frequency content, which is determined by the hammer forcing function and the pile dimensions.

Due to the relation between the speed of sound in steel (~5000 m/s) relative to the speed of sound in the water (~1525 m/s at the depth of the pile), the Mach cone propagates away from the pile and impinges the seabed at an angle of ~17°. The first bottom bounce occurs within 17 m from the pile, and the first surface bounce occurs within 36 m from the pile. As shown in maps presented in Figures 13 and 16 and 15 and 18, the Mach cone corresponding to the shallowest pile penetration, when the longest portion of the pile is exposed to the water column, introduces substantial energy that propagates through the water column. This is in contrast to the deepest pile penetration for the subsea jacket foundation pile scenario, for which underground sound propagation tends to dominate near the pile.

The modelling of the three penetration depths for each pile provides a detailed quantification of the associated sound levels for each penetration. The distances to per-strike isopleths are generally farthest when most of the pile is in the water column, and distances are shortest at the end of piling when most of the pile is buried in the sediment. This is despite the per-strike pile penetration being less during the final stages of driving, and the increased resistance generating stronger stress-wave reflections at the pile toe.

For criteria based on SEL_{24h} metrics, the distances above must be considered in context of the duration of operations. One pile will be driven per day; therefore, the corresponding sound level is denoted as SEL_{24h}. However, the estimated time for driving a single pile was 6.4 h for the foundation pile with MHU 500T hammer and 2.9 h for the foundation pile with IHC 800S hammer (Table 16). One of the main parameters that influence the SEL_{24h} sound field extents is the number of strikes that are considered to install the pile to completion, see Section 3.2.2. Given that the number of strikes considered here may be more than expected in-situ due to conservative design principles, SEL_{24h} sound field extents may be smaller than what is predicted here. The converse also applies. If more strikes occur, then sound field extents would be larger. The modelling conduct herein, incorporates realistic conservativism based on the available information.

The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within the driving period and assumes that an animal is consistently exposed to such noise levels at a fixed position. The radii that correspond to SEL_{24h} typically represent an unlikely worst-case scenario for SEL-based exposure. More realistically, marine fauna (mammals, sea turtles or fish) would not stay in the same location or at the same distance from a sound source for an extended period. Therefore, a reported radius associated with the accumulated SEL criteria does not mean that any animal travelling within this radius of the source will be injured, but rather that it could be injured if it remained in that range for the entire period of driving (8.10 and 3.60 hours). While it may be nominally feasible to install more than one pile per day, this scenario would need to be considered in the modelling.

Distances to relevant acoustic thresholds for pile driving are shown in Table 29.

Table 29. *Piling Operations:* Maximum (R_{max}) horizontal distances (in km) to relevant thresholds for marine fauna.

Hearing group	Threshold Type	Metric	Threshold	MHU 500T hammer	IHC 800S hammer
				R_{max} (km)	R_{max} (km)
Low frequency cetaceans	PTS [a]	$L_{E,24h}$	183	35.6	19.1
	TTS [a]	$L_{E,24h}$	168	98.1	61.1
High frequency cetaceans	PTS [a]	$L_{E,24h}$	185	0.12	–
	TTS [a]	$L_{E,24h}$	170	2.30	0.13
Very high-frequency cetaceans	PTS [a]	$L_{E,24h}$	155	6.40	1.20
	TTS [a]	$L_{E,24h}$	140	21.6	6.46
Sirenians	PTS [a]	$L_{E,24h}$	226	0.13	–
	TTS [a]	$L_{E,24h}$	220	2.40	0.15
All Marine Mammal Groups	Behavioural Response [b]	L_p	160	21.6	18.5
Fish without swim bladder	Mortality and Potential mortal injury [c]	$L_{E,24h}$	219	0.70	0.21
	Recoverable injury [c]	$L_{E,24h}$	216	0.78	0.26
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	213	0.23	0.13
Fish with swim bladder not involved in hearing	Mortality and Potential mortal injury [c]	$L_{E,24h}$	210	2.37	1.15
	Recoverable injury [c]	$L_{E,24h}$	203	6.40	2.55
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	207	0.70	0.29
Fish with swim bladder involved in hearing	Mortality and Potential mortal injury [c]	$L_{E,24h}$	207	3.47	1.38
	Recoverable injury [c]	$L_{E,24h}$	203	6.40	2.55
	TTS [c]	$L_{E,24h}$	186	35.1	23.5
	Recoverable injury [c]	L_{pk}	207	0.70	0.29
Sea turtles	PTS [d]	$L_{E,24h}$	204	4.92	2.24
	TTS [d]	$L_{E,24h}$	189	26.2	16.6
	Behavioural disturbance [e]	L_p	166	11.7	9.97
	Behavioural response [e]	L_p	175	3.85	3.09

L_{pk}= unweighted peak sound pressure level (dB re 1 µPa)
L_p= unweighted root-mean-square sound pressure level (dB re 1 µPa)
L_E= sound exposure level for single strike (dB re 1 µPa^2 s)
$L_{E,24h}$= sound exposure level over 24 hours (dB re 1 µPa^2 s), unweighted for fish and frequency weighted for all other groups
[a] Southall et al. (2019) criteria for marine fauna
[b] NOAA (2019) recommended unweighted behavioural threshold for marine mammals
[c] Popper et al. (2014)
[d] Finneran et al. (2017)
[e] McCauley et al. (2000)

5.1.1. Animal Movement Modelling

The estimated sound fields produced by source and propagation models for the planned Crux development were incorporated into an animat sound exposure model for migrating pygmy blue whales. Animat modelling was then used to estimate the radial distance within which 95% of the exposure exceedances occur ($ER_{95\%}$), along with the probability that an animat (i.e., a simulated animal) with the closest point of approach within that distance would be exposed above the relevant threshold (P_{exp}).

For the exposure analysis, two impact pile driving scenarios were run for south-bound migrating pygmy blue whales. The pile is located approximately 120 km outside of the migratory BIA for pygmy blue whales and therefore, animats were not restricted to the BIA. Sections 5.1.1.1 and 5.1.1.2 summarise the PTS, TTS and behavioural exposure range results, with Table 30 summarising the maximum exposure range results for pygmy blue whales not restricted to their corresponding BIAs.

Table 30. *Pile Driving:* Summary of animat simulation results for PTS, TTS and SPL behavioural response criteria for pygmy blue whales with unrestricted seeding Maximum exposure ranges of both hammers show $ER_{95\%}$ (km) first and probability of exposure of animats travelling within the $ER_{95\%}$ (P_{exp} (%)) in parentheses.

Pile Description	Species	Behavioural re□□□n□e (SPL)[4]	TTS (SEL_{24h})[3]	PTS (SEL_{24h})[3]
		160[2]	168[1]	183[1]
Jacket Foundation Pile	Pygmy blue whale	18.0 (72%)	56.4 (58%)	19.8 (75%)

[1] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[2] SPL (L_p; dB re 1 µPa)
[3] Southall et al. (2019) criteria for marine fauna.
[4] NOAA (2019) recommended unweighted behavioural threshold for marine mammals.

5.1.1.1. Behavioural Effects

Exposure ranges for single exposure metrics, such as the SPL behavioural response criteria, are typically comparable to the predicted acoustic ranges. Maximum acoustic ranges (e.g. R_{max}) are conservatively calculated using the maximum-over-depth sound fields and assuming static receivers, while exposure ranges account for animats sampling the sound field vertically and horizontally based on species-specific diving parameters, so exposure ranges are often slightly lower than acoustic ranges, which is the case for this study.

For the MHU 500T case, the $ER_{95\%}$ to the behavioural threshold is 21.6 km with a probability of exposure of animats travelling within the $ER_{95\%}$ of 72%. This is 3.6 km less than the maximum R_{max} from the acoustic modelling and is a more realistic measure as it accounts for the distribution of the sound within the water column and how the pygmy blue whales interact with it.

Due to the main lobe of acoustic energy remaining constant as depth increases, the animat determined exposure ranges were very similar to the static acoustic ranges for both pile driving scenarios, as expected based on the vertical distribution of the sound field. Migrating pygmy blue whales are expected to spend most of their time in a behavioural mode where most dives reach less than 20 m in depth, and at the surface (Section 3.5.2). Figure 45 shows a vertical slice beginning at the source location and extending towards deeper water at an azimuth of 280°. This plot shows how migrating pygmy blue whales sample the upper portion of the water column and the surface, which is quieter compared to the remaining portions of the water column, which do not differ greatly, and results in exposure ranges that are slightly smaller than acoustic ranges at this location.

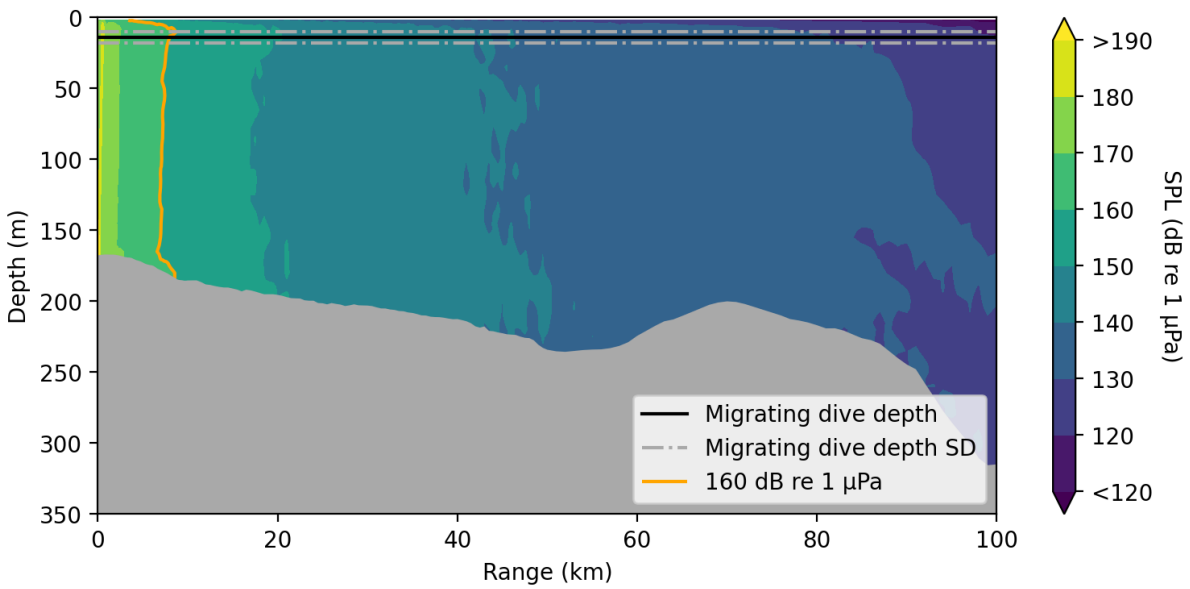

Figure 45. *IHC 800S, PD03 – 102.5 m:* Example SPL vertical from the pile driving location at an azimuth of 280°. The 160 dB re 1 µPa behavioural response threshold is highlighted in orange, and the migrating pygmy blue whale dive depth (mean and one standard deviation) is indicated by horizontal lines.

5.1.1.2. PTS and TTS

Exposure ranges from animal movement modelling for PTS and TTS criteria are typically shorter than those predicted using acoustic propagation modelling because of the generally shorter time ('dwell time') to accumulate sound energy of the moving animats. In this analysis, the $ER_{95\%}$ for PTS and TTS considering the MHU 500T hammer was 19.8 and 56.4 km, respectively, with corresponding exposure probabilities for animats travelling within that range of 75 and 58%. Using a IHC 800S hammer reduced the $ER_{95\%}$ for PTS and TTS to 9.10 and 33.8 km with corresponding exposure probabilities for animats travelling within that range of 73 and 70%. The difference in exposure ranges between the two hammer models is likely due to their efficiency, i.e., the IHC 800S had a reduced total number of strikes per pile penetration, as well as shorter hours of operation per 24h. Therefore, the moving animats are exposed for a shorter time and accumulate less sound energy during the 24h simulation.

The animat modelling was included in the scope of work to provide context to possible exposures to migrating pygmy blue whales over an entire day. The distances to isopleths associated with the effect thresholds for PTS and TTS, are more realistic than those from the static sound fields as they consider potential animal movements during migration, passing through the operational region.

5.2. Vessel and Drilling Operations

This study predicted underwater sound levels associated with several vessel scenarios and a drilling scenario which includes vessels in isolation and a combined vessel scenario. Vessel and drilling noise was modelled as an isotropic point source. Thus, changes in sound footprint maps are mainly due to variations in bathymetric features, most notably when interacting with shoals. Scenarios including the construction vessel produced the largest distances to isopleths due to its higher source levels. Maximum distances to isopleths are shown in Table 31.

Table 31. *Vessel operations*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) and maximum (R_{max}) horizontal distances (in km) and ensonified area (km^2) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds from the most appropriate location for considered sources per scenario.

Site	Description	SPL		TTS, SEL_{24h}	
		R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	Area (km^2)
1	Construction Vessel in isolation	28.4	25.8	6.94	130.3
2	AHT support vessel with 150 MT BP	19.1	17.2	3.85	40.0
3	AHT support vessel with 75 MT BP	11.4	10.5	2.19	13.0
Combined Scenario					
Scenario 1	Construction Vessel + 3x 150 MT BP + 1x 75 MT BP support vessels	43.1	38.7	13.0	420.7
Drilling					
Drilling	Drilling at Crux Platform	0.94	0.90	0.06	0.015

AHT: Anchor handling tug
MT BP: Megaton bollard pull

5.2.1. Animal Movement Modelling

The estimated sound fields produced by source and propagation models for the planned Crux development were incorporated into an animat sound exposure model for migrating pygmy blue whales to estimate the radial distance within which 95% of the exposure exceedances occur ($ER_{95\%}$), along with the probability that an animat with the closest point of approach within that distance would be exposed above the relevant threshold (P_{exp}).

For the exposure analysis, one vessel operation scenario was run for south-bound migrating pygmy blue whales. The vessels are located approximately 120 km outside of the migratory BIA for pygmy blue whales and therefore, animats were not restricted to the BIA.

Sections 5.2.1.1 and 5.2.1.2 summarise the PTS, TTS and behavioural exposure range results, with Table 30 summarising the maximum exposure range results for pygmy blue whales not restricted to their corresponding BIAs.

Table 32. *Vessel Operations:* Summary of animat simulation results for PTS, TTS and SPL behavioural response criteria for pygmy blue whales with unrestricted seeding Maximum exposure ranges show $ER_{95\%}$ (km) first and probability of exposure of animats travelling within the $ER_{95\%}$ (P_{exp} (%)) in parentheses.

Scenario Description	Species	Behavioural response (SPL)[4]	TTS (SEL_{24h})[3]	PTS (SEL_{24h})[3]
		120[2]	179[1]	199[1]
All vessels	Pygmy blue whale	36.8 (93%)	0.19 (79%)	<0.01 (30%)

[1] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[2] SPL (L_p; dB re 1 µPa)
[3] Southall et al. (2019) criteria for marine fauna.
[4] NOAA (2019) recommended unweighted behavioural threshold for marine mammals.

5.2.1.1. Behavioural Effects

Exposure ranges for single exposure metrics, such as the SPL behavioural response criteria, are typically comparable to the predicted acoustic ranges. Maximum acoustic ranges (e.g. R_{max}) are conservatively calculated using the maximum-over-depth sound fields and assuming static receivers, while exposure ranges account for animats sampling the sound field vertically and horizontally based

on species-specific diving parameters, so exposure ranges are often slightly lower than acoustic ranges, which is the case for this study.

The $ER_{95\%}$ to the behavioural threshold is 36.8 km with a probability of exposure of animats travelling within the $ER_{95\%}$ of 93%. This is 6.3 km less than the maximum R_{max} from the acoustic modelling and is a more realistic measure as it accounts for the distribution of the sound within the water column and how the pygmy blue whales interacts with it. Migrating pygmy blue whales are expected to spend most of their time in a behavioural mode where most dives reach less than 20 m in depth and at the surface. They sample the upper portion of the water column and the surface, which is quieter as shown in Figure 45, and results in exposure ranges that are slightly shorter than acoustic ranges at this location.

5.2.1.2. PTS and TTS

Exposure ranges from animal movement modelling for PTS and TTS criteria are typically shorter than those predicted using acoustic propagation modelling because of the generally shorter time ('dwell time') to accumulate sound energy of the moving animats. In this analysis, the $ER_{95\%}$ for PTS and TTS was <0.01 and 0.19 km, respectively, with corresponding exposure probabilities for animats travelling within that range of 30 and 79%.

The animat modelling was included in the scope of work to provide context to possible exposures to migrating pygmy blue whales over an entire day. The distances to isopleths associated with the effect thresholds for PTS and TTS, are more realistic than those from the static sound fields as they consider potential animal movements during migration, passing through the operational region.

Glossary

Unless otherwise stated in an entry, these definitions are consistent with ISO 18405 (2017).

1/3-octave

One third of an octave. *Note*: A 1/3-octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec).

1/3-octave-band

Frequency band whose bandwidth is one 1/3-octave. *Note*: The bandwidth of a 1/3-octave-band increases with increasing centre frequency.

90 % energy time window

The time interval over which the cumulative energy rises from 5 to 95 % of the total pulse energy. This interval contains 90 % of the total pulse energy. Used to compute the 90 % sound pressure level. Unit: second (s). Symbol: T_{90}.

90 % sound pressure level (90 % SPL)

The sound pressure level calculated over the 90 % energy time window of a pulse. Unit: decibel (dB).

absorption

The conversion of sound energy to heat energy. Specifically, the reduction of sound pressure amplitude due to particle motion energy converting to heat in the propagation medium.

acoustic impedance

The ratio of the sound pressure in a medium to the volume flow rate of the medium through a specified surface due to the sound wave. It is a measure of how well sound propagates through a particular medium.

acoustic noise

Sound that interferes with an acoustic process.

acoustic self-noise

Sound at a receiver caused by the deployment, operation, or recovery of a specified receiver, and its associated platform (ISO 18405:2017).

ambient sound

Sound that would be present in the absence of a specified activity (ISO 18405:2017). Usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium. Attenuation depends on frequency—higher frequency sounds are attenuated faster than lower frequency sounds.

auditory frequency weighting

The process of applying an auditory frequency-weighting function. An example for marine mammals are the auditory frequency-weighting functions published by Southall et al. (2007).

auditory frequency-weighting function

Frequency-weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.

azimuth

A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also known as bearing.

background noise

Combination of ambient sound, acoustic self-noise, and, where applicable, sonar reverberation (ISO 18405:2017) that is detected, measured, or recorded with a signal.

bandwidth

A range within a continuous band of frequencies. Unit: hertz (Hz).

broadband level

The total level measured over a specified frequency range. If the frequency range is unspecified, the term refers to the entire measured frequency range.

cavitation

A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean

Member of the order Cetacea. Cetaceans are aquatic mammals and include whales, dolphins, and porpoises.

compressional wave

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called a longitudinal wave. In seismology/geophysics, it's called a primary wave or P-wave. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

conductivity-temperature-depth (CTD)

Measurement data of the ocean's conductivity, temperature, and depth; used to compute sound speed profiles and salinity.

continuous sound

A sound whose sound pressure level remains above the background noise during the observation period and may gradually vary in intensity with time, e.g., sound from a marine vessel.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006). For example, one decade up from 1000 Hz is 10,000 Hz, and one decade down is 100 Hz.

decibel (dB)

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Especially suited to quantify variables with a large dynamic range.

decidecade

One tenth of a decade. Approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct), and for this reason sometimes referred to as a 1/3-octave.

decidecade band

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

energy source level

A property of a sound source equal to the sound exposure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2\,m^2\,s$.

ensonified

Exposed to sound.

far field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point.

Fourier transform, Fourier synthesis

A mathematical technique which, although it has varied applications, is referenced in a physical data acquisition context as a method used in the process of deriving a spectrum estimate from time-series data (or the reverse process, termed the inverse Fourier transform). A computationally efficient numerical algorithm for computing the Fourier transform is known as the fast Fourier transform (FFT).

frequency

The rate of oscillation of a periodic function measured in cycles per unit time. The reciprocal of the period. Unit: hertz (Hz). Symbol: f. 1 Hz is equal to 1 cycle per second.

frequency weighting

The process of applying a frequency-weighting function.

frequency-weighting function

The squared magnitude of the sound pressure transfer function (ISO 18405:2017). For sound of a given frequency, the frequency-weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency-weighting function*: compensatory frequency-weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
- *System frequency-weighting function*: frequency-weighting function describing the sensitivity of an acoustic recording system, which typically consists of a hydrophone, one or more amplifiers, and an analog-to-digital converter.

functional hearing group

Category of animal species when classified according to their hearing sensitivity, hearing anatomy, and susceptibility to sound. For marine mammals, initial groupings were proposed by Southall et al. (2007), and revised groupings are developed as new research/data becomes available. Revised groupings proposed by Southall et al. (2019) include low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, phocid carnivores in water, other carnivores in water, and sirenians. See auditory frequency-weighting functions, which are often applied to these groups.

Example hearing groups for fish include species for which the swim bladder is involved in hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

geoacoustic

Relating to the acoustic properties of the seabed.

harmonic

A sinusoidal sound component that has a frequency that is an integer multiple of the frequency of a sound to which it is related. For a sound with a fundamental frequency of f, the harmonics have frequencies of $2f$, $3f$, $4f$, etc.

hearing threshold

For a given species or functional hearing group, the sound level for a given signal that is barely audible (i.e., that would be barely audible for a given individual in the presence of specified background noise during a specific percentage of experimental trials).

hertz (Hz)

Unit of frequency defined as one cycle per second. Often expressed in multiples such as kilohertz (1 kHz = 1000 Hz).

high-frequency (HF) cetaceans

See functional hearing group. *Note*: The mid- and high-frequency cetaceans groups proposed by Southall et al. (2007) were renamed high- and very-high-frequency cetaceans, respectively, by Southall et al. (2019).

hydrophone

An underwater transducer. A passive electronic device for recording or listening to underwater sound.

hydrostatic pressure

The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid. Unit: pascal (Pa).

intermittent sound

A sound whose level abruptly drops below the background noise level multiple times during an observation period.

impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 s), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Sources of impulsive sound include, among others, explosives, seismic airguns, and impact pile drivers.

isopleth

A line drawn on a map through all points having the same value of some specified quantity (e.g., sound pressure level isopleth).

knot (kn)

Unit of vessel speed equal to 1 nautical mile per hour.

level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. For example, a value of sound pressure level with reference to 1 μPa^2 can be written in the form *x* dB re 1 μPa^2.

low-frequency (LF) cetaceans

See functional hearing group.

manual analysis

Human examination of acoustic data via visual review of spectrograms and/or aural inspection of data.

masking

Obscuring of sounds of interest by other sounds at similar frequencies.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetaceans

See functional hearing group. *Note*: The mid-frequency cetaceans group proposed by Southall et al. (2007) was renamed high-frequency cetaceans by Southall et al. (2019).

monopole source level (MSL)

A source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point source (monopole). Often used to quantify source levels of vessels or industrial operations from measurements. See also radiated noise level.

multiple linear regression

A statistical method that seeks to explain the response of a dependent variable using multiple explanatory variables.

M-weighting

A set of auditory frequency-weighting functions proposed by Southall et al. (2007).

mysticete

Member of the Mysticeti, a suborder of cetaceans. Also known as baleen whales, mysticetes have baleen plates (rather than teeth) that they use to filter food from water (or from sediment as for grey whales). This group includes rorquals (Balaenopteridae, such as blue, fin, humpback, and minke whales), right and bowhead whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

N percent exceedance level

The sound level exceeded *N* % of the time during a specified time interval. See also percentile level.

non-impulsive sound

Sound that is not an impulsive sound. Not necessarily a continuous sound.

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

Member of Odontoceti, a suborder of cetaceans. These whales, dolphins, and porpoises have teeth (rather than baleen plates). Their skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

other marine carnivores in water (OCW)

See functional hearing group.

parabolic equation method

A computationally efficient solution to the acoustic wave equation that is used to model propagation loss. The parabolic equation approximation omits effects of backscattered sound (which are negligible for most ocean-acoustic propagation problems), simplifying the computation of propagation loss.

peak sound pressure level (PK), zero-to-peak sound pressure level

The level (L_{pk}) of the squared maximum magnitude of the sound pressure (p_{pk}^2) in a stated frequency band and time window. Defined as $L_{\mathrm{pk}} = 10log_{10}(p_{\mathrm{pk}}^2/p_0^2) = 20log_{10}(p_{pk}/p_0)$. Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 μPa^2.

peak-to-peak sound pressure

The difference between the maximum and minimum sound pressure over a specified frequency band and time window. Unit: pascal (Pa).

percentile level

The sound level not exceeded *N* % of the time during a specified time interval. The *N*th percentile level is equal to the (100−*N*) % exceedance level. See also N percent exceedance level.

permanent threshold shift (PTS)

An irreversible loss of hearing sensitivity caused by excessive noise exposure. Considered auditory injury. Compare with temporary threshold shift.

point source

A source that radiates sound as if from a single point.

propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, $\mathrm{PL}(x) = \mathrm{SL} - L(x)$. Unit: decibel (dB).

radiated noise level (RNL)

A source level that has been calculated assuming sound pressure decays geometrically with distance from the source, with no influence of the sea-surface or seabed. Often used to quantify source levels of vessels or industrial operations from measurements. See also monopole source level.

received level

The level of a given field variable measured (or that would be measured) at a given location.

reference value

Standard value of a quantity used for calculating underwater sound level. The reference value depends on the quantity for which the level is being calculated:

Quantity	Reference value
Sound pressure	$p_0{}^2$ = 1 µPa^2 or p_0 = 1 µPa
Sound exposure	E_0 = 1 µPa^2 s
Sound particle displacement	$\delta_0{}^2$ = 1 pm^2
Sound particle velocity	$u_0{}^2$ = 1 nm^2/s^2
Sound particle acceleration	$a_0{}^2$ = 1 µm^2/s^4

shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium. In common meaning, a form of energy that propagates through media (e.g., water, air, ground) as pressure waves.

sound exposure

Time integral of squared sound pressure over a stated time interval in a stated frequency band. The time interval can be a specified time duration (e.g., 24 h) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: pascal squared second (Pa^2 s). Symbol: E.

sound exposure level (SEL)

The level (L_E) of the sound exposure (E) in a stated frequency band and time window: $L_E = 10\log_{10}(E/E_0)$ (ISO 18405:2017). Unit: decibel (dB). Reference value (E_0) for sound in water: 1 µPa^2 s.

sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum (ISO 18405:2017). Unit: pascal squared second per hertz (Pa^2 s/Hz).

sound field

Region containing sound waves.

sound intensity

Product of the sound pressure and the sound particle velocity (ISO 18405:2017). The magnitude of the sound intensity is the sound energy flowing through a unit area perpendicular to the direction of propagation per unit time. Unit: watt per metre squared (W/m^2). Symbol: I.

sound particle acceleration

The rate of change of sound particle velocity. Unit: metre per second squared (m/s^2). Symbol: a.

sound particle velocity

The velocity of a particle in a material moving back and forth in the direction of the pressure wave. Unit: metre per second (m/s). Symbol: u.

sound pressure

The contribution to total pressure caused by the action of sound (ISO 18405:2017). Unit: pascal (Pa). Symbol: p.

sound pressure level (SPL), rms sound pressure level

The level (L_p) of the time-mean-square sound pressure (p^2_{rms}) in a stated frequency band and time window: $L_p = 10\log_{10}(p^2_{\mathrm{rms}}/p^2_0) = 20\log_{10}(p_{rms}/p_0)$, where rms is the abbreviation for root-mean-square. Unit: decibel (dB). Reference value (p^2_0) for sound in water: 1 μPa^2. SPL can also be expressed in terms of the root-mean-square (rms) with a reference value of p_0 = 1 μPa. The two definitions are equivalent.

sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

source level (SL)

A property of a sound source equal to the sound pressure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa^2 m^2.

spectrum

Distribution of acoustic signal content over frequency, where the signal's content is represented by its power, energy, mean-square sound pressure, or sound exposure.

surface duct

The upper portion of a water column within which the gradient of the sound speed profile causes sound to refract upward and therefore reflect repeatedly off the surface resulting in relatively long-range sound propagation with little loss.

temporary threshold shift (TTS)

Reversible loss of hearing sensitivity caused by noise exposure. Compare with permanent threshold shift.

thermocline

A depth interval near the ocean surface that experiences larger temperature gradients than the layers above and below it due to warming or cooling by heat conduction from the atmosphere and by warming from the sun.

unweighted

Term indicating that no frequency-weighting function is applied.

very high-frequency (VHF) cetaceans

See functional hearing group.

wavelength

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ.

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Appendix A. Acoustic Metrics

This section describes in detail the acoustic metrics, impact criteria, and frequency weighting relevant to the modelling study.

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 2017, ANSI S1.1-2013).

The sound pressure level (SPL or L_p; dB re 1 μPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T g(t)\,p^2(t)\,dt/p_0^2\right)\ \mathrm{dB} \tag{A-1}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function.

The sound exposure level (SEL or L_E; dB re 1 μPa²·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)\,dt/T_0 p_0^2\right)\ \mathrm{dB} \tag{A-2}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right)\ \mathrm{dB}\,. \tag{A-3}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.4). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3 octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}}\ \mathrm{kHz} \tag{A-4}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \tag{A-5}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 10 (f_c (10) = 10 Hz) to band 44 ($f_c(44)$ = 25 kHz).

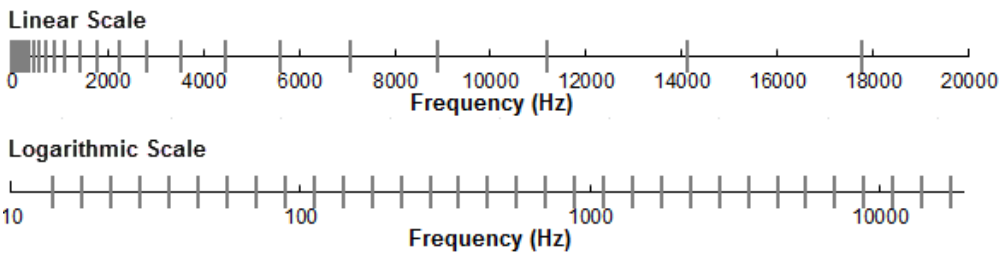

Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10\, log_{10} \int_{f_{lo,i}}^{f_{hi,i}} S(f)\, \mathrm{d}f \ \ \mathrm{dB} \tag{A-6}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}}\ \mathrm{dB} \tag{A-7}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient sound signal. Because the decidecade bands are wider than 1 Hz, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

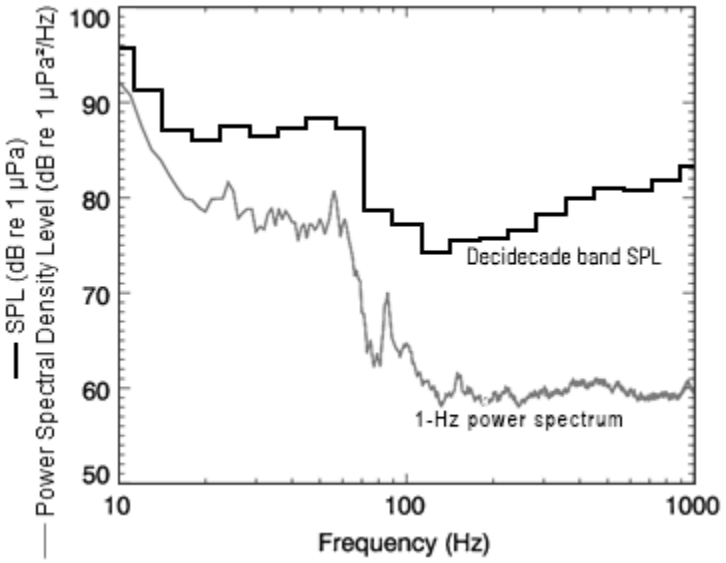

Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the power spectrum.

A.3. Marine Mammal Noise Effect Criteria – Continuous

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggest that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for auditory injury, impairment, and disturbance. The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

A.3.1. Injury and Hearing Sensitivity Changes

In recognition of shortcomings of the SPL-only based auditory injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual auditory injury criteria for impulsive sounds that included peak pressure level thresholds and SEL24h thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for humans; see Appendix A.4). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower PTS and TTS values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 μPa^2·s. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced the Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 μPa^2·s.

As of present, a definitive approach is still not apparent. There is consensus in the research community that an SEL-based method is preferable, either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes auditory injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018 (NMFS 2018). Southall et al. (2019) revisited the interim criteria published in 2007. All noise exposure criteria in NMFS (2018) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds); however, the mid-frequency cetaceans from NMFS (2018) are classified as high-frequency cetaceans in Southall et al. (2019), and high-frequency cetaceans from NMFS (2018) are classified as very-high-frequency cetaceans in Southall et al. (2019).

A.3.2. Behavioural Response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus(Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 μPa SPL (unweighted) for non-impulsive sounds to assess and regulate noise-induced behavioural impacts on marine mammals (NOAA 2019). The 120 dB re 1 μPa threshold is associated with continuous sources and was derived based on studies examining behavioural responses to drilling and dredging (NOAA 2018), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 μPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 μPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

For impulsive noise, NMFS currently uses step function thresholds of 160 dB re 1 μPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA 2018, NOAA 2019). The threshold for impulsive sound is derived from the High-Energy Seismic Survey (HESS) panel (HESS 1999) report that, in turn, is based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1984). The HESS team recognised that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above a SPL of 140 dB re 1 μPa. Southall et al. (2007) found varying responses for most marine

mammals between a SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions.

A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \quad \text{(A-8)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018), and in the latest guidance by Southall (2019). The updates did not affect the content related to either the definitions of frequency-weighting functions or the threshold values, however, the terminology for mid- and high-frequency cetaceans was changed to high- and very high-frequency cetaceans. Table A-1 lists the frequency-weighting parameters for each hearing group relevant to this assessment, and Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by Southall et al. (2019).

Hearing group	a	b	fl (Hz)	fhi (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
High-frequency cetaceans (most dolphins, plus sperm, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
Very-high-frequency cetaceans (true porpoises, *Kogia*, river dolphins, *Cephalorhynchus* spp., *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Sirenians *(Dugongs, manatees)*	1.8	2	12,000	140,000	1.36

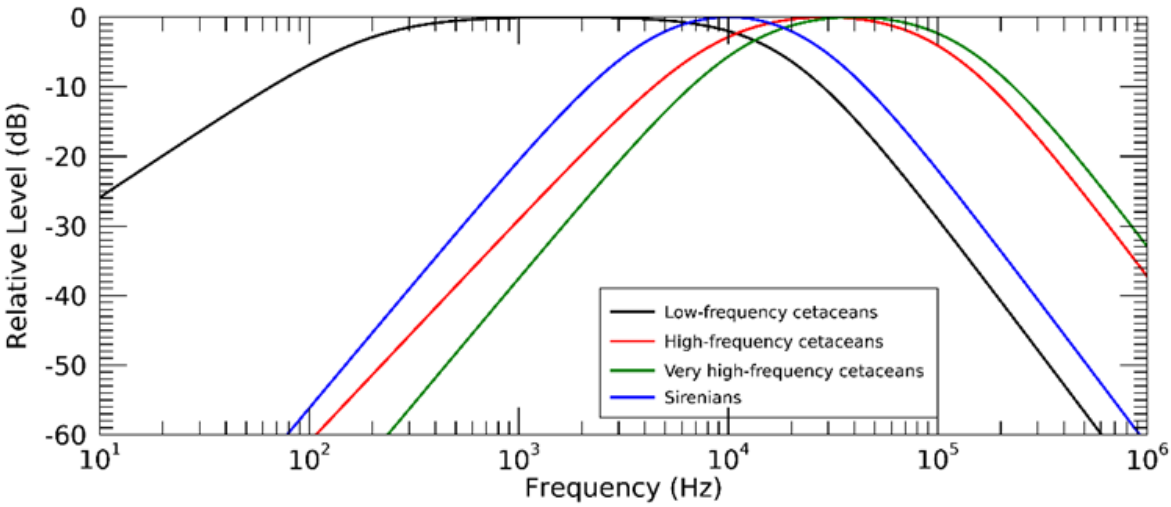

Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by Southall et al. (2019).

Appendix B. Acoustic Source Model

B.1. Acoustic Source Model – Pile Driving

B.1.1. Source Properties

For most projects involving pile driving, there is potential for direct transmission from the sound source to biological receivers, and there are reflected sound paths from the water's surface and bottom that may be perceived by marine fauna. Normally, ground-radiated sound is dominated by low frequencies that cannot propagate efficiently through shallow water. When pile driving is the sound source, there is the potential for substrate-borne sound caused by the hammer's action on the pile to be re-radiated back into the water where it may reach a biological receiver. For pile driving, energy transmission through water depends on the following factors (Christopherson and Lundberg 2013):

1. Direct contact between the pile and the water
2. The depth of the water column
3. The size of the pile
4. The type of hammer
5. The hammer energy
6. The addition of re-radiation of substrate-borne sound

The way sound propagates in water is affected by obstructions (barges, breakwater walls, other piles, etc.) and the bathymetric characteristics (Buehler et al. 2015). Figure B-1 illustrates these basic propagation concepts.

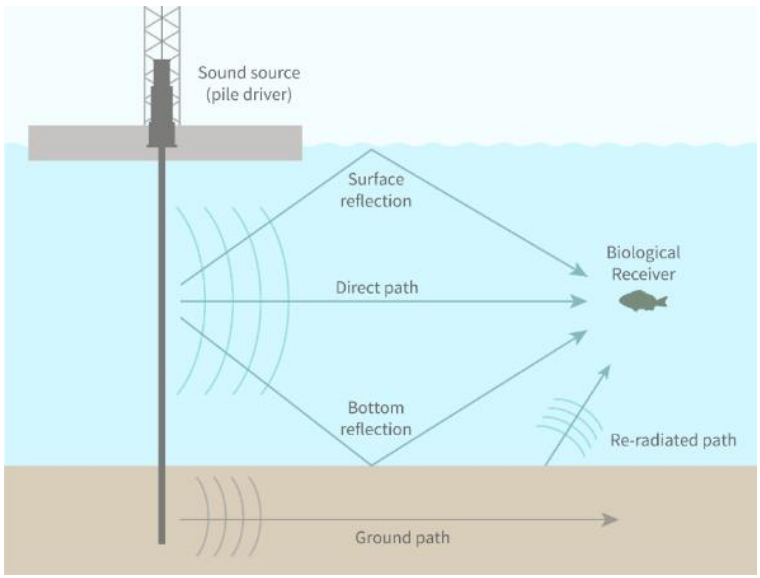

Figure B-1 Underwater sound propagation paths associated with pile driving (Buehler et al. 2015).

B.1.2. Source Model

A physical model of pile vibration and near-field sound radiation is used to calculate source levels of piles. The physical model employed in this study computes the underwater vibration and sound radiation of a pile by solving the theoretical equations of motion for axial and radial vibrations of a

cylindrical shell. These equations of motion are solved subject to boundary conditions, which describe the forcing function of the hammer at the top of the pile and the soil resistance at the base of the pile, as shown in Figure B-2. Damping of the pile vibration due to radiation loading is computed for Mach waves emanating from the pile wall. The equations of motion are discretised using the finite difference (FD) method and are solved on a discrete time and depth mesh.

To model the sound emissions from the piles, the force of the pile driving hammers also had to be modelled. The force at the top of each pile was computed using the GRLWEAP 2010 wave equation model (GRLWEAP, Pile Dynamics 2010), which includes a large database of simulated hammers—both impact and vibratory—based on the manufacturer's specifications. The forcing functions from GRLWEAP were used as inputs to the FD model to compute the resulting pile vibrations.

The sound radiating from the pile itself is simulated using a vertical array of discrete point sources. The point sources are centred on the pile axis. Their amplitudes are derived using an inverse technique, such that their collective particle velocity, calculated using a near-field wave-number integration model, matches the particle velocity in the water at the pile wall. The sound field propagating away from the vertical source array is then calculated using a time-domain acoustic propagation model (FWRAM, Appendix C.3). MacGillivray (2014) describes the theory behind the physical model in more detail.

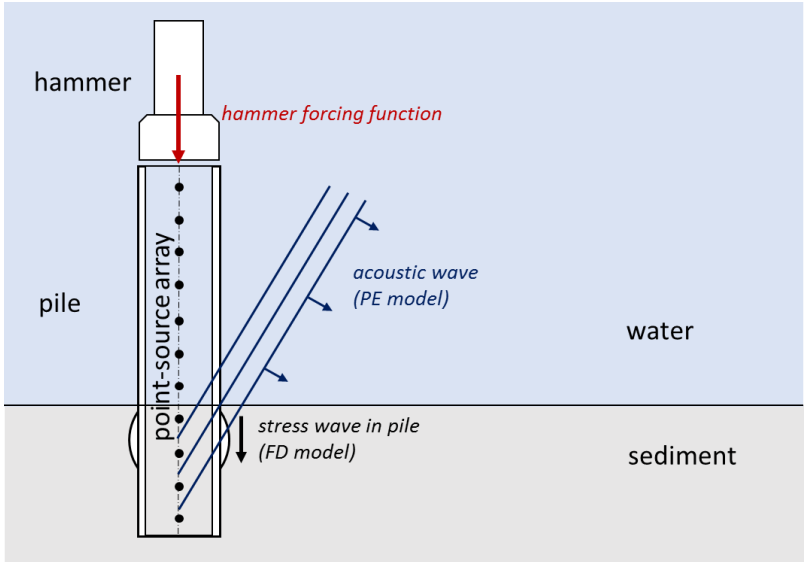

Figure B-2. Physical model geometry for impact driving of a cylindrical pile(vertical cross-section). The hammer forcing function is used with the finite difference (FD) model to compute the stress wave vibration in the pile. A vertical array of point sources is used with the parabolic equation (PE) model to compute the acoustic waves that the pile wall radiates.

Appendix C. Sound Propagation Models

C.1. Propagation Loss

The propagation of sound through the environment was modelled by predicting the acoustic propagation loss—a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which propagation loss occurs. Propagation loss also happens when the sound is absorbed and scattered by the seawater, and absorbed scattered, and reflected at the water surface and within the seabed. Propagation loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

If the acoustic energy source level (ESL), expressed in dB re 1 $\mu Pa^2 \cdot s\ m^2$, and propagation loss (PL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 $\mu Pa^2 \cdot s$ by:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{PL}. \tag{C-1}$$

C.2. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). Compared to VSTACK, MONM less accurately predicts steep-angle propagation for environments with higher shear speed but is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 5 Hz to 1 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the US Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies >1 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling propagation loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure C-1).

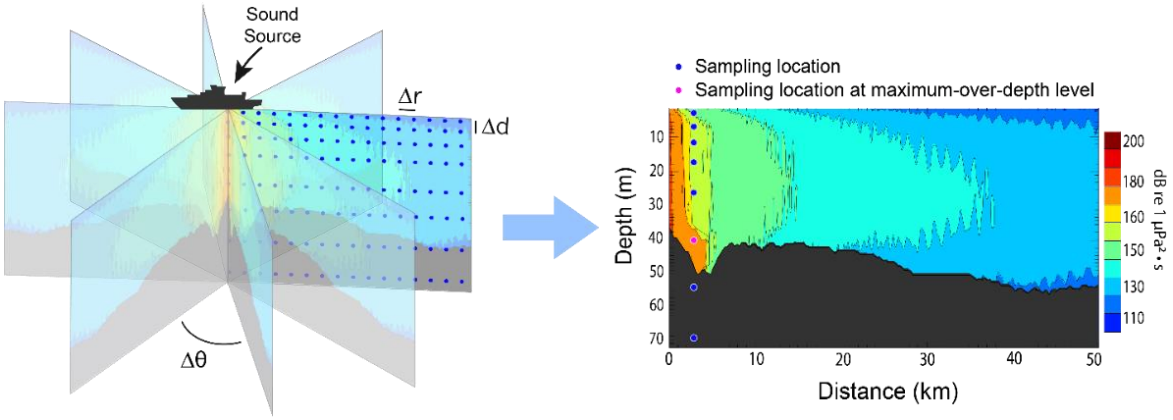

Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of decidecade bands. Sufficiently many decidecade bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade band received per-1s, for impulsive and non-impulsive noise sources respectively, SEL are computed by subtracting the band propagation loss values from the directional source level in that frequency band. Composite broadband received per-pulse SEL are then computed by summing the received decidecade band levels.

The received per-1s SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. The maximum received per-1s SEL at many sampling depths are taken over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-1s SEL are presented as contours around the source.

C.3. Full Waveform Range-dependent Acoustic Model: FWRAM

For impulsive sounds from the seismic source, time-domain representations of the pressure waves generated in the water are required to calculate SPL and PK. Furthermore, the seismic source must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Appendix D. Methods and Parameters

D.1. Environmental Parameters

D.1.1. Bathymetry

Bathymetry throughout the modelled area was extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded and combined onto a Map Grid of Australia (MGA) coordinate projection (Zone 51) with a regular grid spacing of 250 × 250 m (Figure D-1).

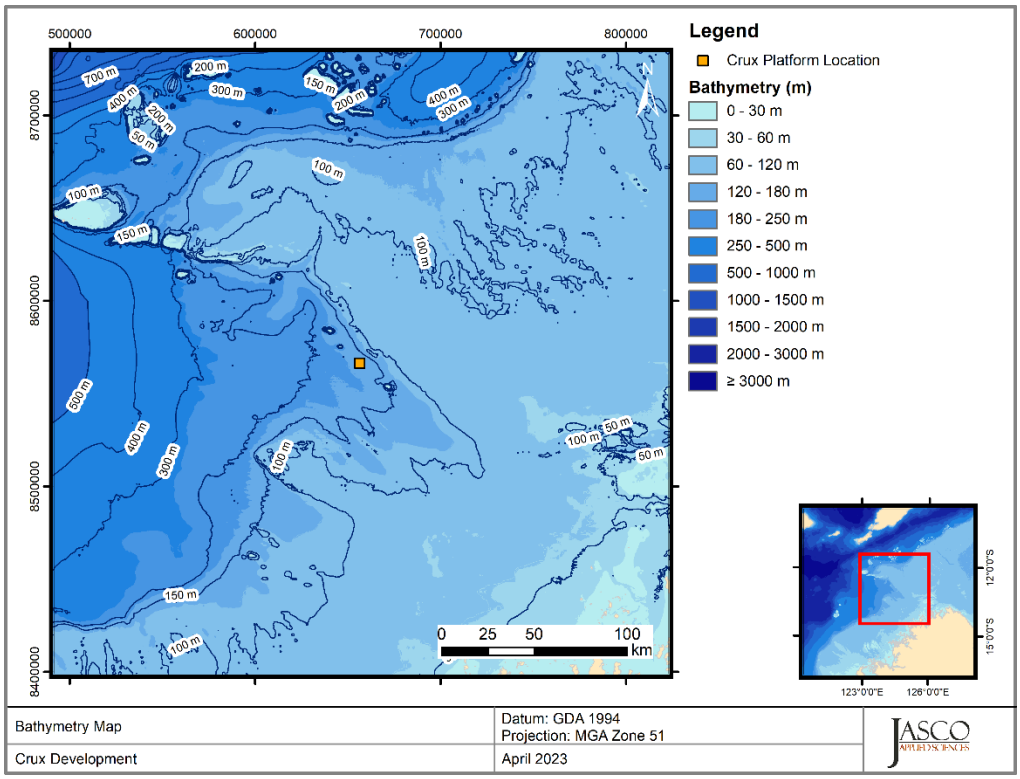

Figure D-1. Bathymetry in the modelled area.

D.1.2. Sound Speed Profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the US Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the US Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles within a 100 km box radius encompassing the modelling area. To determine the sound speed profile that is expected to be most favourable to longer-range sound propagation during the proposed survey time frame, each month was modelled for each area and the ranges were compared. As such, July was selected to as part of a

conservative approach to estimate distances to received sound level thresholds. Figure D-2 shows the resulting profile used as an input to the sound propagation modelling.

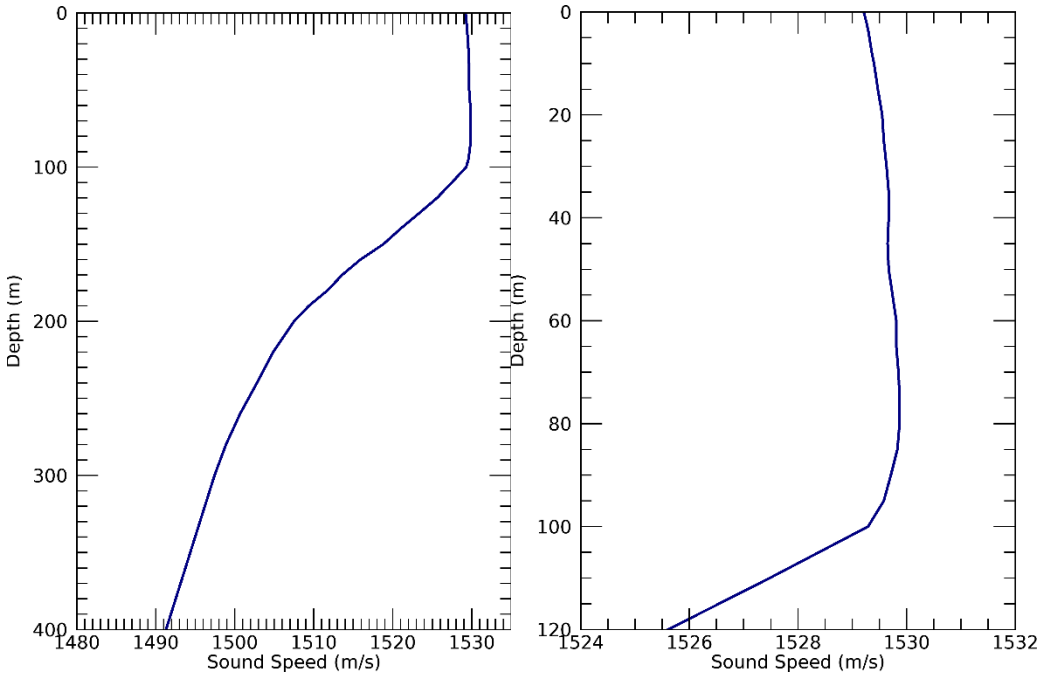

Figure D-2. The modelling sound speed profile corresponding to July: full profile (left) and top 120 m (right) Profiles are calculated from temperature and salinity profiles from Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.1.3. Geoacoustics

The propagation model used in this study considered a single geoacoustic profile for all sites. This profile determines how sound is reflected from the seabed, as well as how it is transmitted, reflected and absorbed into the sediment layers. The geology in this area was generated using client-supplied geotechnical reports. Within the vicinity of the Crux development site the geology is mainly characterised by unconsolidated sediment interspersed with some cemented layers. Representative grain sizes and porosities were used in the grain-shearing model proposed by Buckingham (2005) to estimate the geoacoustic parameters required by the sound propagation models. Table D-1 presents the geoacoustic profile used for all modelled sites for the Crux development.

Table D-1. Geoacoustic profile for the Crux development's associated modelled sites.

Depth below □eafl□□r (m)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave atten□ati□n (dB/λ)	S-wave □□eed (m/s)	S-wave atten□ati□n (dB/λ)
0 - 16	Carbonate silty SAND to sandy SILT overlying sandy SILT or sandy MUD	2011.1	1605.5 – 1817.7	0.078 - 0.865	231.3	3.653
16 - 19.1	Siliceous carbonate to carbonate muddy or silty SAND	2054.6	1921.1 - 1942.7	1.076 – 1.133		
19.1 - 22.75	Clayey carbonate MUD	1444.0	1539.4 – 1545.2	0.426 – 0.45		
22.75 – 32.5	Carbonate silty SAND and CALCARENITE	2090.4	2936.2 – 3133.9	2.516 – 2.654		
32.5 - 37	Carbonate MUD with sand overlying carbonate muddy SAND with calcarenite	2071.3	2134 – 2160.7	1.536 – 1.588		
37 – 117.7	Comprising layers of: Carbonate MUD with sand; Clayey carbonate to carbonate sandy MUD; Carbonate muddy or silty SAND.	1999.0	1880.2 – 2047.2	1.069 – 1.473		
117.7 – 250.1	Carbonate silty CEMENTED SAND & CALCARENITE with layers of Sandy MUD; Silty SAND and; DETRITAL LIMESTONE	2076.5	2582.2 – 2916.3	2.200 – 2.513		

D.2. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-3).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-3(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-3(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

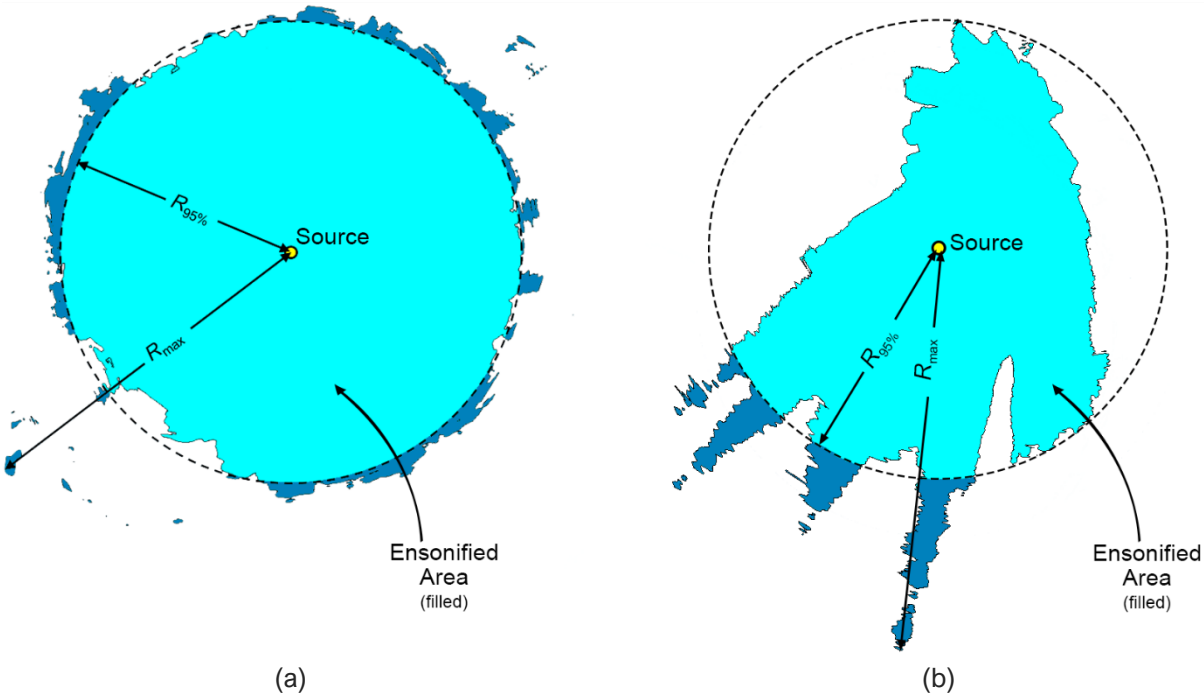

Figure D-3. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

D.3. Model Validation Information

Predictions from JASCO's propagation models (MONM, FWRAM, and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (e.g. Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018, Quijano et al. 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities that have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016, Austin et al. 2018, Beach Energy Limited 2020).

Appendix E. Animal Movement and Exposure Modelling

Animal movement and exposure modelling considers the movement of both sound sources and animals over time. Acoustic source and propagation modelling are used to generate 3-D sound fields that vary as a function of distance to source, depth, and azimuth. Sound sources are modelled at representative sites and the resulting sound fields are assigned to source locations using the minimum Euclidean distance. The sound received by an animal at any given time depends on its location relative to the source. Because the true locations of the animals within the sound fields are unknown, realistic animal movements are simulated using repeated random sampling of various behavioural parameters. The Monte Carlo method of simulating many animals within the operations area is used to estimate the sound exposure history of the population of simulated animals (animats).

Monte Carlo methods provide a heuristic approach for determining the probability distribution function (PDF) of complex situations, such as animals moving in a sound field. The probability of an event's occurrence is determined by the frequency with which it occurs in the simulation. The greater the number of random samples, in this case the more simulated animats, the better the approximation of the PDF. Animats are randomly placed, or seeded, within the simulation boundary at a specified density (animats/km^2). Higher densities provide a finer PDF estimate resolution but require more computational resources. To ensure good representation of the PDF, the animat density is set as high as practical allowing for computation time. Typically, the animat density is much higher than the real-world density to ensure good representation of the PDF. The resulting PDF can be scaled using the real-world density if it is available.

Several models for marine mammal movement have been developed (Ellison et al. 1987, Frankel et al. 2002, Houser 2006). These models use an underlying Markov chain to transition from one state to another based on probabilities determined from measured swimming behaviour. The parameters may represent simple states, such as the speed or heading of the animal, or complex states, such as likelihood of participating in foraging, play, rest, or travel. Attractions and aversions to variables like anthropogenic sounds and different depth ranges can be included in the models.

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was based on the open-source marine mammal movement and behaviour model (3MB, Houser 2006) and used to predict the exposure of animats to sound arising from the anthropogenic activities. Animats are programmed to behave like the species likely to be present in the survey area. The parameters used for forecasting realistic behaviours (e.g., diving, foraging, aversion, surface times, etc.) are determined and interpreted from marine species studies (e.g., tagging studies) where available, or reasonably extrapolated from related species. An individual animat's modelled sound exposure levels are summed over the total simulation duration to determine its total received energy, and then compared to the assumed threshold criteria.

JASMINE uses the same animal movement algorithms as 3MB (Houser, 2006), but has been extended to be directly compatible with JASCO's Marine Operations Noise Model (MONM) and Full Waveform Range-dependent Acoustic Model acoustic field predictions, for inclusion of source tracks, and importantly for animats to change behavioural states based on time and space dependent modelled variables such as received levels for aversion behaviour, although aversion was not considered in this study.

E.1. Animal Movement Parameters

JASMINE uses previously measured behaviour to forecast behaviour in new situations and locations. The parameters used for forecasting realistic behaviour are determined (and interpreted) from marine species studies (e.g., tagging studies). Each parameter in the model is described as a probability distribution. When limited or no information is available for a species parameter, a Gaussian or uniform distribution may be chosen for that parameter. For the Gaussian distribution, the user determines the mean and standard deviation of the distribution from which parameter values are drawn. For the uniform distribution, the user determines the maximum and minimum distribution from which parameter values are drawn. When detailed information about the movement and behaviour of a species are available, a user-created distribution vector, including cumulative transition probabilities, may be used (referred to here as a vector model; Houser 2006). Different sets of parameters can be defined for different behaviour states. The probability of an animat starting out in or transitioning into a given behaviour state can in turn be defined in terms of the animat's current behavioural state, depth, and the time of day. In addition, each travel parameter and behavioural state has a termination function that governs how long the parameter value or overall behavioural state persists in simulation.

The parameters used in JASMINE describe animal movement in both the vertical and horizontal planes. The parameters relating to travel in these two planes are briefly described below.

Travel sub-models

- **Direction**– determines an animat's choice of direction in the horizontal plane. Sub-models are available for determining the heading of animats, allowing for movement to range from strongly biased to undirected. A random walk model can be used for behaviours with no directional preference, such as feeding and playing. In a random walk, all bearings are equally likely at each parameter transition time step. A correlated random walk can be used to smooth the changes in bearing by using the current heading as the mean of the distribution from which to draw the next heading. An additional variant of the correlated random walk is available that includes a directional bias for use in situations where animals have a preferred absolute direction, such as migration. A user-defined vector of directional probabilities can also be input to control animat heading. For more detailed discussion of these parameters, see Houser (2006) and Houser and Cross (1999).
- **Travel rate**–defines an animat's rate of travel in the horizontal plane. When combined with vertical speed and dive depth, the dive profile of the animat is produced.

Dive sub-models

- **Ascent rate**–defines an animat's rate of travel in the vertical plane during the ascent portion of a dive.
- **Descent rate**–defines an animat's rate of travel in the vertical plane during the descent portion of a dive.
- **Depth**–defines an animat's maximum dive depth.
- **Reversals**–determines whether multiple vertical excursions occur once an animat reaches the maximum dive depth. This behaviour is used to emulate the foraging behaviour of some marine mammal species at depth. Reversal-specific ascent and descent rates may be specified.
- **Surface interval**–determines the duration an animat spends at, or near, the surface before diving again.

E.2. Exposure Integration Time

The interval over which acoustic exposure (L_E) should be integrated and maximal exposure (L_p) determined is not well defined. Both Southall et al. (2007) and the NMFS (2018) recommend a 24 h baseline accumulation period, but state that there may be situations where this is not appropriate (e.g., a high-level source and confined population). Resetting the integration after 24 h can lead to overestimating the number of individual animals exposed because individuals can be counted multiple times during an operation. The type of animal movement engine used in this study simulates realistic movement using swimming behaviour collected over relatively short periods (hours to days) and does not include large-scale movement such as migratory circulation patterns. For this study, a representative 24-hour period was simulated.

Ideally, a simulation area is large enough to encompass the entire range of a population so that any animal that could approach the source during an operation is included. However, there are limits to the simulation area, and computational overhead increases with area. For practical reasons, the simulation area is limited. In the simulation, every animat that reaches a border is replaced by another animat entering at the opposing border—e.g., an animat crossing the northern border of the simulation is replaced by one entering the southern border at the same longitude. When this action places the animat in an inappropriate water depth, the animat is randomly placed on the map at a depth suited to its species definition. The exposures of all animats (including those leaving the simulation and those entering) are kept for analysis. This approach maintains a consistent animat density and allows for longer integration periods with finite simulation areas.

E.3. Seeding Density and Scaling

Seeding density refers to the spatial sample rate, in units of animats/km^2, used in the simulation. It is not related to the real-world animal density, but rather is a model parameter that controls the how samples are drawn from the model space. The minimum required seeding density for any given project depends on several factors such as bathymetry, source characteristics, and the behavioural profile of the animats, with the main constraint being computation time and resources. Seeding density is adjusted as needed based on model conditions specific to a project or project area.

In the present study, the exposure criteria for impulsive and non-impulsive sounds were used to determine the number of animats exceeding exposure thresholds. To generate statistically reliable probability density functions, all simulations were seeded with an animat density of 4 animat/km^2 over the entire simulation area. Due to insufficient density data availability, the modelling results are not related to real-world density estimates for pygmy blue whales within the BIA.

Appendix H Consideration of the Indirect Consequences under Section 527E of the EPBC Act

Shell does not consider that the Activity will result in indirect material GHG emissions. For completeness, Shell has considered Policy Statement "indirect consequences" of an action: Section 527E of the EPBC Act, as required by NOPSEMA. Shell's consideration of how that Policy Statement applies in the context of this EP is provided below.

Consistent with the provisions outlined in section 527E(1) of the EPBC Act, an event or circumstance is an 'impact' of an action taken by a person if it meets these criteria:

(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 GHG 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 are either within the contemplation of the proponent of the primary action or are a reasonably foreseeable consequence of the primary action.

In preparing this EP Shell has considered the potential for 'indirect consequences' to arise in relation to the development and specifically the petroleum activity that is the subject of this EP.

Under the EPBC Act, 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 (section 527E(1)(b)); and
- Facilitating, to a major extent, the action taken by the third party (as further explained in section 527E(2)).

In the context of this EP, and in the context of the [Policy Statement], the scope of relevant petroleum activity is limited to the installation and cold commissioning of the Crux infrastructure, excluding the hot commissioning and operation of other facilities necessary for hydrocarbon production and transportation. Therefore, Shell does not consider the Activity will result in material indirect emissions, noting:

- Gas or condensate recovery does not occur as a direct result of the installation and cold commissioning activities under this EP. Subsequent petroleum activities, subject to authorisation under the OPGGS(E) Regulations, are necessary before any gas or condensate is capable of being recovered.
- The petroleum activities (installation and cold commissioning) under this EP do not reasonably facilitate gas consumption/combustion. Even if some kind of facilitation could be observed, installation activities cannot reasonably be characterised as an important or majority facilitator of that action. These activities are multiple steps removed from being characterised as primary actions in relation to a secondary action involving gas consumption/combustion.
- A chain of events must precede and follow the recovery of resources (i.e. gas and condensate) before any consumption or combustion by a third party occurs.

In this context, Shell has concluded that Crux installation and cold commissioning activities does not facilitate, to a major extent, gas/condensate consumption or combustion and this petroleum activity is not a substantial cause of scope 3 GHG emissions associated with gas combustion by the end user.

At a later stage, Shell will submit an EP to extract, produce and transport the gas and condensate. Shell cannot extract natural gas from the development wells until these petroleum activities have been assessed, have met the criteria in section 59 of the OPGGS(E) Regulations and NOPSEMA has accepted the EP.

The causal relationship between production operations petroleum activities and consumption or combustion of gas by a third party is different in those circumstances. Shell will consider indirect consequences when developing the future production operations EP

Appendix I: Shell Crux FCGT & Dewatering Plume Modelling & Dispersal Report

CRUX SUBSEA STRUCTURES AND PIPELINE EPCI SERVICES

Shell Crux FCGT & Dewatering Plume Modelling & Dispersal Report

03	01/09/23	Approved for Construction	SFIN	SFIN	SOSE
02	13/06/23	Issued for Approval	SFIN	SFIN	SOSE
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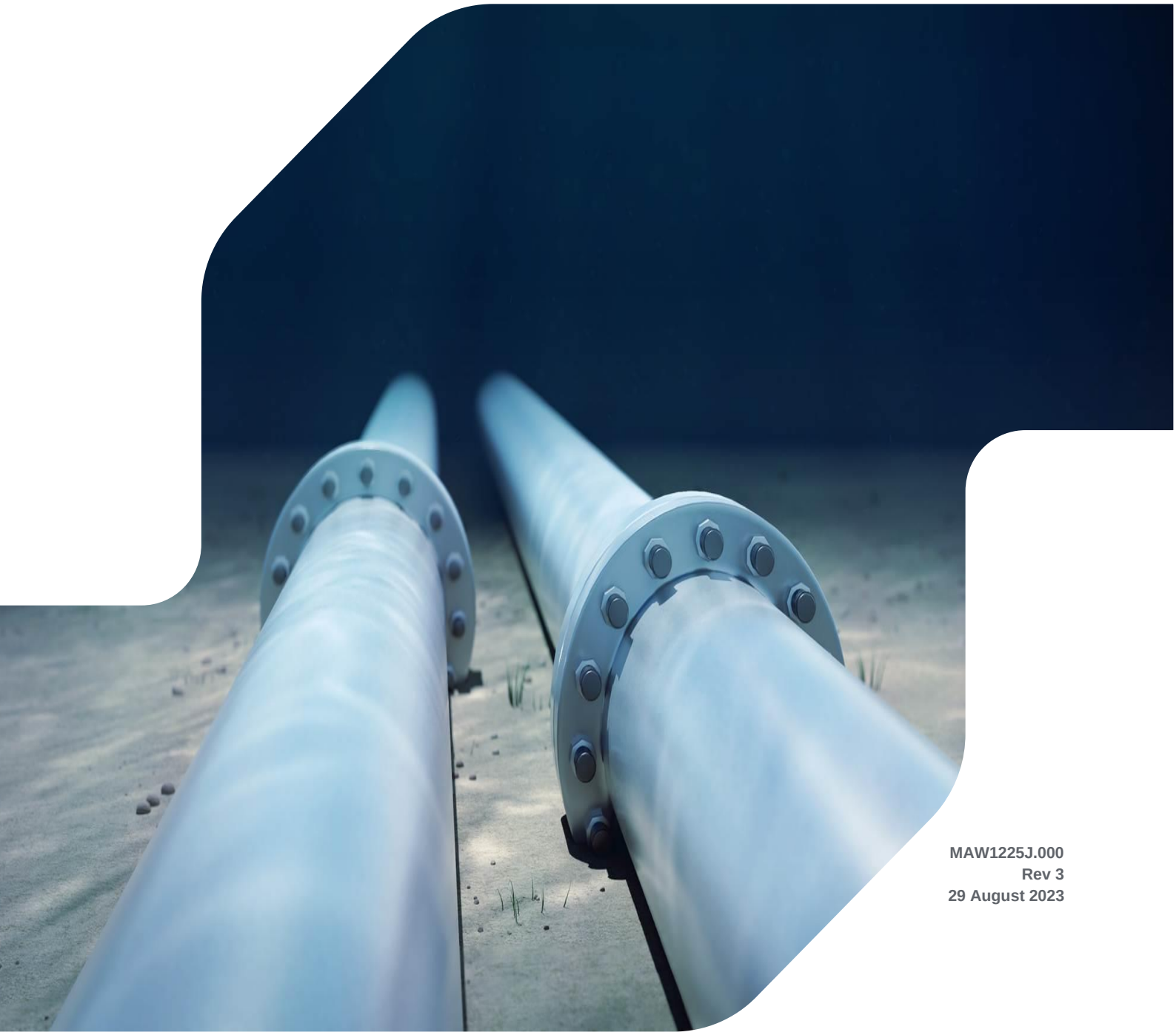
SHELL CRUX PIPELINE DEWATERING

Dispersal Investigation



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Rev 3	Clarifications added	S. Langtry	S. Langtry	S. Langtry	29/08/2023

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Scott Langtry		29 August 2023

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Prepared by:

RPS

Scott Langtry
Principal Scientist

Level 3, 500 Hay Street
Subiaco, WA 6008

T +61 8 9211 1111
E david.wright@rpsgroup.com

Prepared for:

Allseas Marine Contractors Australia Pty Ltd

Steve Finan
Work Pack Manager

Level 17, 1 William Street, Perth WA 6000.
Australia

T +61 8 6181 9558
E SFin@allseas.com

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1 BACKGROUND

RPS has been commissioned by Allseas Marine Contractors Australia Pty Ltd (Allseas), on behalf of Shell Australia Pty Ltd (Shell), to undertake a marine dispersion modelling study of proposed water discharges from pipeline hydrotest and dewatering operations that would be carried out at the end of the pipeline that will connect to the Prelude floating liquefied natural gas (FLNG) vessel.

The aim of this study was to quantify the likely extents of the near-field and far-field mixing zones for the chemicals added for treatment to map out the zone of potential environmental influence. The boundaries of this environmental effect zone have been calculated based on the instruction that the discharged water will contain up to 500 mg/l of a chemical mixture formulated to prevent degradation of the pipeline and that this mixture must be diluted to at least 1 ppm (i.e., 0.01 mg/l) to be protective of marine species, following previous assessment by Shell. This study does not assess for, or consider consequences of, any cross-contamination with facilities on the Prelude FLNG. However, advice is provided on controls that would prevent or limit the potential for such cross-contamination.

Shell provided details that the chemical mixture is most likely to be the treatment product Hydrosure™ O-3670R, which is formulated as an oxygen scavenger, corrosion inhibitor, and biocide. The Material Safety Data Sheet (MSDS) for this proprietary product lists the ingredients as including Benzyl-(C12-C16 Alkyl)-Dimethyl-Ammonium Chloride (up to 30%); Dipropylene Glycol Monomethyl Ether (up to 5%); Ethylene Glycol (up to 5%); Acetic Acid (up to 5%) and Basic Violet 10 dye (combining Rhodamine B or D&C Red No 19; up to 5%). The MSDS sheet for the product (NALCO Champion, Version 1, revision date 9/6/2016) claims low environmental effect of the product to aquatic organisms when mixed into waterways and lists maximum concentration limits of each of the above ingredients (alone) for protection of fish and invertebrates at higher concentrations than the treatment concentration that has been proposed (i.e., > 500 mg/l). These details indicate that the requirement to dilute to 1 mg/l for protection of the marine environment may be conservative for the influence of individual chemicals in the mixture. However, these details do not account for any additive effects that may be expressed by the combination of chemicals, which were unknown to this assessment. Beyond any chemical toxicity that might be imparted, removal of oxygen from the treated water would impart additional physicochemical stress on marine organisms. As a minimum, the anoxic water would need to mix with ambient water to raise the oxygen content of the water to natural levels.

The Prelude FLNG (Prelude) vessel operates within the Browse Basin, in Australian Commonwealth waters, offshore the North-West coast of Australia (Figure 1-1; Figure 1-2). Prelude is positioned approximately 147 km east of the Scott Reef/Seringapatam complex, 44 km to the north-west of Browse Island and 155 km from the Australian mainland. Water depth under Prelude is approximately 250 m on a gently sloping section of seabed, deepening towards the north-west. The 100 m depth contour extends within 50-90 km to the south-east and east. The nearest shoals with depths <20 m are Echuca Shoal (63 km to the east) and Heywood Shoal (85 km to the north-east).

Prelude processes well fluids to produce gas and condensate from the Browse field for offload to LNG, LPG, and Condensate carriers. The vessel is ~480 m long and rotates at the bow section around a turret structure that is held in place by an array of anchors. Well fluids enter the facility through the turret structure. The Crux production facility would deliver well fluids to Prelude via a 160 km long subsea pipeline.

Allseas will be responsible for constructing, installing, and testing the new subsea pipeline. Once constructed, the pipeline must be filled with seawater for flushing, cleaning and pressure gauging to ensure that the pipeline is free from leakage. The seawater will be dosed on filling with a defined concentration of the treatment chemical to ensure that corrosion, scale formation and microbial growth does not occur inside the pipeline. Allseas has advised that the volume of water held in the pipeline when full would be 49,959 m^3.This volume shall then be displaced with another line volume of chemically-treated seawater, with displacement of the first line volume of chemically treated water at the riser base of the Crux pipeline, with the discharge occurring just above the seabed (4 m ABL) and ~ 450 m from the Prelude FLNG (Figure 1-2).

After an extended period of preservation, and connection of the pipeline to the Prelude FLNG, the line volume of chemically-treated seawater shall then be displaced and replaced with dry air, with displacement of this water planned to occur via a temporary hose line directed through the turret at the bow of the FLNG. The discharge point for this discharge would be at the bottom of the FLNG, approximately 18-20 m below sea level depending upon the displacement of the vessel at that time.

At the time of this assessment there was uncertainty about some variables that would significantly affect the nearfield dispersion of the discharges:

1. The diameter of the port though which the FCG stage is discharged might potentially range from 245 mm (4 inches) to 622 mm (10 inches), with a large influence on the discharge velocity for a given discharge rate. The orientation might also vary between vertical upwards or horizontal depending upon the port that is used.
2. The discharge rates for each stage might range from 0.1 m^3/s to 0.3 m^3/s depending upon control of the speed of the pigging device that is used to clear the treated water, which, in combination with the port size, would affect the velocity of the discharge through the ports, and hence the initial mixing rate.
3. The density of the discharges might vary depending upon the temperature of the held-up water relative to the background water at the receiving depth. The water might range from slightly dense to neutral density, which would affect whether the plume tends to sink or remain at the discharge depth.

In general, higher mixing rates (higher dilution) will occur with higher velocity discharges, into stronger current flows, and where there is a differential of the discharge and receiving water densities that will force the plume to sink or rise (with the proviso that the plume is not constrained by the seabed or the water surface or some other overhead barrier, respectively). These inputs will each be under the control of the managers of the discharge.

Testing and comment on the influence of these variables has been included in this report.

Dewatering will be managed by driving a pigging train through the pipeline from the Crux development toward the Prelude location. The rate of discharge would be controlled by the speed that the pigging equipment is driven through the pipeline. Given that the discharge volume for each stage of discharge would be a constant (49,959 m^3), the duration of each discharge period will vary with the pigging speed that is applied for that stage.

The FCG scenario would be completed once, while the DEW scenario may be repeated up to 3 times. However, the time that would elapse between the three DEW scenarios is expected to be longer than the time required for dispersion of the plume of treated water. Hence, the three DEW discharges can be considered independent of each other (not additive).

Dilution of the discharges will occur through different physical processes over different distances:

1. Dilution generated due to the turbulent release through the pipeline openings, and any associated variation in the density of the discharge and receiving water, which will occur close to the discharge point – referred to as “near-field dilution”.
2. Subsequent dilution of the discharge plume generated by transport and dispersive forces imparted by the receiving water, which will occur over further distance – referred to as “far-field dilution”.

The phases of dilution may also be distinguished in terms of time requirements, with near-field dilution processes completing over short time scales (tens of seconds to minutes) and far-field dilution to safe levels of dilution requiring orders of magnitude longer (tens of minutes).

Hence, to accurately determine the dilution of the hydrotest discharge and the total potential area of influence, the effect of both near-field and far-field mixing must be considered. Different modelling approaches are required for calculating near-field and far-field dilutions due to the differing hydrodynamic scales.

To assess the rate of mixing of the treatment chemicals under each scenario, near-field dispersion modelling was carried out using a deterministic dispersion model, CORMIX, accounting for fixed inputs for the rates of discharge, the size of the opening, the densities of the discharge and receiving water, and the range of local current speeds at the discharge depth. This process calculates a range of outcomes based on the array of inputs.

Calculations for representative levels of initial dilution generated by near-field processes were used as input to stochastic dispersion modelling over the far-field. Stochastic modelling involved repeated simulation of ongoing discharge under each scenario, with each simulation using a unique time-sequence of prevailing current flow. Unlike the near-field calculations, these calculations accounted for the outcome of ongoing discharge (spanning the calculated durations of discharge under each scenario) under varying ocean conditions. This allowed for processes such as double-dosing of the plume and temporary build up over period of reduced current, such as the turning of the tide. Representation of prevailing currents was derived using measurements of current flow over 2.8 years (September 2007 to May 2010) commissioned by Shell Australia at a nearby location (Figure 1-2).

The potential area that may be influenced by the hydrotest discharge plumes was separately assessed by stochastic modelling of the far-field dilution field under samples of current selected, at random, from the sequence of measured current data, with the process repeated for current data selected from three seasons: (i) summer (December to February); (ii) the transitional periods (March and September to November); and (iii) winter (April to August). This approach captured variation in the path and rate of dilution of the discharge plume.

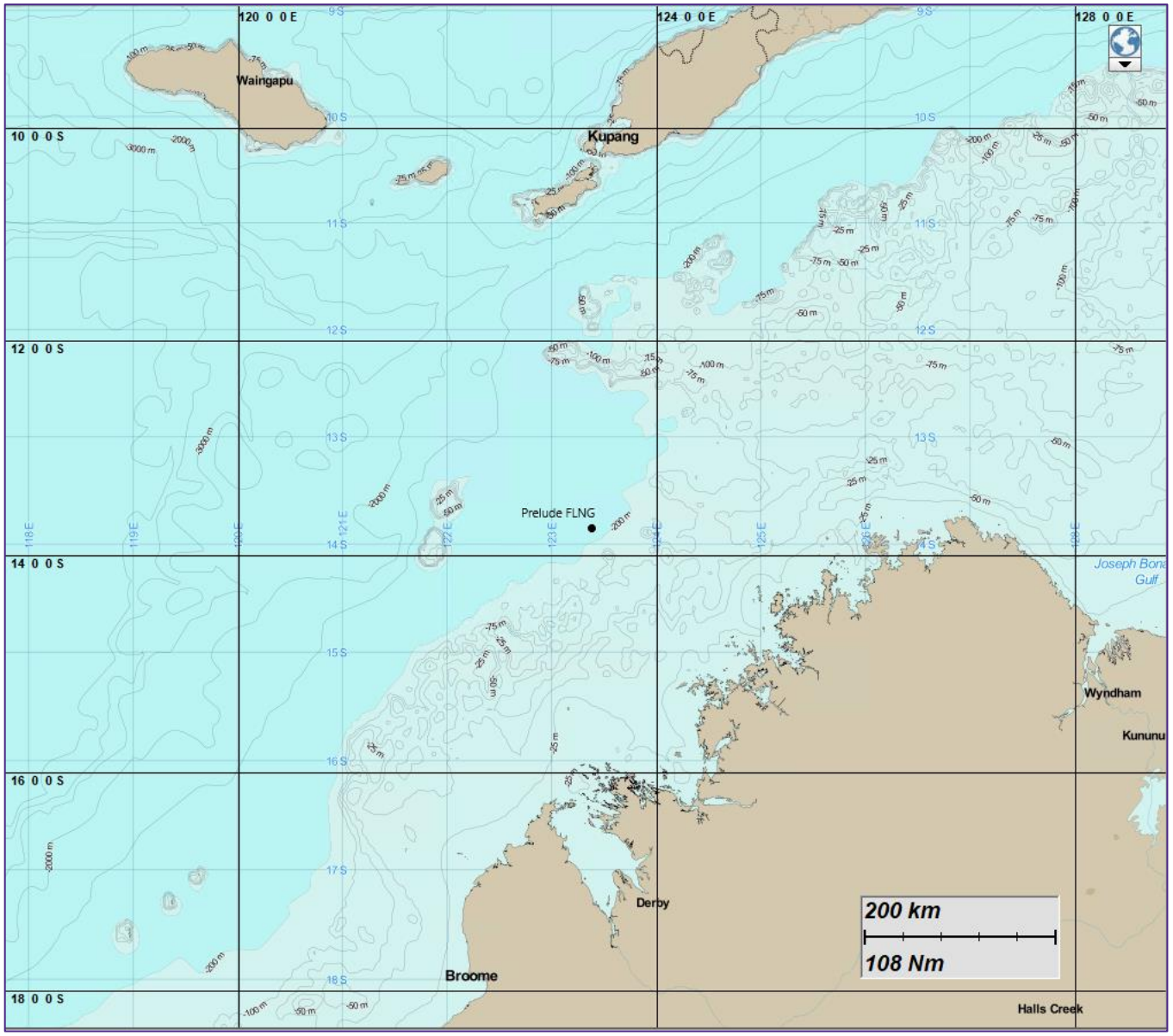

Figure 1-1 Regional bathymetric setting of the Prelude FLNG vessel.

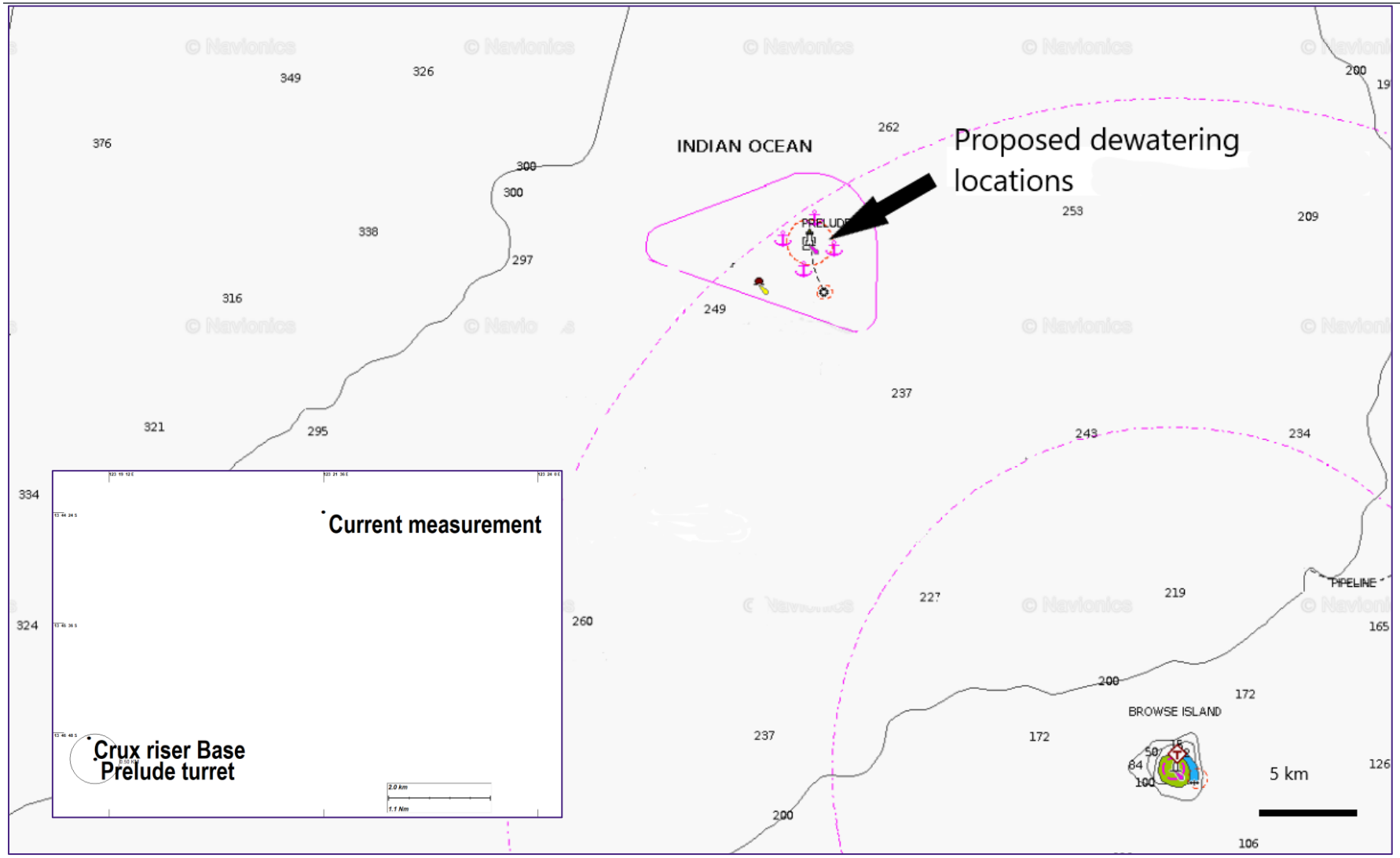

Figure 1-2 **Local bathymetric setting of proposed dewatering operations around the Prelude FLNG vessel (map source: Navionics). The inset shows the locations of the proposed discharges relative to a current measurement location. The distance ring (500 m radius) shown in the inset marks the outer radius of Prelude, which rotates around the turret location.**

Table 1-1 Locations of the proposed dewatering operations that were assumed for the modelling.

Release site	Latitude (°S)	Longitude (°E)	Water depth (m)	Distance above seabed (m)
FCG discharge scenario from the Crux riser base	13° 46’ 51.53	123° 18’ 58.53”	246	4
DEW discharge scenario from the turret centre of Prelude	13° 47’ 10.93”	123° 19’ 3.14””	20	230

2 MODELLING METHODS

2.1 Near-field modelling

2.1.1 Overview

Near-field and far-field modelling are used to describe different dilution processes attributable to different forcing conditions and operating at different time and space scales. Near-field modelling is designed to calculate the initial dilution that can be expected from discharging a stream of fluids of a defined density, through a restriction, into the background water. The model accounts for the velocity of the discharge stream (jet) and the viscous resistance imparted by the receiving water. This modelling also accounts for the orientation of the jet relative to the current and the magnitude of the current speed. If density differences remain between the partially-diluted plume and the receiving water after the momentum is lost, near-field modelling also calculates for buoyancy effects that may force the plume to rise or sink through the receiving water, generating further dilution.

Critically, near-field modelling only calculates outcomes for steady state conditions, i.e., fixed definitions of the discharge rate, opening dimensions, relative densities, and background current flow, and assumes that the background water is free of previous exposure to the discharge stream. Among other guidance, near-field modelling allows testing for the optimum discharge configuration that will maximise initial dilution. The endpoint for near-field calculations will occur when the influence of the discharge jet and any subsequent buoyancy gradients have ended.

Far-field modelling operates over larger time and space scales and accounts for dynamically-changing inputs (discharge details, current forces, etc.) over longer time-spans. Consequently, far-field modelling results will not necessarily correspond to the outcomes at the end of the near-field mixing zone for any given discharge scenario. The far-field modelling may include episodes of pooling of the discharge plume under weak currents (such as at the turn of the tide) or repeat dosing if the partially-diluted plume returns to the location receiving ongoing discharge, yielding higher remaining concentrations from a given number of dilutions. Far-field modelling must also account for the wide range of possible current flows that might be occurring at the discharge locations over the discharge duration and extending longer until dispersion has reached a required endpoint. This variability is accounted for by stochastic modelling and statistical analysis to identify typical and more extreme outcomes.

2.1.2 Description of the near-field model

2.1.3 Model selection

The near-field mixing and dispersion of water discharges were simulated using the three-dimensional flow model, CORMIX. CORMIX is a mixing-zone model for environmental impact assessment of regulatory mixing zones. CORMIX contains a series of elements for the analysis and design of conventional or toxic, single, or multi-port, submerged or surface, buoyant or nonbuoyant pollutant discharges into stratified or unstratified water bodies, with emphasis on the geometry and dilution characteristics of the initial mixing zone (Doneker & Jirka, 1990). CORMIX has been validated in multiple studies (http://www.cormix.info/validations.php) and was therefore considered to be appropriate for this investigation.

Based on the inputs, the CORMIX model defines the appropriate equations for the situation; for example, if the plume is positively or negatively buoyant relative to the receiving water.

Inputs to the CORMIX model include:

- Height (above bed) and depth (below surface) of the discharge point.
- Orientation of the discharge relative to the seabed and prevailing current.
- Number, dimensions and horizontal spacings of the port(s).
- Discharge rate.
- Temperature and salinity of the discharge.
- Vertical profile of temperature and salinity within the receiving waters.

- Ambient current speed and direction relative to the discharge direction.
- Roughness of the seabed.

CORMIX calculates a shape and centreline dilution for the discharge jet (or jets in the case of multiple outlets), and the subsequent evolution of the plume in response to density and ambient current. The centreline is defined by the points of maximum concentration (minimum dilution) at each vertical section along the longitudinal axis. An average dilution of the cross-section of the plume is also calculated.

2.1.4 Inputs and assumptions

The CORMIX model was applied to simulate the maximum discharge rate for each of the dewatering scenarios, using specifications summarised in Table 2-1 (FCG scenario) and Table 2-2 (DEW Scenario).

It is noteworthy that the FCG discharge would occur away from large infrastructure that might influence current flow or the behaviour of the plume. However, the DEW discharge would occur from the base of the turret that holds Prelude in place and at the depth of the bottom plates of that vessel. Prelude rotates around the turret in response to the balance of wind and current forces, with dominant forcing by current flow due to the drag induced by subsea intakes, so that the hull is likely to be down-current from the proposed discharge locations during the dewatering operations. It is therefore necessary to consider whether the hull of the vessel would influence the dispersion of the DEW discharge, or if the DEW discharge plume might be drawn into seawater intakes on the hull. The potential for interaction between the plume and the hull would depend on three variables under the control of the operation:

1. The discharge orientation
2. The discharge velocity
3. The density of the discharge relative to ambient water

Downward-directed discharge of negatively-dense water at high velocity would be the ideal configuration to avoid interaction by directing the plume below hull depth until the momentum of the plume and neutral density is reached so that there would be no tendency for the plume to rise back up to the hull due to buoyancy. Low velocity discharge of neutrally- or positively-buoyant water would maximise the interaction because the plume would tend to remain at discharge depth (if at neutral buoyancy) or rise to the bottom of hull (if positively buoyant).

The density of the discharge water during each scenario was set assuming that the pipeline was filled with seawater at 34.5 ppt and that the water in the pipeline had cooled to match the temperature of the ambient water at seabed level (12 °C) over the storage periods. The addition of the treatment chemicals (density = 1.05 kg/l) at relatively low concentrations (500 mg/l) would have negligible influence upon the density of the treated water. This assumption would result in the water being neutrally buoyant relative to the receiving water during the FCG scenario when the discharge was assumed to be immediately above the seabed (hence at the same temperature as the treated water), and negatively buoyant (by 4-5 kg/m^3) relative to the receiving water during the DEW discharge scenario when the discharge would be into warmer water close to the surface.

The FCG discharge was assumed to be horizontal (i.e., level with the seabed) while the DEW discharge is expected to be vertically- downward due to the discharge exiting at the base of the turret.

A vertically-downward arrangement of the DEW discharge, at velocity, combined with the slight-negative buoyancy of the discharge can be expected to result in the discharge plume sinking below the hull of Prelude and, therefore, acting independently of any influence of the hull of Prelude on the prevailing current or dispersing plume. On this basis, the DEW discharge was assumed to occur in open space (below hull depth).

The maximum discharge rate (0.3 m^3/s) was assumed in each case because this would be the worst case in terms of initial concentrations generated in the receiving water. However, higher discharge rates also tend to generate higher discharge velocities, which will generate more dilution through mixing. Markedly different discharge velocities would result from the assumed orifice diameters for the FCG and DEW discharges. There would also be a large variation between the discharge velocities achieved for the FCG discharge depending upon the port size. The markedly larger upper potential port size (622 mm diameter) would result in relatively sluggish discharge (< 1 m/s), rapid dissipation of discharge velocity, and relatively low rates of initial dilution, compared to the smaller port choice, which would generate high jet velocities (up to 37 m/s) and high turbulent mixing that will extending further from the discharge port (See Section 2.1.5).

Given horizontal discharge from a fixed position of the FCG manifold, the discharge will occur across the prevailing current. Both the current direction and speed can be expected to vary over time relative to the discharge orientation, which will result in variability in the initial dilution rates. The range of discharge velocities that might be set up for FCG discharges (Table 2-1) are all markedly higher than the currents near seabed so that the plume would only be weakly deflected until the jet dissipates. Being neutrally buoyant, the FCG discharge would not tend to rise of sink. However, the thickness of the FCG plume would tend to increase with distance (i.e., the plume will spread vertically).

If the FCG discharge is directed through the larger port option (24.5”) much reduced discharge velocities would be set up over the range of pumping rates (Table 2-1), with these discharge velocities only marginally exceeding the prevailing current speeds. This will result in much reduced initial dilution and will require dispersion over longer time and distance beyond this zone. For discharge close to the seabed (4 m above), the base of the plume is also likely to impinge onto the seabed over a shorter distance, after the plume has undergone lower dilution.

Downward discharge at 0.3 m^3/s through the 10“ pipeline proposed for DEW discharge would result in a relatively rapid (5.92 m/s) discharge jet, with the jet directed downwards across the weaker (generally < 0.5 m/s) ambient current, irrespective of the current direction. Although this arrangement would set up lower velocity than the This discharge velocity would be an order of magnitude higher than ambient current velocities resulting in the jet initially moving downwards under momentum but then progressive bending of the plume to follow the ambient current as momentum is lost. Negative buoyancy of the DEW discharge would add to maintenance of the downward dispersion of the DEW plume until neutral density is reached, following which phase the plume would not tend to rise or sink but will be subject to vertical spreading. This is significant because this outcome would result in vertical separation of the plume from the hull of Prelude and prevent cross-contamination of water intakes on the hull.

At lower rates of pumping through the same outlet (i.e.,10”), the jet velocity of the DEW would be reduced (e.g., 2.96 m/s average velocity at 0.15 m^3/s; 1.97 m/s at 0.1 m^3/s). These rates would remain faster than the upper range of ambient current speeds, but the influence of the prevailing current will increase as the jet velocity decreases resulting in bending of the plume over a shorter distance, hence decreasing the vertical separation from Prelude hull depth. Lower pumping rates in combination with a port larger than 10”, and/or discharge of water that is not negatively buoyant can be expected to further erode the vertical separation of the discharge plume from Prelude hull depth and should be avoided.

Table 2-1 Inputs to near-field dispersion modelling assumed for the FCG scenario.

Operation	Variable	Set value
FCG	Orifice diameter (inches) [mm]	4 [100] or 24.5 [622]
	Discharge rate range (m^3/s)	0.15 to 0.30
	Discharge velocity range (m/s)	18.5 to 36.7 at 100 mm 0.49 to 0.99 at 622 mm
	Depth	4 m above seabed
	Orientation	Horizontal
	Maximum chemical concentration (ppm)	500
	Discharge density (assumed; kg/m^3)	1027.3
	Receiving water density	Vertically variable. See Table 2-3 & Figure 2-1.

Table 2-2 Inputs to near-field dispersion modelling assumed for the DEW scenario.

Operation	Variable	Set value
DEW	Orifice diameter (inches) [mm]	10 [245]
	Discharge rate range (m^3/s)	0.15 to 0.30
	Discharge velocity range (m/s)	2.96 to 5.92
	Depth	20 m below seabed
	Orientation	Vertical downwards
	Chemical concentration (ppm)	500
	Discharge density (assumed; kg/m^3)	1027.3
	Receiving water density	Vertically variable. See Table 2-3 & Figure 2-1.

Table 2-3 Average vertical profile of the water column during each seasonal period assumed for the Prelude facility (source: calculated from World Ocean Atlas 2013).

Season	Depth (m)	Temperature (°C)	Salinity (ppt)	Density (kg/m^3)
Summer	0	29.62	34.58	1,021.65
	10	29.54	34.57	1,022.10
	30	28.89	34.55	1,022.82
	100	25.35	34.54	1,023.44
	170	17.86	34.63	1,025.83
	250	14.58	34.64	1,026.67
Transitional	0	27.34	34.19	1,021.85
	10	27.33	34.21	1,022.18
	30	27.18	34.23	1,022.33
	100	24.43	34.33	1,023.57
	170	16.25	34.59	1,026.26
	250	13.45	34.6	1,027.23
Winter	0	28.49	34.34	1,021.85
	10	28.39	34.35	1,021.94
	30	27.48	34.39	1,022.35
	100	24.82	34.39	1,023.50
	170	16.98	34.59	1,026.09
	250	13.3	34.62	1,027.28

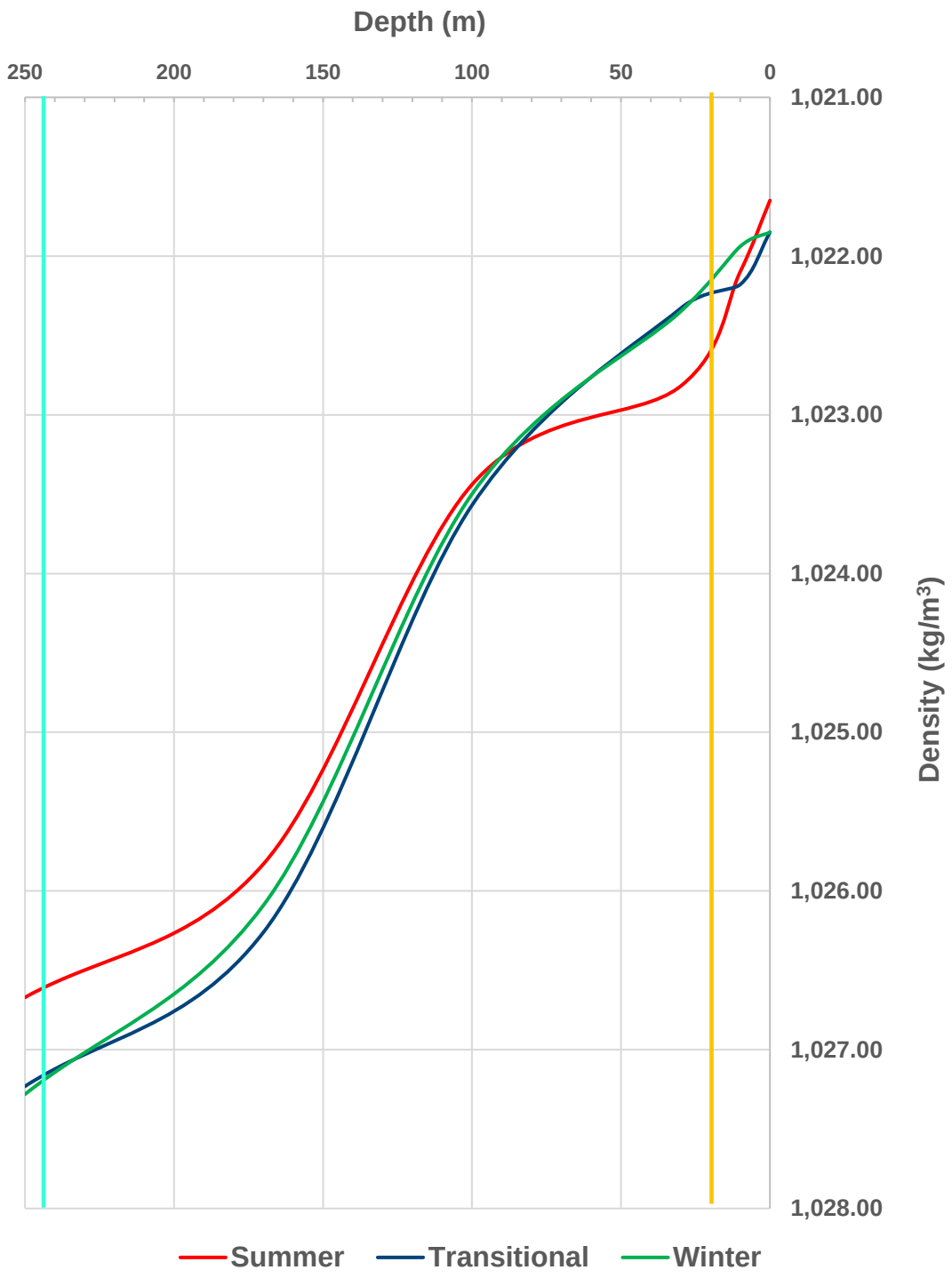

Figure 2-1 **Average vertical profile of the water column during each seasonal period assumed for the Prelude facility (source: calculated from World Ocean Atlas 2013). Vertical lines indicate the depths of the FCG discharge scenario (light blue) and DEW scenario (gold).**

2.1.5 Ambient currents

The Metocean Design Basis for the Prelude field (Shell, 2010) identifies that ocean circulation near Prelude is complex, with the principal driving mechanisms for current flow over the site (outside of cyclone events) being:

- Astronomical tides that are imposed throughout the water column along an elliptical orbit with the long axis directed south-east on the flooding tide and north-west on the ebbing tide.
- Local, wind-induced currents acting on the water surface, with propagation diminishing with depth.
- Regional current flows due to varying contributions of an anticlockwise gyre from the Indian Ocean, the South Equatorial current through the Timor Sea, affecting the full water column, and the Indian-Ocean Throughflow, which brings warm water from the equator with larger effect from surface to mid-depth.
- Short-term current pikes set up by internal waves (solitons) at the shelf break that occur through the water column beneath the near-surface stratification layer.

Astronomical tides generate regular and predictable tidal oscillations aligned with the main tidal axis and will tend to force plumes to oscillate about that axis. This outcome has implication for discharges that persist longer than a tidal phase (a few hours) because the dispersing plume may pass back over the source to be double-dosed. Variation in the speed of the prevailing current will also influence rates of dilution of water streams with higher initial dilution occurring under faster currents and lower initial dilution under slower currents. Increased concentrations can therefore build up around the source as the tide is turning.

Non-tidal forcing conditions will contribute stochastic variation to the speed and the path of plumes and will tend to divert plumes away from the tidal axis. Non-tidal flows frequently persist for longer than tidal cycles and can therefore override the cyclic nature of tidal flows on the initial dilution rates.

Data to indicate the distribution, pattern, and source of current flow over the Prelude location were available from two sources. Measurements of current flow, varying with water depth, were available from measurements at a location ~7.4 km to the north-east of the Prelude location (Figure 1-2). This data represents continuous measurement of current at the horizontal position of the measurement string over 2.8 years (2 September 2007 until 27 May 2010) with some small data gaps ranging from hours to days between sampling campaigns. The measurements are quality controlled, suggesting that the measurements should be reliable, and do span multiple years to provide indications of variation over time scales ranging from hourly to inter-annual. Being measurements at a single location, the data lacks information on spatial variability of the current around the measurement point.

Data to indicate the distribution of currents with depth were also available from hydrodynamic models that are operational over the area. These include the OFAM ocean model, operated by the Australian Bureau of Meteorology, and the HYCOM ocean model, operated by the US National Ocean and Atmospheric Administration. These models produce calculations for the non-tidal current flows and must be augmented by calculations for astronomical tidal flows. The models integrate regular ocean observations from satellite and other sources to improve accuracy but calculations of current with depth must be inferred, with increased likelihood of error with depth. The modelled data has the potential advantage of representing a larger set of variations in local circulation for the Prelude location (available for 10 years or more) and representing spatial variability in current at each time step.

Comparisons of the non-tidal components from overlapping periods of measured data and modelled data from the OFAM model indicate that the model was able to capture some of the short-term fluctuations in non-tidal current flow but frequently misrepresented other fluctuations and, overall, frequently under-represented the speed of the non-tidal current in the near-surface measurements. The direction of current flow is also frequently misrepresented. The speed of the non-tidal contribution to current flow near seabed is markedly slower than near the surface, but similar departures from the speed and direction can be identified. Based on these comparisons the measured current data were considered more reliable and were applied to represent current forcing in this study.

Current roses produced from the measured data at the heights closest to the dewatering locations indicate that residual currents may flow in any direction but are more frequently at stronger speed toward the south-east and north-east at the depth approximating the DEW discharge and towards the east or western sector at the depth approximating the FCG discharge.

The peak, non-tidal current speeds are, however, relatively low at either depth level. At the higher water level, the 95th percentile speed (not exceeded >5% of the time) of the tide-filtered data was calculated at 0.28

m/s and the median current speed was calculated at 0.11 m/s. Residual currents measured at the lower water level are an order of magnitude lower. The 95th percentile speed was calculated as 0.07 m/s and the median was reduced to 0.035 m/s.

Current roses summarising the data measured during each month of the year indicate the over-riding influence of the astronomical tidal currents on water flow around the Prelude location, resulting in higher peak current speeds than the non-tidal component, and a consistent north-west to south-east axis to the combined flow at the depth approximating the DEW discharge and a consistent east to west fluctuation at the depth approximating the FCG discharge. The shift in direction toward the seabed reflects the increased influence of the seabed slope in directing the combined current flows. The monthly current roses indicate that the relative influence of the non-tidal component varies among months at both depth levels.

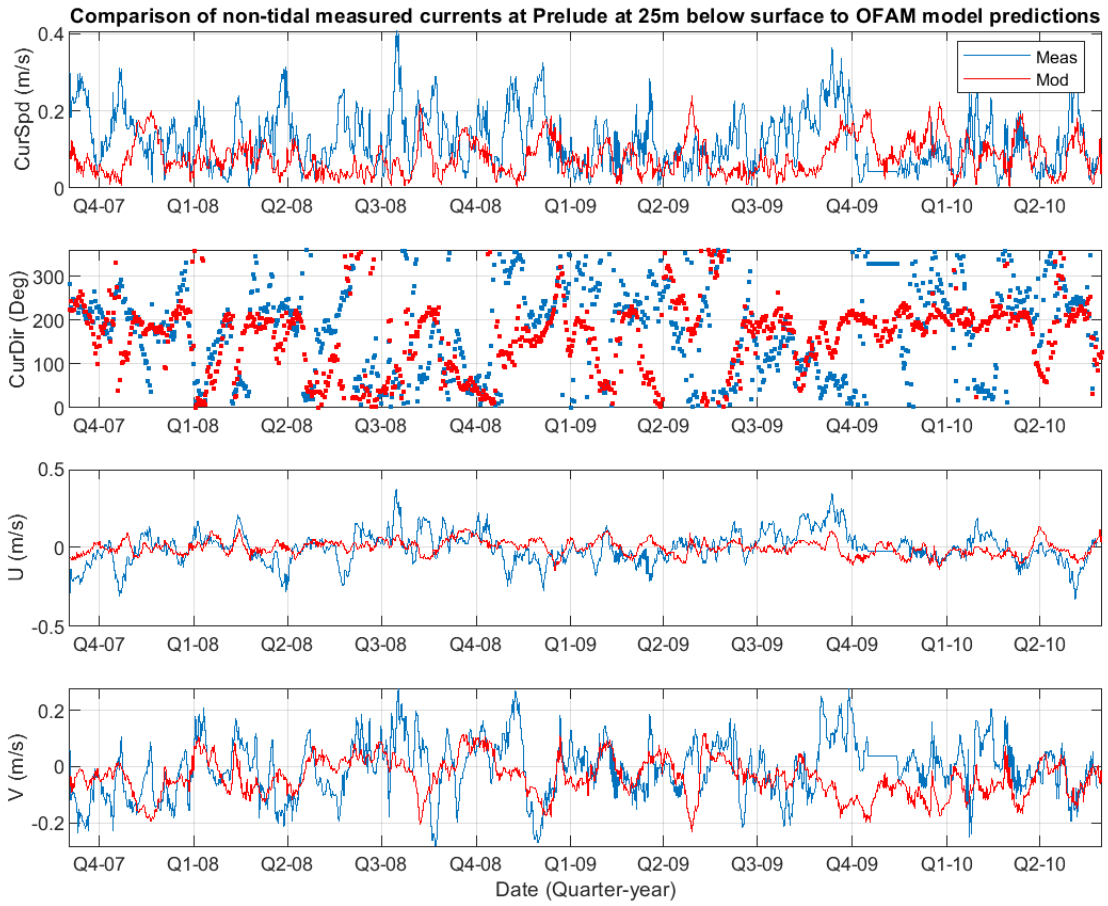

Figure 2-2 Comparison of the residual (non-tidal) current speed and direction from measurements at 25 m below sea level and as calculated by the OFAM model for the same depth level.

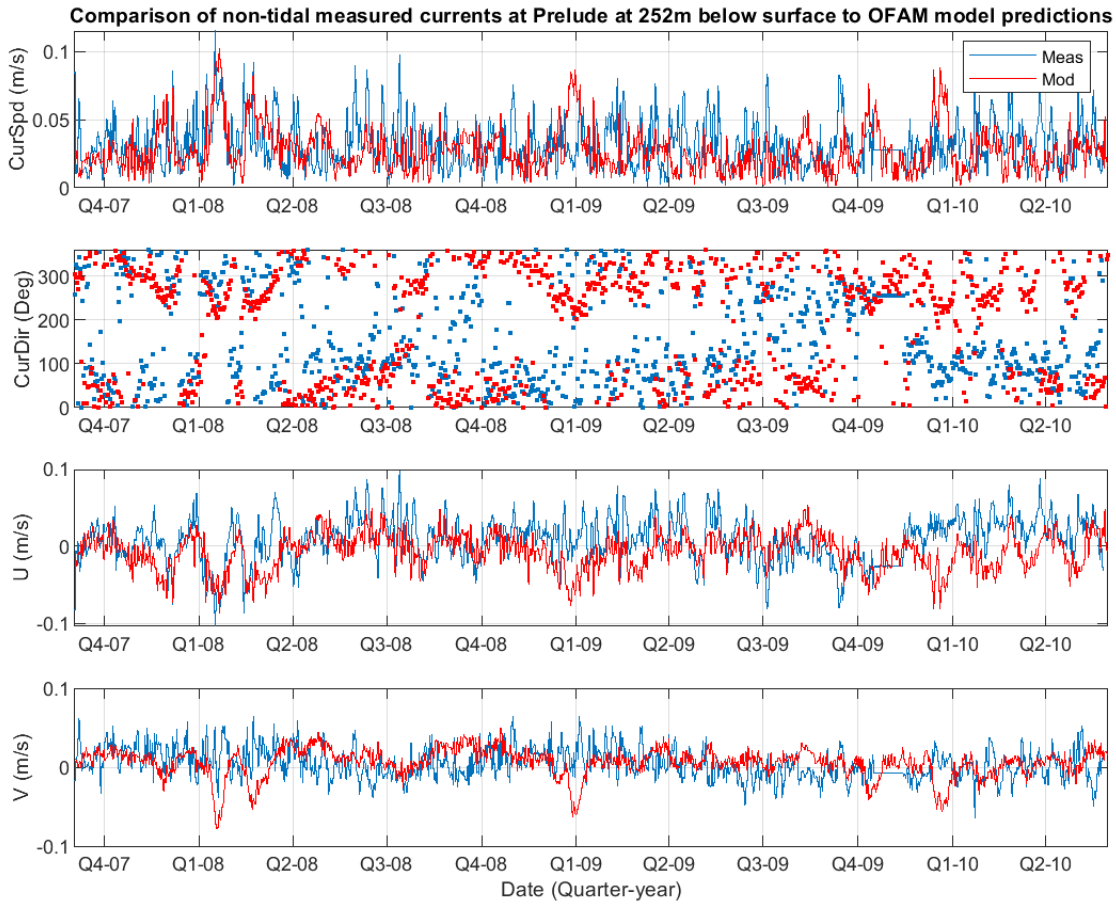

Figure 2-3 Comparison of the residual (non-tidal) current speed and direction from measurement at 252 m below sea level and as calculated by the OFAM model for the same depth level.

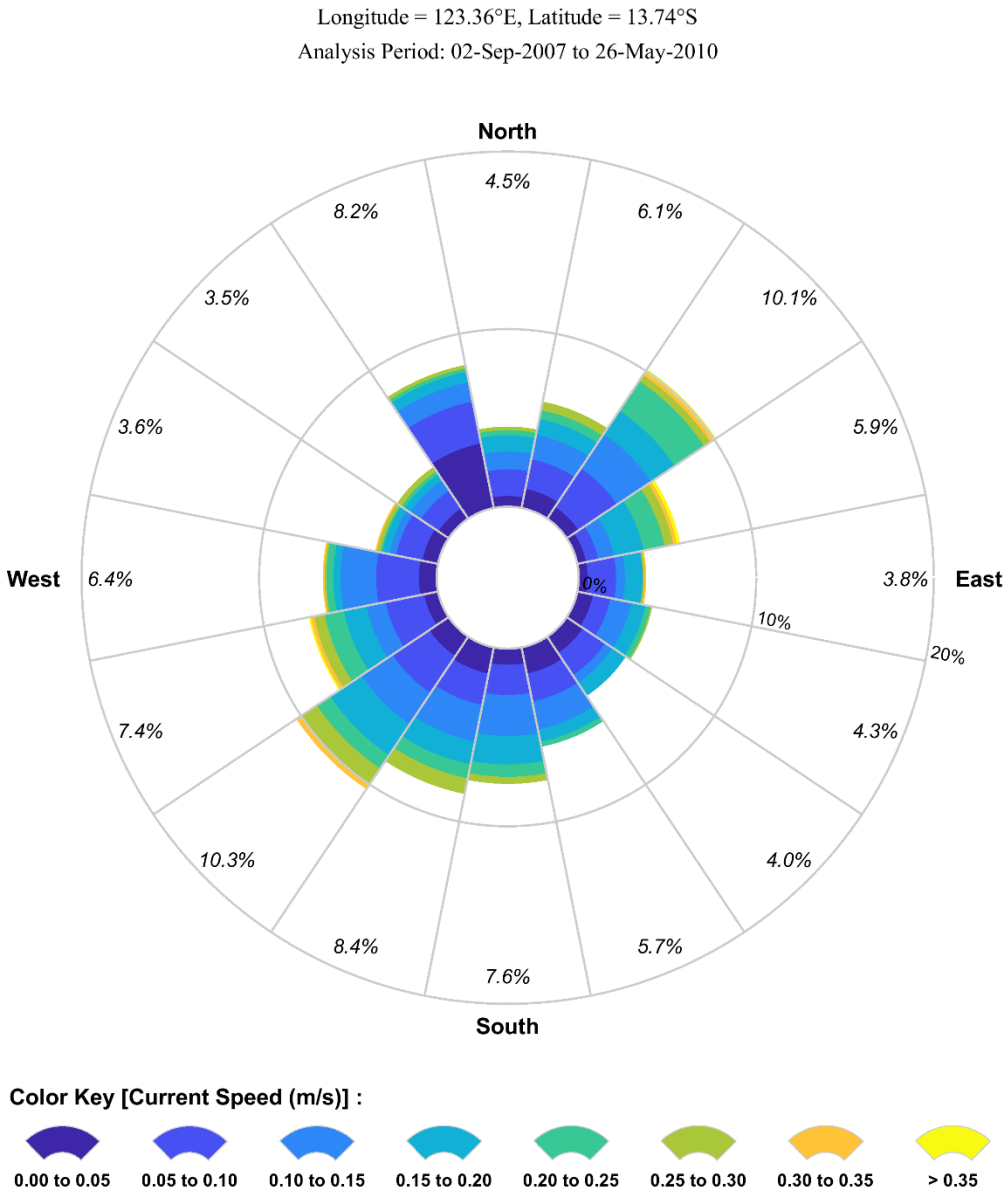

Figure 2-4 **Directional frequency distribution of the residual current speed measured at 24.9 m below sea level. Data were derived by filtering to remove the tidal component. Sectors point in the direction towards which the current was flowing. The length of each segment indicates the relative frequency of a given current speed and direction. Colour-coding indicates the speed.**

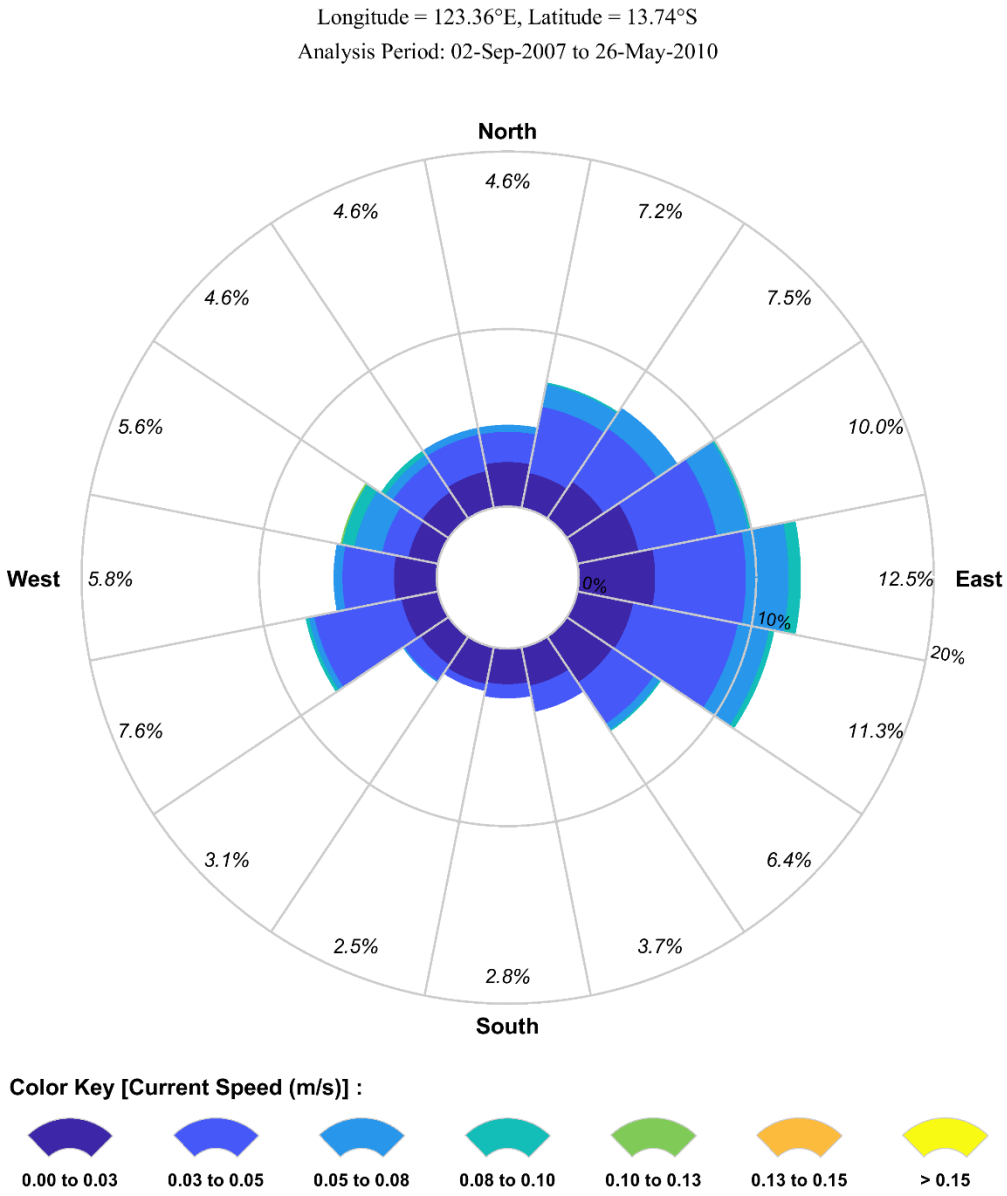

Figure 2-5 Directional frequency distribution of the residual current speed measured at 251.9 m below sea level. Data were derived by filtering to remove the tidal component. Coding as per Figure 2-4.

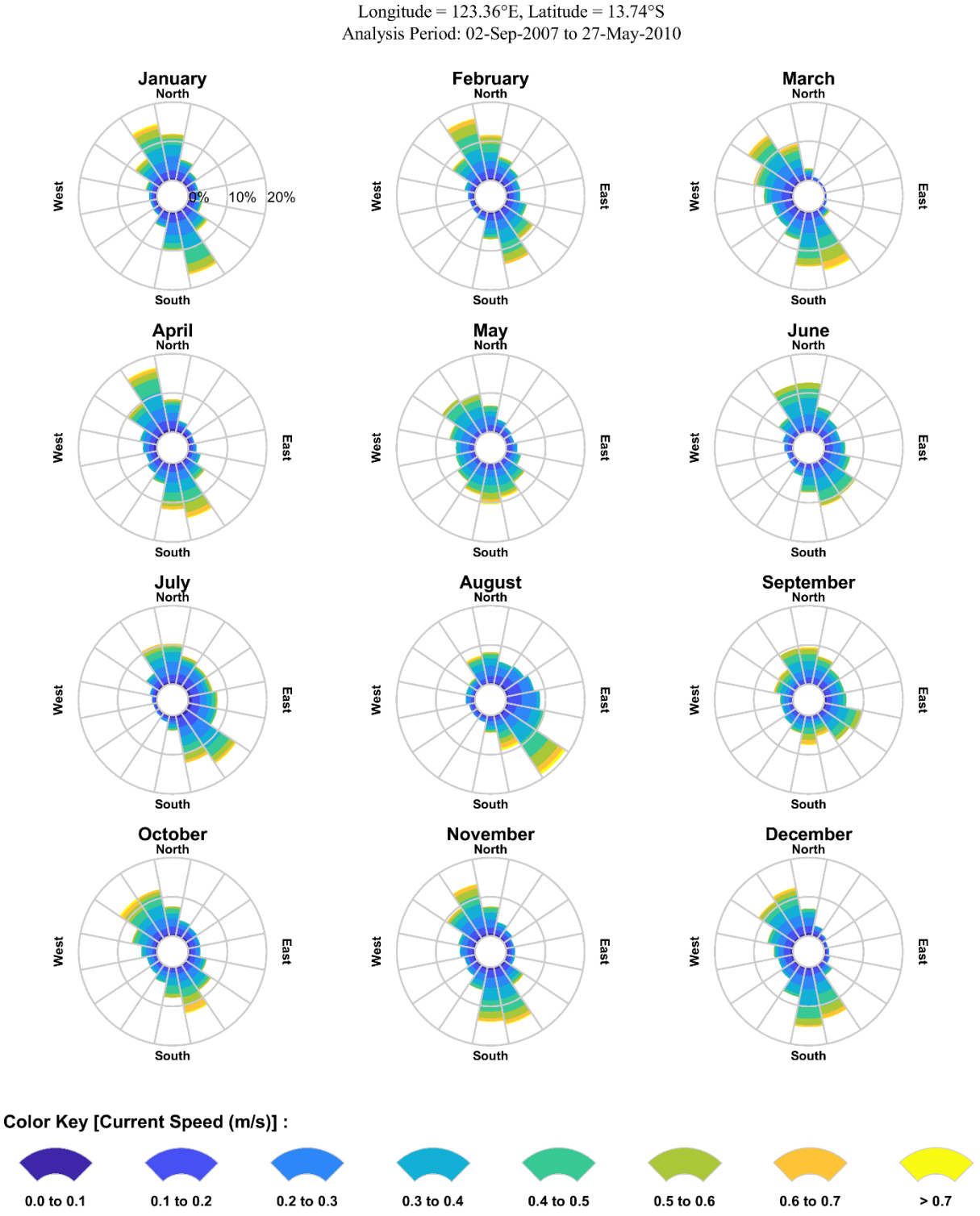

Figure 2-6 **Directional frequency distribution of the current speed measured at 24.9 m below sea level summarised for each month of the year. Coding as per Figure 2-4.**

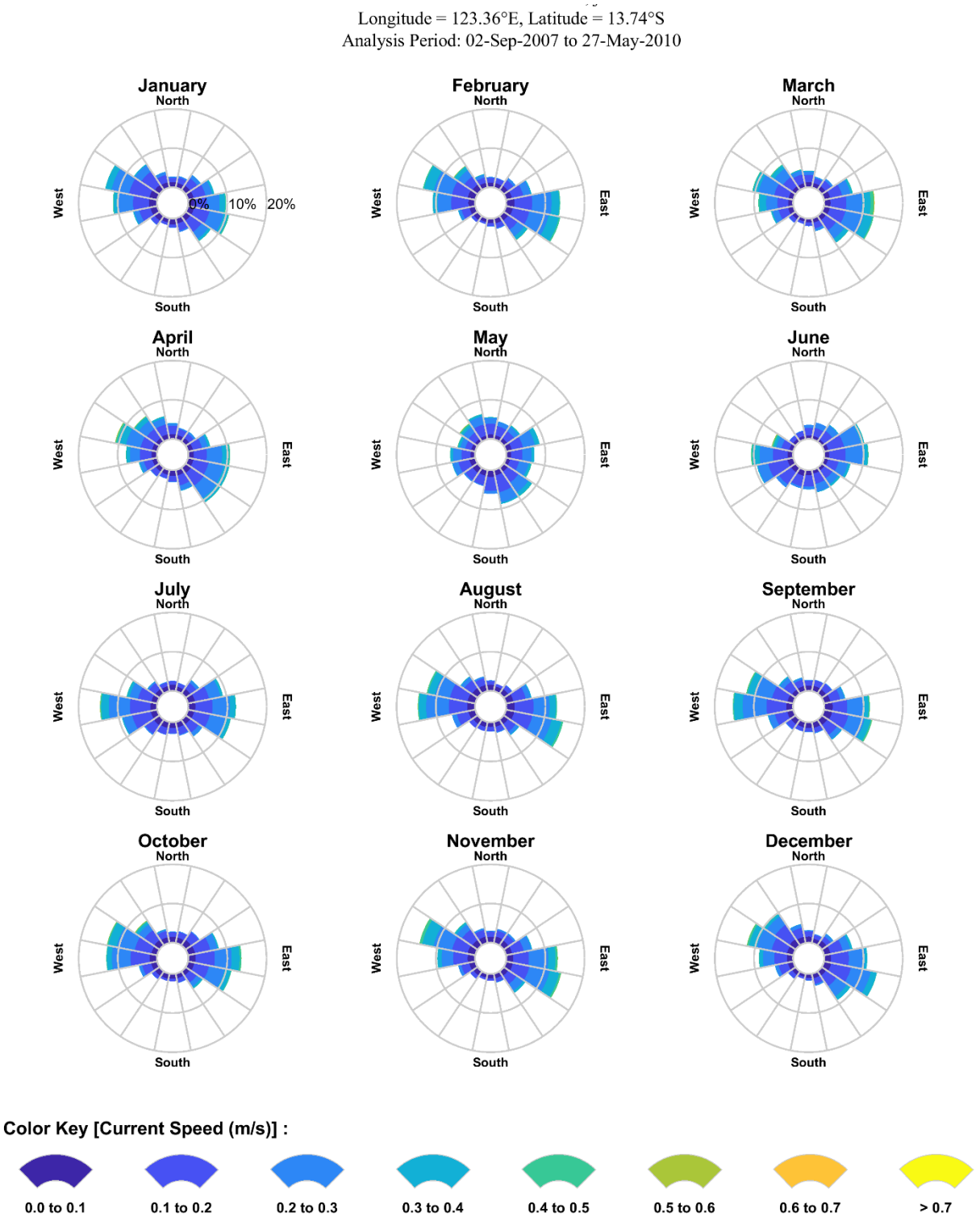

Figure 2-7 Directional frequency distribution of the current speed measured at 251.9 m below sea level summarised for each month of the year. Coding as per Figure 2-4.

2.1.6 Calculations of initial dilution rates

CORMIX modelling was conducted to calculate the initial dilution that can be expected from discharge under fixed configurations of discharge rate, port size and orientation, and relative density, under a range of current speeds, following the distributions calculated from the measurement at each depth level (Figure 2-8).

The initial dilution was judged for the end of the zone where dilution rates of 50 and 500-fold were calculated under constant conditions.

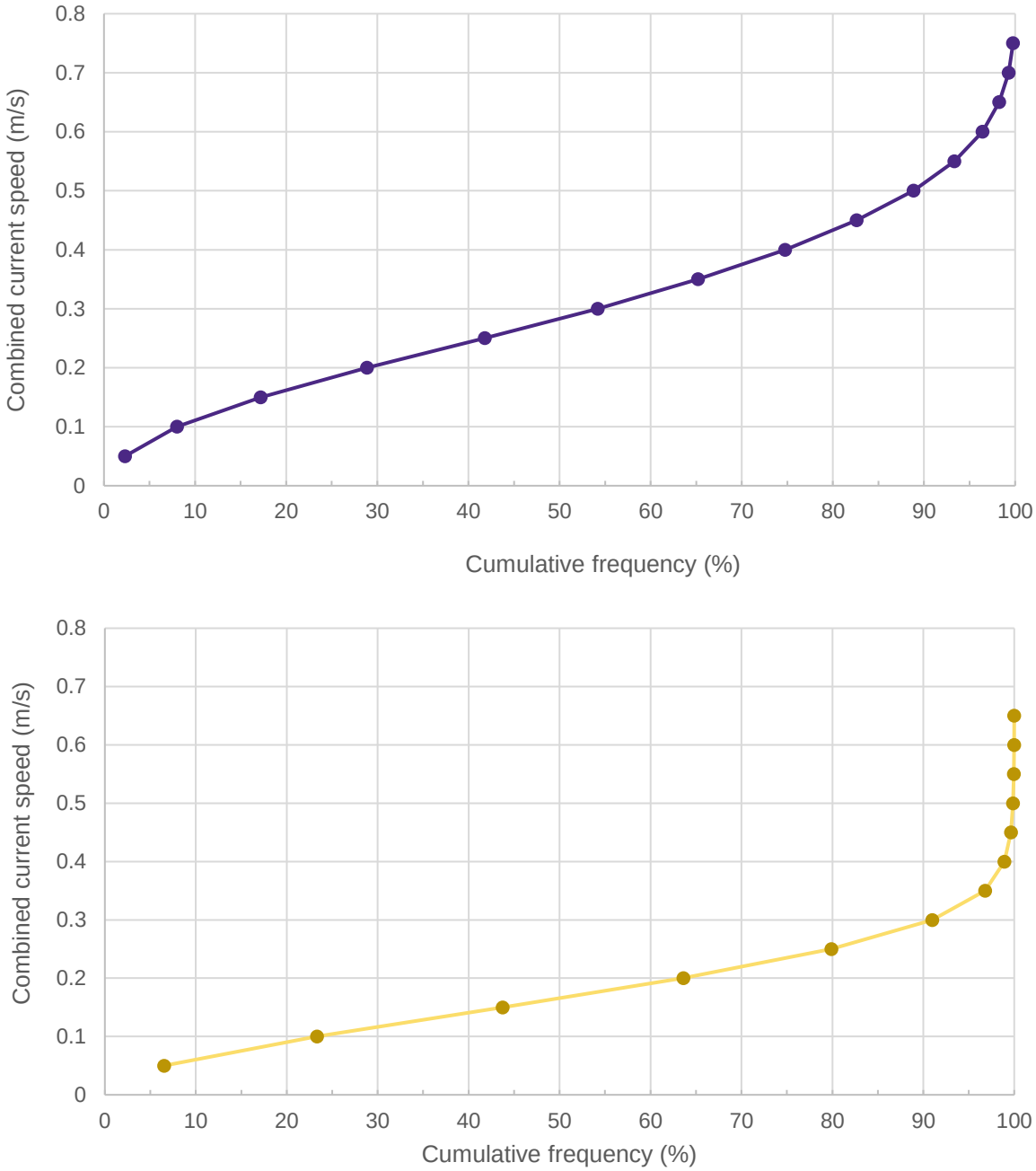

Figure 2-8 Cumulative frequency of current speeds measured at 24.9 m (DEW scenario: upper plot) and at 251.9 m (FCG scenario: lower plot).

The discharge arrangement at the FCG locations would be horizontal, or near-horizontal, relative to the seabed. The orientation of this discharge relative to the current flow would vary depending upon the positioning of the outlet on the FCG riser base and might range from with the current, through across the current to against the current. Due to the high velocity of the discharge relative to the range of ambient current speeds at the FCG riser base, the discharge velocity would dominate movement of the plume and there would be only weak deflection of the plume when across or opposed to the current.

CORMIX calculations indicated that FCG discharge through the smaller port option would set up a relatively long and thin jet plume that could dilute to the target threshold of 1 mg/l within distances ranging from 94 to 257 m under sustained current flow, depending upon the orientation and speed of the ambient current. Increased mixing over shorter distances is indicated for the case where the current acts across the plume, causing the plume to deflect with distance as the momentum of the discharge jet dissipates. In contrast, markedly lower initial dilutions would be achieved with the larger port option, extending the distances required for 500 dilutions up to 1 km (Table 2-4). The smaller port would therefore be best practice for that discharge.

CORMIX indicated that the DEW discharge, which would be negatively buoyant and orientated downwards and always across the current, would follow a downwards directed arc due to the combination of the higher velocity and negative density of the DEW discharge. The vertical distance of the plunge from the DEW discharge through a 10” outlet was calculated to vary with the strength of the prevailing current: greatest when the cross-current was at the weak end of the local range and decreasing at the high end of the range. Consequently, the near-field plume from the DEW scenario would flag over a depth range of ~80-100 m, hence vertically separated from the hull of Prelude over the range of current speeds. Dilution of the plume to the threshold level of 1 mg/l was calculated to occur over a range of 74 to 300 m of the discharge point with the longest distances when near-surface current speeds are at the high end of the range (Table 2-4). As stated previously, the plume will follow the prevailing current under the hull of Prelude and slower discharge through a larger port would not be ideal for maintaining vertical separation of the plume from intakes on the hull of Prelude.

The general shape and dilution of the near-field portions of the plumes that were calculated by CORMIX for the FCG and DEW configurations under variations in current speed are illustrated in Figure 2-9 to Figure 2-11, with the caveat that these plots show idealised profiles. The real plume would be expected to have a ragged edge and the distribution of dilutions would be more stochastic due to unsteady inputs of the discharge, turbulent-mixing and current speeds. In general, longer, and thinner plumes are calculated with distance for smaller port diameters that will set up higher jet velocities relative to prevailing current speeds. Because dispersion occurs as a function of time, the plume will travel further within a given time if the jet velocity is high relative to the current velocity. Stronger ambient currents across the flow will induce more rapid deflection of the plume to follow the current direction.

It should be noted that these CORMIX calculations assume instantaneous discharge of a quantity of water, dilution of the discharge by seawater that has not previously been contaminated by the discharge, and persistence of the current speeds until the threshold dilutions are reached. Because current speeds and directions would not hold constant over the duration of the discharge, and ongoing discharge could result in accumulation of concentrations of the process chemicals in the diluting water, these dilutions rates can only be considered as indicative. The far-field modelling provides for these other variations.

Table 2-4 CORMIX calculations for the dilution of the water discharges, and the diameter of the plume at distances from the source for variations of the FCG discharge configuration and ambient current.

Discharge scenario	Current speed (m/s)	Dilutions	Horizontal distance (m)	Plume diameter (m) at horizontal distance
FCG through 4” outlet with current	0.05	50	38	0.06
		500	242	77
	0.17	50	25	0.04
		500	235	25
	0.33	50	24	0.03
		500	257	19
FCG through 4” outlet across current	0.05	50	5	0.08
		500	94	63
	0.17	50	7	0.1
		500	98	27
	0.33	50	6	0.1
		500	142	20
FCG through 24.5” outlet across current	Weak (0.05)	50	91.4	15.6
		500	861.6	173.4
	Medium (0.17)	50	191.8	8.7
		500	981.0	27.6
	Strong (0.33)	50	331.2	6.4
		500	873.7	28.1

Table 2-5 CORMIX calculations for the dilution of the water discharges, and the diameter of the plume at distances from the source for variations of the DEW discharge configuration and ambient current.

Discharge scenario	Current speed (m/s)	Dilutions	Horizontal distance (m)	Plume diameter (m) at horizontal distance
DEW through 10” outlet downward across current	0.06	50	9	9
		500	74	37
	0.28	50	14	6
		500	186	22
	0.58	50	27	5
		500	299	14.

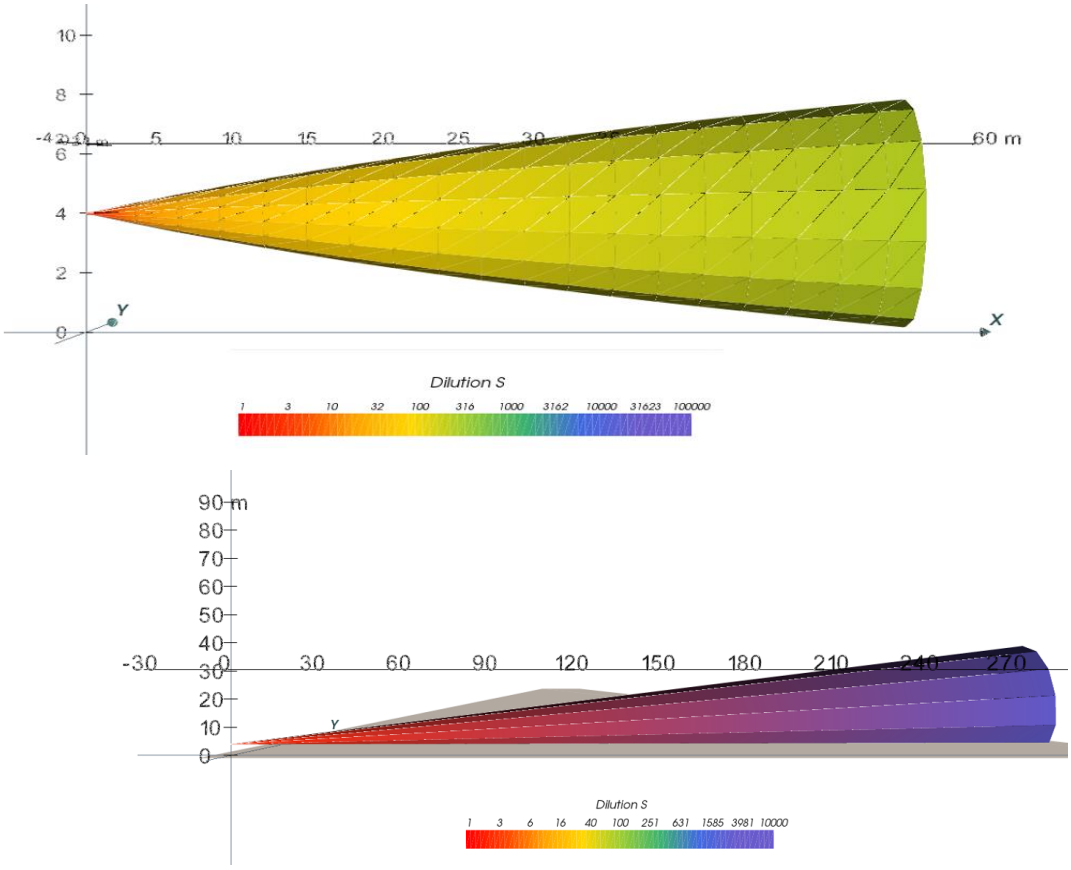

Figure 2-9 **CORMIX calculations for the shape and dilution rate of the near-field plume set up by the FCG scenario at 0.3 m³/s into weak current-flow (A: 0.03 m/s) and strong cross-flow (B: 0.17 m/s) through a 10" port.**

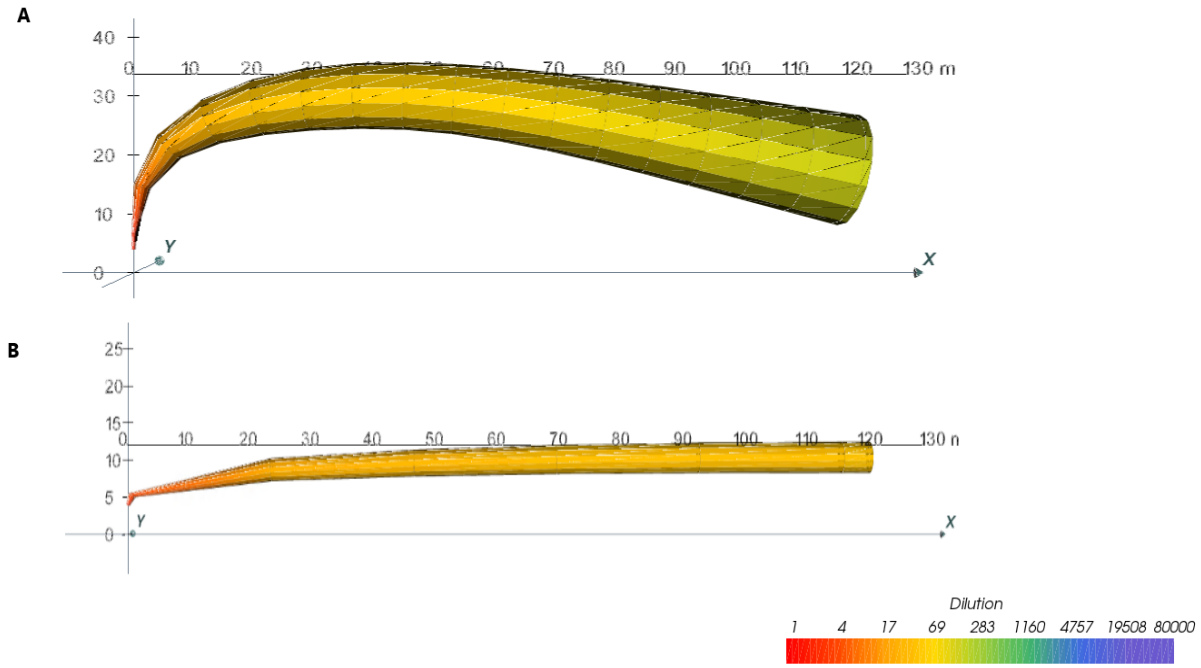

Figure 2-10 **CORMIX calculations for the shape and dilution rate of the near-field plume set up by the FCG scenario under weak cross-flow (A: 0.05 m/s) and strong cross-flow (B: 0.33 m/s) through a 24.5" port. Note that the dilution key differs to Figure 2-9.**

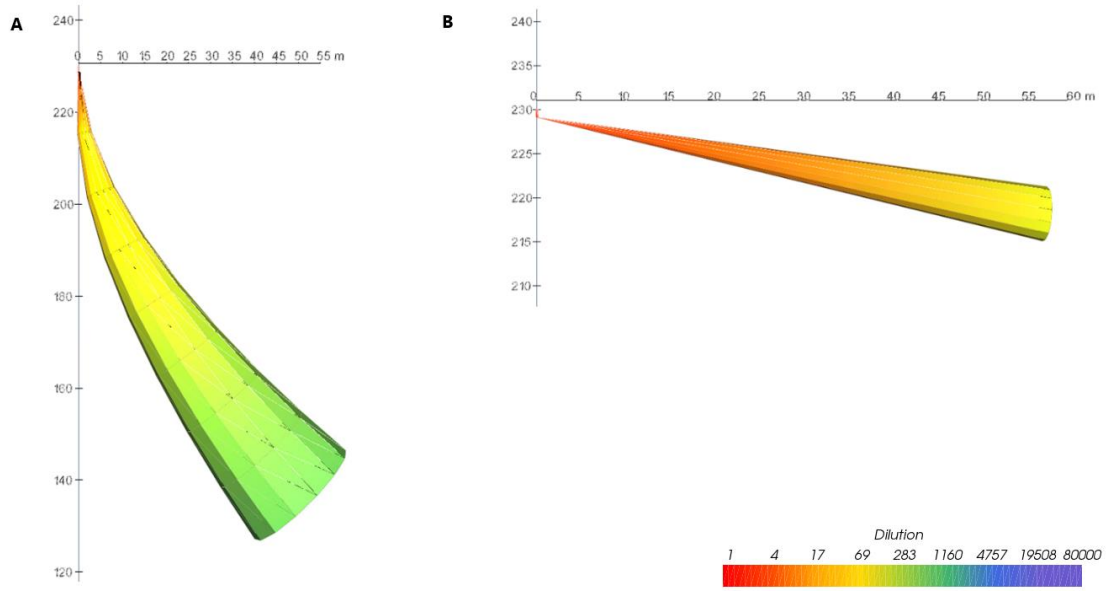

Figure 2-11 CORMIX calculations for the shape and dilution rate of the near-field plume set up by the DEW scenario at 0.3 m^3/s under weak cross-flow (A: 0.06 m/s) and strong cross-flow (B: 0.58 m/s) though a 4" port.

2.2 Far-field modelling

2.2.1 Description of the CHEMMAP model

The mixing and dispersion of the dewatering plumes were calculated using the three-dimensional discharge and plume behaviour model, CHEMMAP (French-McCay & Isaji, 2002; French-McCay et al., 2004, 2008, Whittier et. al. 2006).

CHEMMAP predicts the movement and fate of a wide variety of chemical products that can be present in different forms, including soluble chemicals and product mixtures. CHEMMAP calculates for multiple processes that can affect the dilution of discharges, including transport, spreading of floating chemicals; transport of dissolved or particulate chemicals in three dimensions; evaporation or volatilisation of chemicals at the surface; dissolution; re-suspension; sedimentation; and degradation of chemicals.

The most important inputs associated with the chemical model are the physical properties relating to the released chemical. The properties used to predict the fate and transport of each chemical include density, vapour pressure, water solubility, environmental degradation rates, adsorbed/dissolved partitioning coefficients (KOW, KOC), viscosity, and surface tension. CHEMMAP applies a chemical database of information compiled from published literature sources.

The transport algorithm within CHEMMAP depend upon the input of current data and coefficients of dispersion representative of the release location. The model uses a Lagrangian, three-dimensional, transport model to predict the movement of the chemical in the water column. For this study, the chemical mixture was assumed to be fully dissolved in the pipeline water and chemically stable; hence only dispersion and transport processes would affect the concentration of the discharge.

CHEMMAP may be applied to deterministic simulations, simulating the outcome of a single chemical release over a defined time-sequence of environmental conditions, or in stochastic mode, involving repeated simulation of a defined spill scenario under randomly varying environmental conditions. The latter approach is suited to understanding the response to the wide range of current speeds and directions that might occur over a discharge event and was applied to this study.

2.2.2 Model set up

CHEMMAP is a Lagrangian-particle model that represents the mass of materials introduced into the water as a cloud of independent particles, each representing a proportion of the total mass released, and each having a radius that changes over time due to chemical dispersion. For a solution, the mass of chemical is defined by the concentration of the chemical and the volume of the solution. The movement of the particles is calculated over time in three dimensions following a random-walk procedure due to the prevailing current field, which can vary over space and time, and allowances for random dispersion in the horizontal and vertical planes induced by mixing forces in the water column.

After calculating the movement and dispersion of the chemical mass, a concentration field is calculated at regular time steps by mapping the particle mass into a three-dimensional grid following a Gaussian distribution. For this study, the grid dimensions were set at 10 m x 10 m in the horizontal and 5 m in the vertical. Consequently, concentrations were calculated as averages per 0.5 m^3. This fine grid provided for relatively fine resolution of the chemical concentrations. The model was run at five-minute time steps for fine temporal resolution.

Simulations were run for discharge of the pipeline volumes (49,959 m^3) released at 0.3 m^3/s in each discharge case for 2.5 days (60 hours), with discharge occurring over the first 46.5 hours, allowing time for dispersion to threshold levels.

2.2.3 Stochastic modelling

A stochastic modelling procedure was applied in the far-field modelling to sample a representative set of conditions that could affect the distribution of dissolved chemicals in the surrounding water column. This approach involves multiple possible simulations of a given discharge scenario and season. One hundred simulations were completed for each combination (600 in total), with each simulation using a unique sequence of current data randomly selected from the measured data record for the season under investigation. The FCG simulations were run under currents measured at 24.9 m BMSL and the DEW simulations were run under currents measured at 251.9 m, each being the closest measurement point that should be representative for the relevant discharge case. Once the stochastic modelling was complete, all simulations were statistically analysed to develop the distribution of outcomes.

This methodology is designed to capture the wide variety of outcomes that could occur due to variation in the prevailing current. Frequently occurring conditions will be selected at random more frequently than rarely occurring conditions. Hence, the outcomes will also reflect the likelihood of an outcome.

The multiple simulations for each discharge scenario and season combination were analysed as a batch to map the 95th percentile concentrations that were calculated among the replicate simulations within each grid cell. These summaries will illustrate locations where the concentrations should not be exceeded more than 5% of the time. The 95th percentile is considered more reliable than the maximum due to conservatism built into the model.

CHEMMAP allows for calculation to low concentrations (high dilutions) than might be ecologically significant. Only concentrations exceeding 50% of the threshold concentration of 1 mg/l were considered in the analysis, extending the analysis to areas that might be affected at $\geq$0.5 mg/l (1,000 dilutions) The area that might be affected at $\geq$1 mg/l (500 dilutions) was also mapped as the area of potential influence.

3 RESULTS OF FAR-FIELD MODELLING

3.1 Overview

The following section presents a summary of the far-field calculations for dilution rates that are derived from stochastic modelling. The results are calculated from multiple replicates (100 completed per season and discharge scenario) and account for seasonal differences in prevailing current patterns and the near-field dilutions. Calculations are presented for the following discharge scenarios.

1. FCG discharge through a 4” port
2. FCG discharge through a 10” port
3. DEW discharge through a 4” port

Emphasis is placed on the more extreme distances over which 500-fold dilution might occur. This has been done by calculating the 95th percentile concentrations of the replicate simulations at each grid cell in the horizontal and vertical and then calculating the maximum distance from the source (among any replicate simulation) at which 1 mg/l concentrations were calculated. The horizontal area swept by concentrations $\geq$1 mg/l was also calculated for each replicate simulation and the 95th percentile of these values has been presented. The 95th percentile values represent extents that should not be exceeded >5% of the time.

In this analysis, the multiple DEW discharges have been treated as independent events, with no additive effects due to ample dispersion of any previous discharge and turnover of the water column between events. This assumption is justified on the basis that full dispersion requires a relatively short time (tens of minute to <2 hours) and the elapsed time between each discharge will be longer. Hence, the same distribution of outcomes might occur during any of these discharges but additive effects should not occur.

3.2 Findings

Analysis of the stochastic dispersion modelling of the FCG discharge indicates that there is likely to be variation in the size of the dispersion field around the discharge source to reach the target dilution (assuming 500 dilutions are required) depending upon the prevailing current, and a large difference in the field of effect depending upon the port size that is used. The influence of prevailing conditions is evidenced by the spread in the potential distances among the minimum, mean and maximum distances before 500 dilutions are calculated from the multiple replicates for each season (Table 3-1 and Table 3-2). The overriding influence of the port size is shown by the shift in all slopes and by comparison of plots of the 95th percentile distributions among the scenarios for each season (Figure 3-1 and Figure 3-3).

Calculations for the 95th percentile distance and area swept by the plume to reach 500-dilutions are summarised in Table 3-3 and Table 3-4. The 95th percentile distances are of a similar order to the maximum distances and should be representative of the upper extreme values due to unusual ocean conditions.

The modelling indicates that plumes set up by the FCG discharge through a 4” port could extend up to ~ 430 m before dilution to the target threshold of 1 mg/ml (500 dilutions). This estimate is the longest distance indicated for the 95th percentile. The average distance was calculated at up to 110 m. The largest area that may be affected at > 1 mg/l was calculated at ~ 0.14 km^2. Only minor differences were calculated among the seasons indicating that the outcome will be dominated by the tidal currents that operate over the site with low influence of seasonally-varying drift currents. Stochastic modelling of the FCG discharge through a 24.5” port indicated a substantially larger potential field of effect before 500 dilutions was reached.

The DEW discharge was calculated to undergo faster dilution in the far field due to spreading of the discharge over a larger depth range (varying with the prevailing current speed). The maximum distance for 500 dilutions of the DEW discharge was calculated at ~ 280 m, while the average was calculated to range ~ 80 – 130 m, with the longer distances in the summer and transitional seasons.

Plots showing the distribution of the 95th percentile dilutions calculated from replicate simulations also indicate differences in the current directions with depth. The plots for the FCG discharge scenarios indicate that the plume is more likely to disperse up and down the benthic slope, following the migrations of the tide (Figure 3-4 to Figure 3-12). The distribution of the extreme dilution fields calculated from multiple simulations of DEW discharge follows an ellipse that is orientated along a north-west to south-east axis over a smaller area surrounding the discharge. The distributions indicate that dilution should occur over one or two tidal cycles and within too short a period for drift currents to strongly affect transport.

Table 3-1 Calculations for the minimum, mean and average distance to reach 500 dilutions among the replicate simulations for the FCG discharge though a 4" port.

Season	Minimum	Mean	Maximum
Summer	42	110	410
Transitional	38	99	430
Winter	40	110	420

Table 3-2 Calculations for the minimum, mean and average distance to reach 500 dilutions among the replicate simulations for the FCG discharge though a 24.5" port.

Season	Minimum	Mean	Maximum
Summer	227	490	1,210
Transitional	278	529	1,310
Winter	309	482	1,035

Table 3-2 Calculations for the minimum, mean and average distance to reach 500 dilutions among the replicate simulations for the DEW discharge though a 10" port.

Season	Minimum	Mean	Maximum
Summer	81	128	260
Transitional	60	129	259
Winter	<50	83	279

Table 3-3 Calculations for the maximum area (km^2) that may be swept for the FCG discharge to be diluted 500-fold. Calculations are shown for the 95th percentile of the replicate simulations, varying with the port diameter.

Season	4"	24.5"
Summer	0.14	1.33
Transitional	0.11	1.33
Winter	0.12	1.02

Table 3-4 Calculations for the area that may be swept for the DEW discharges to be diluted 500-fold. Calculations are shown for the 95th percentile of the replicate simulations for a 10" port

Season	Area [km^2]
Summer	0.07
Transitional	0.08
Winter	0.07

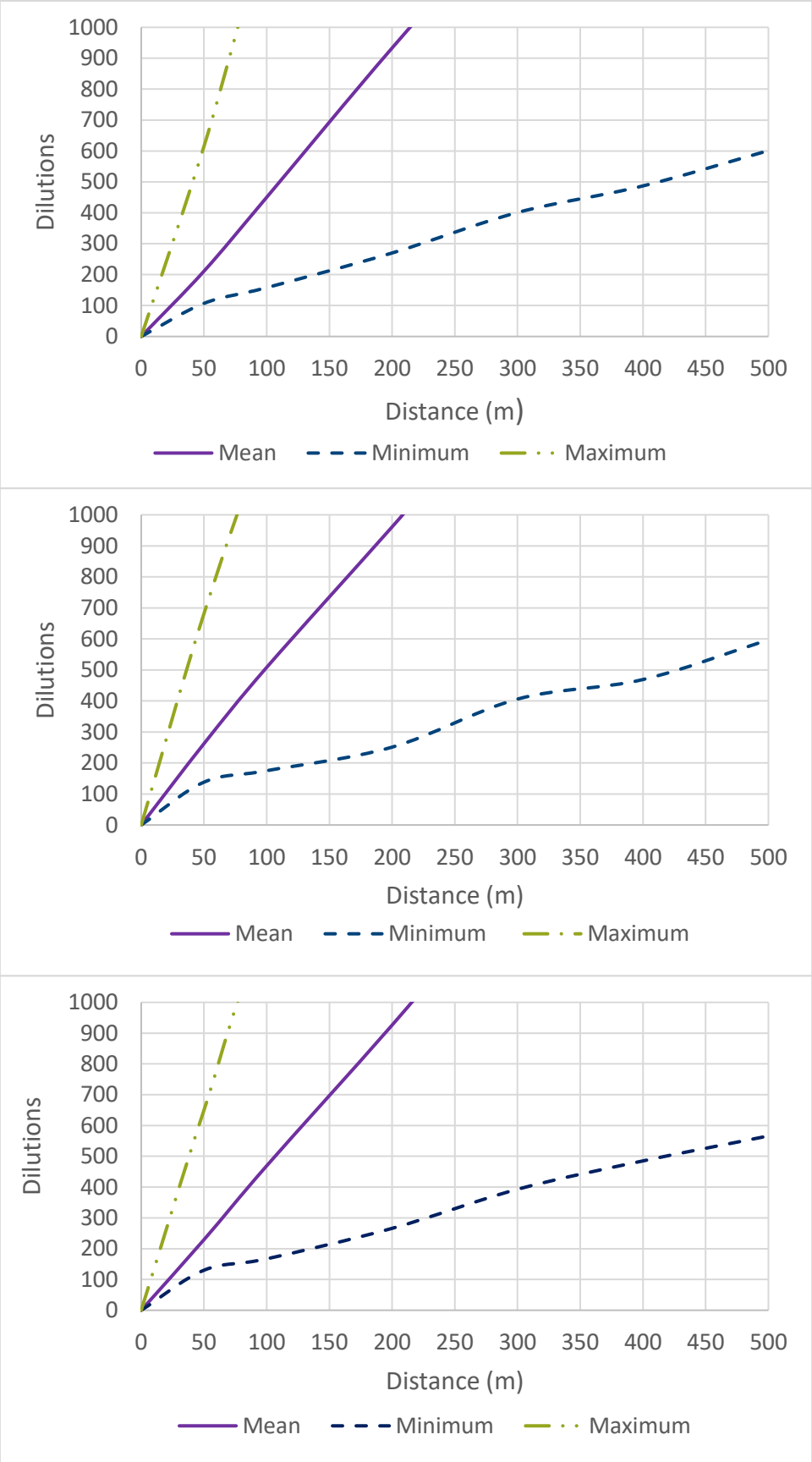

Figure 3-1 **Calculations for dilution with distance over the far-field for the FCG discharge through a 4" port. Results are plotted for the mean, minimum and maximum dilution at distance among the multiple replicate simulations for the summer months (upper), transitional months (middle) and winter months (lower).**

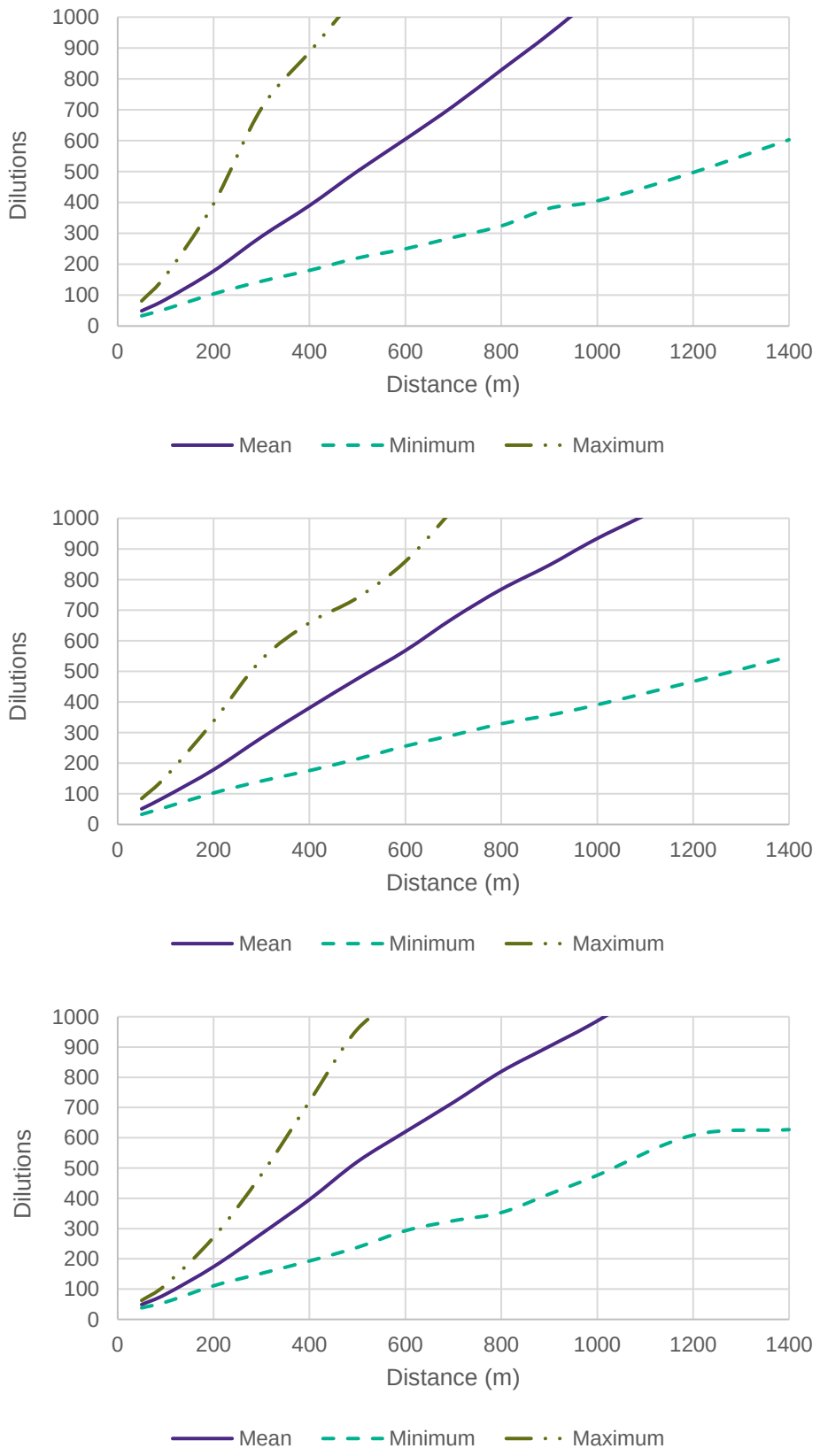

Figure 3-2 **Calculations for dilution with distance over the far-field for the FCG discharge though a 24.5" port. Results are plotted for the mean, minimum and maximum dilution at distance among the multiple replicate simulations for the summer months (upper), transitional months (middle) and winter months (lower).**

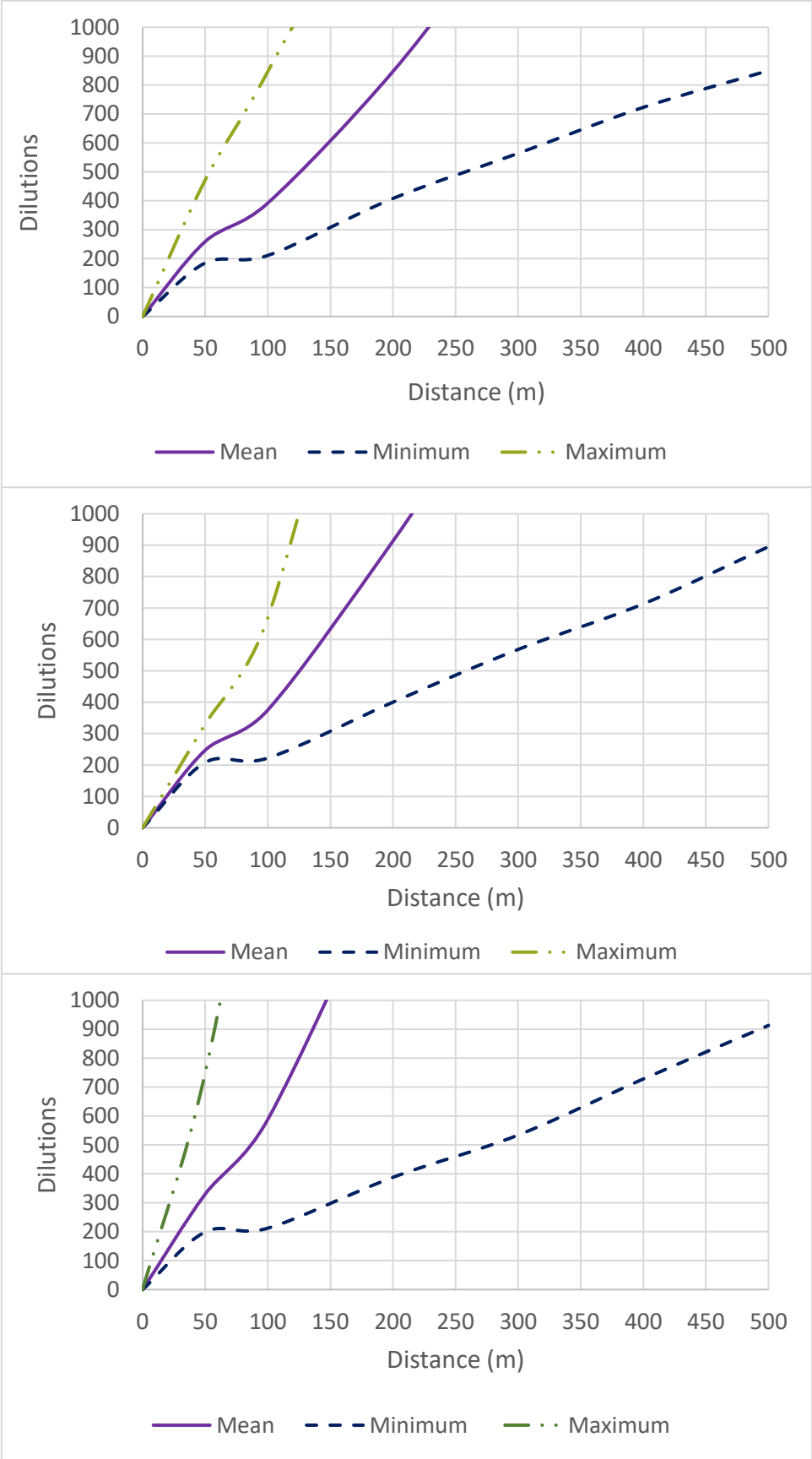

Figure 3-3 **Calculations for dilution with distance over the far-field for the DEW discharge though a 10" port. Results are plotted for the mean, minimum and maximum dilution at distance among the multiple replicate simulations for the summer months (upper), transitional months (middle) and winter months (lower).**

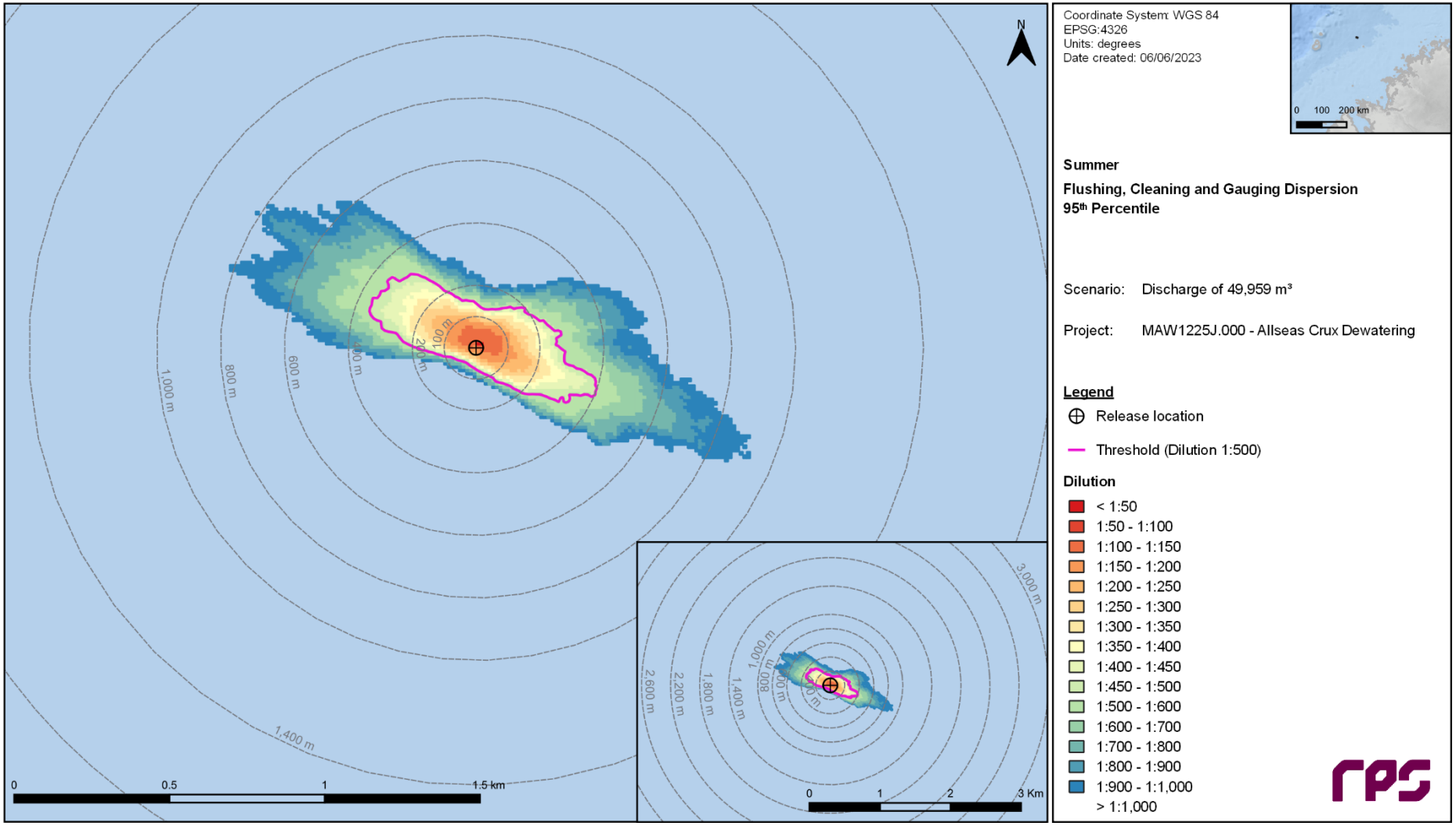

Figure 3-4 **Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 4" port using current data from summer months. The magenta line designates the required level of dilution (500-fold).**

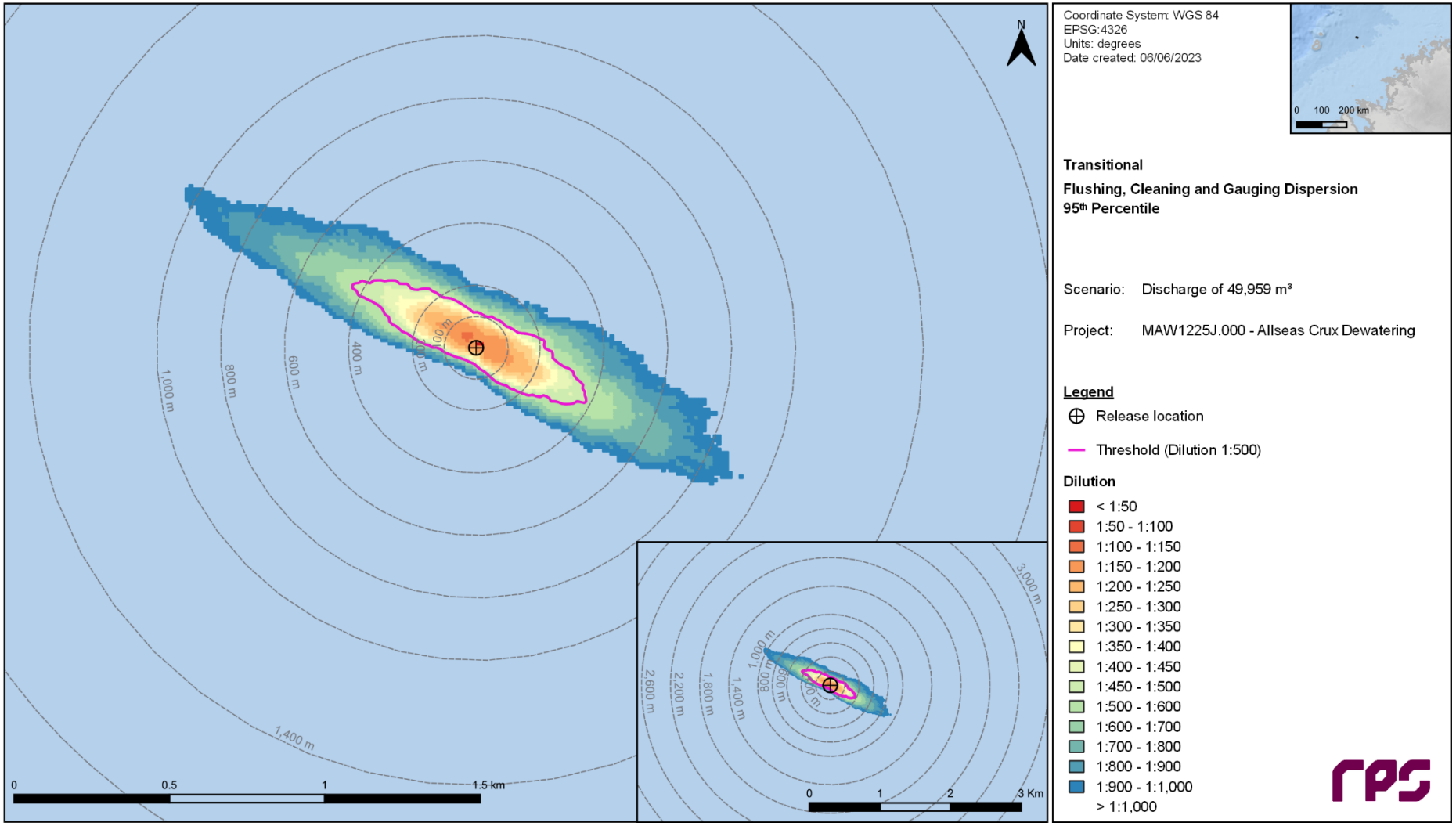

Figure 3-5 **Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 4" port using current data from transitional months. The magenta line designates the required level of dilution (500-fold).**

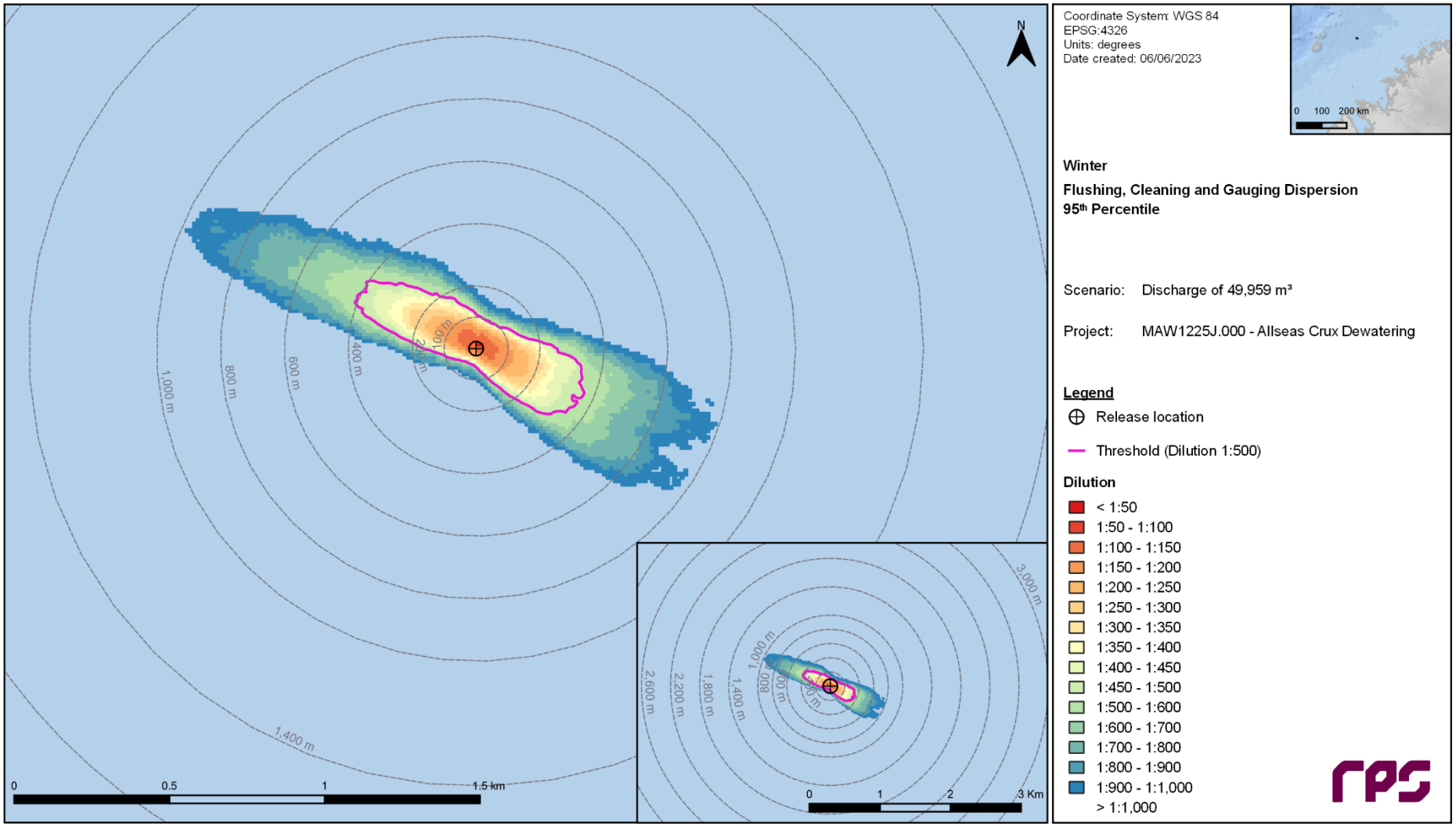

Figure 3-6 Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 4" port using current data from winter months. The magenta line designates the required level of dilution (500-fold).

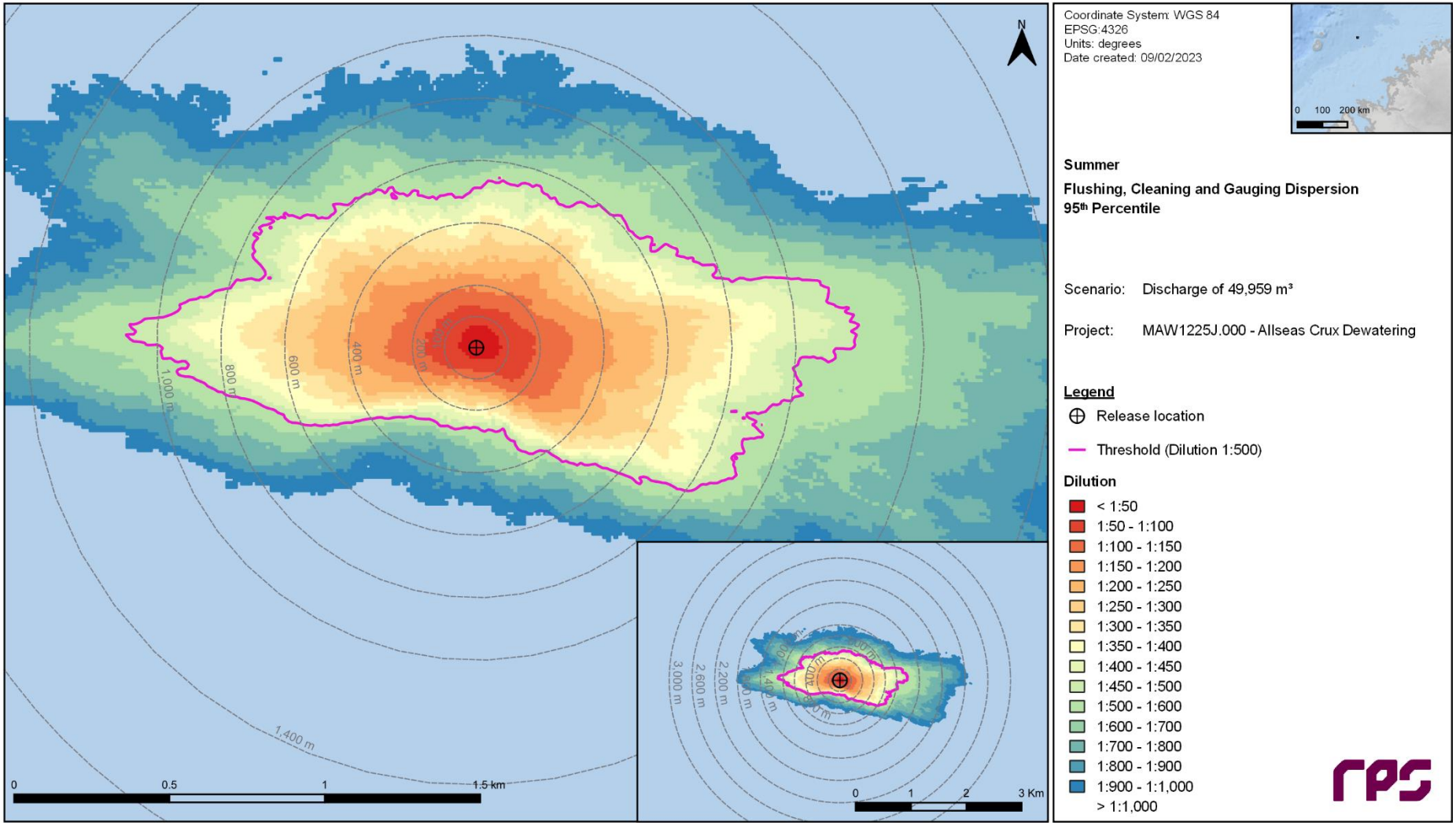

Figure 3-7 Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 24.5" port using current data from summer months. The magenta line designates the required level of dilution (500-fold).

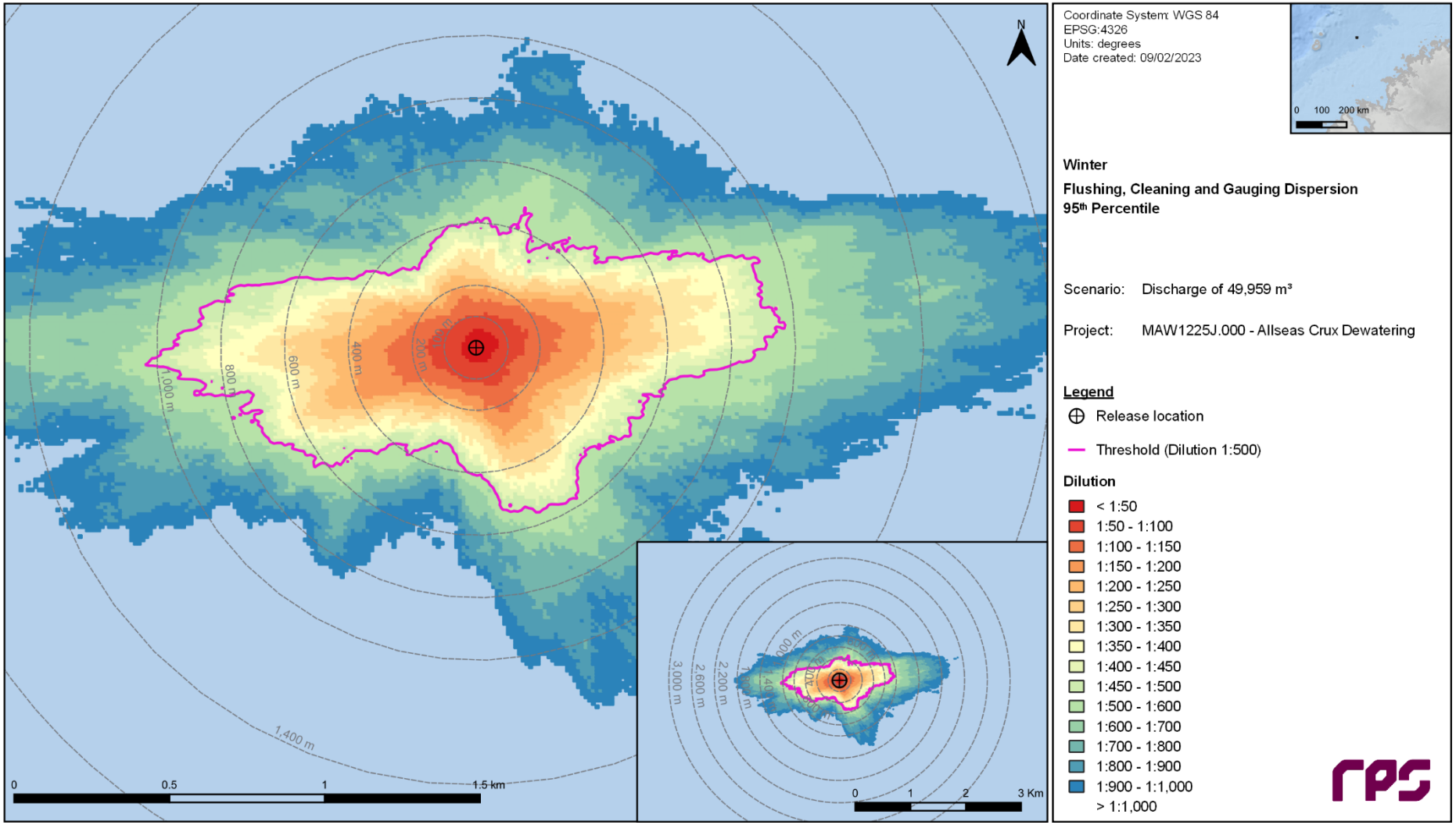

Figure 3-8 **Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 24.5" port using current data from transitional months. The magenta line designates the required level of dilution (500-fold).**

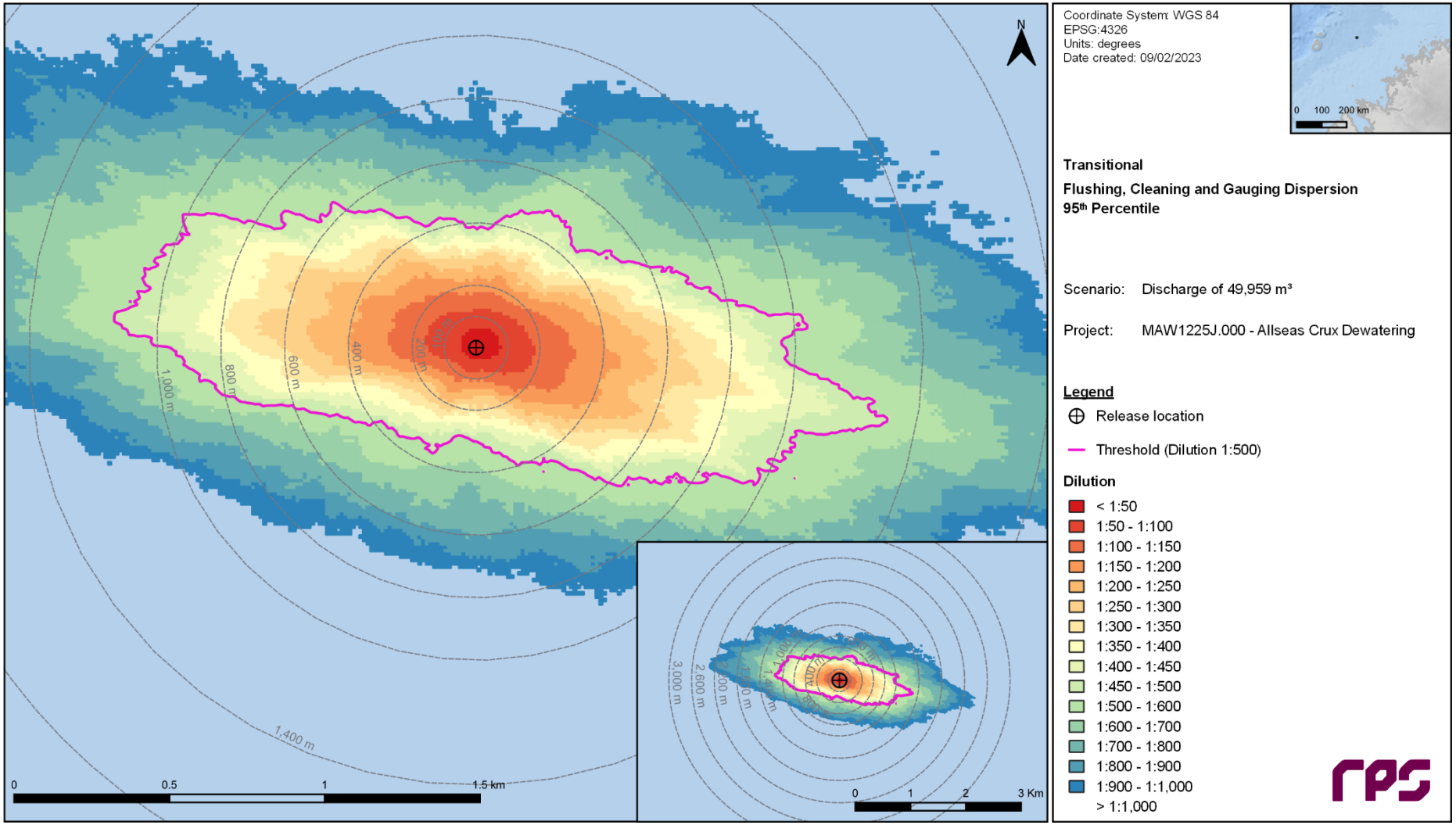

Figure 3-9 **Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the FCG discharge through a 24.5" port using current data from winter months. The magenta line designates the required level of dilution (500-fold).**

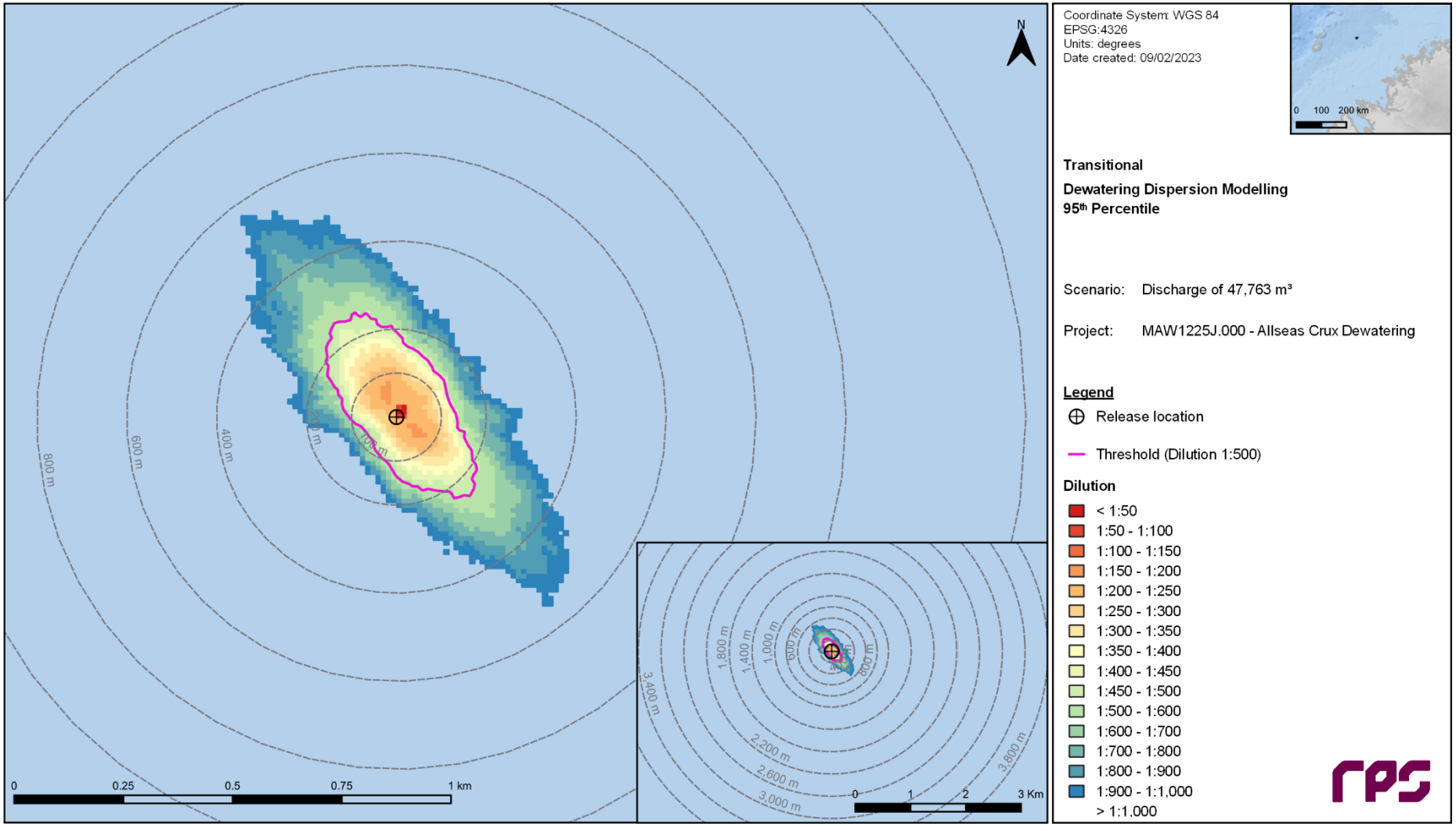

Figure 3-10 Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the DEW discharge through a 10" port using current data from summer months. The magenta line designates the required level of dilution (500-fold).

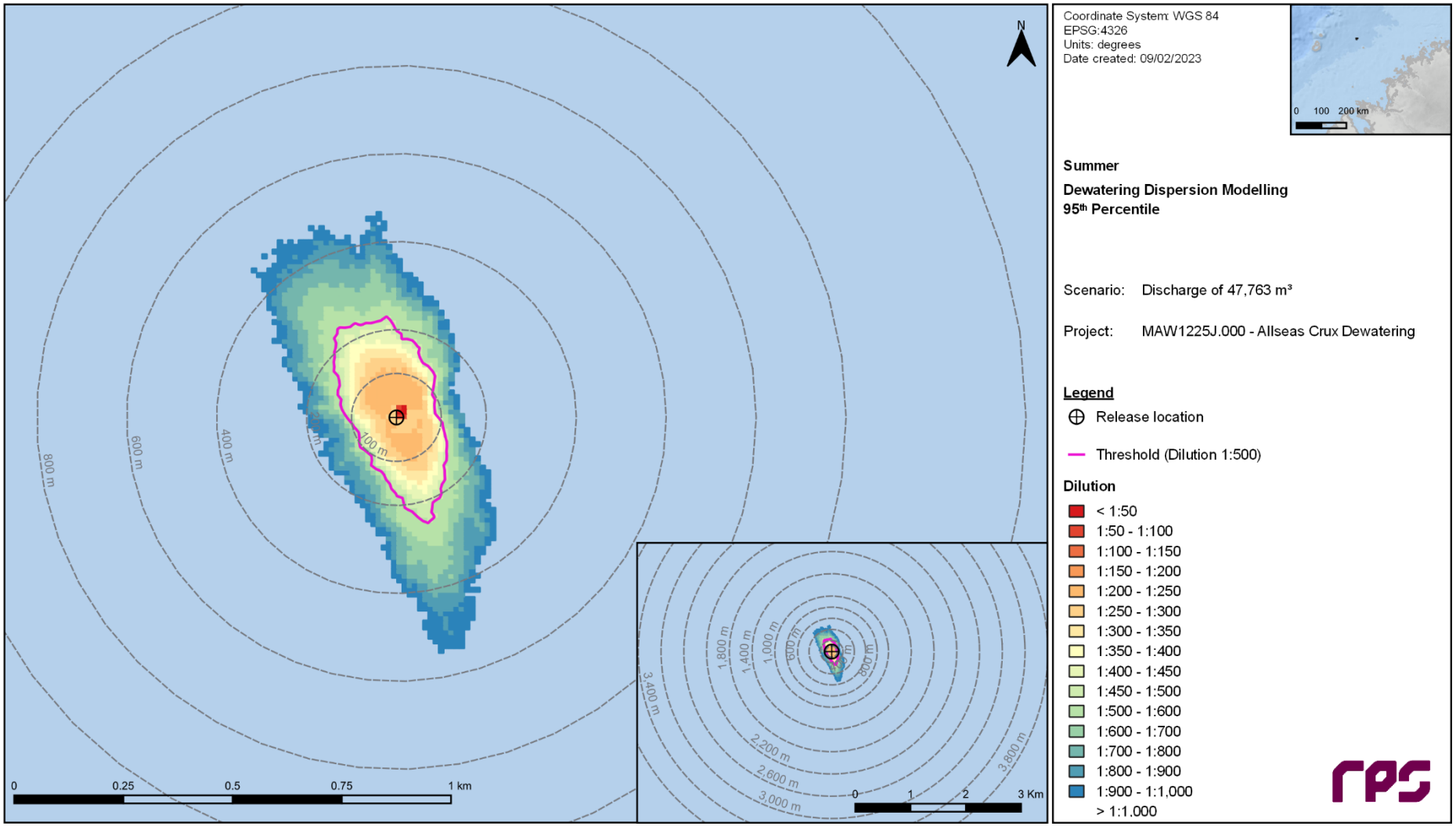

Figure 3-11 Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the DEW discharge through a 10" port using current data from transitional months. The magenta line designates the required level of dilution (500-fold).

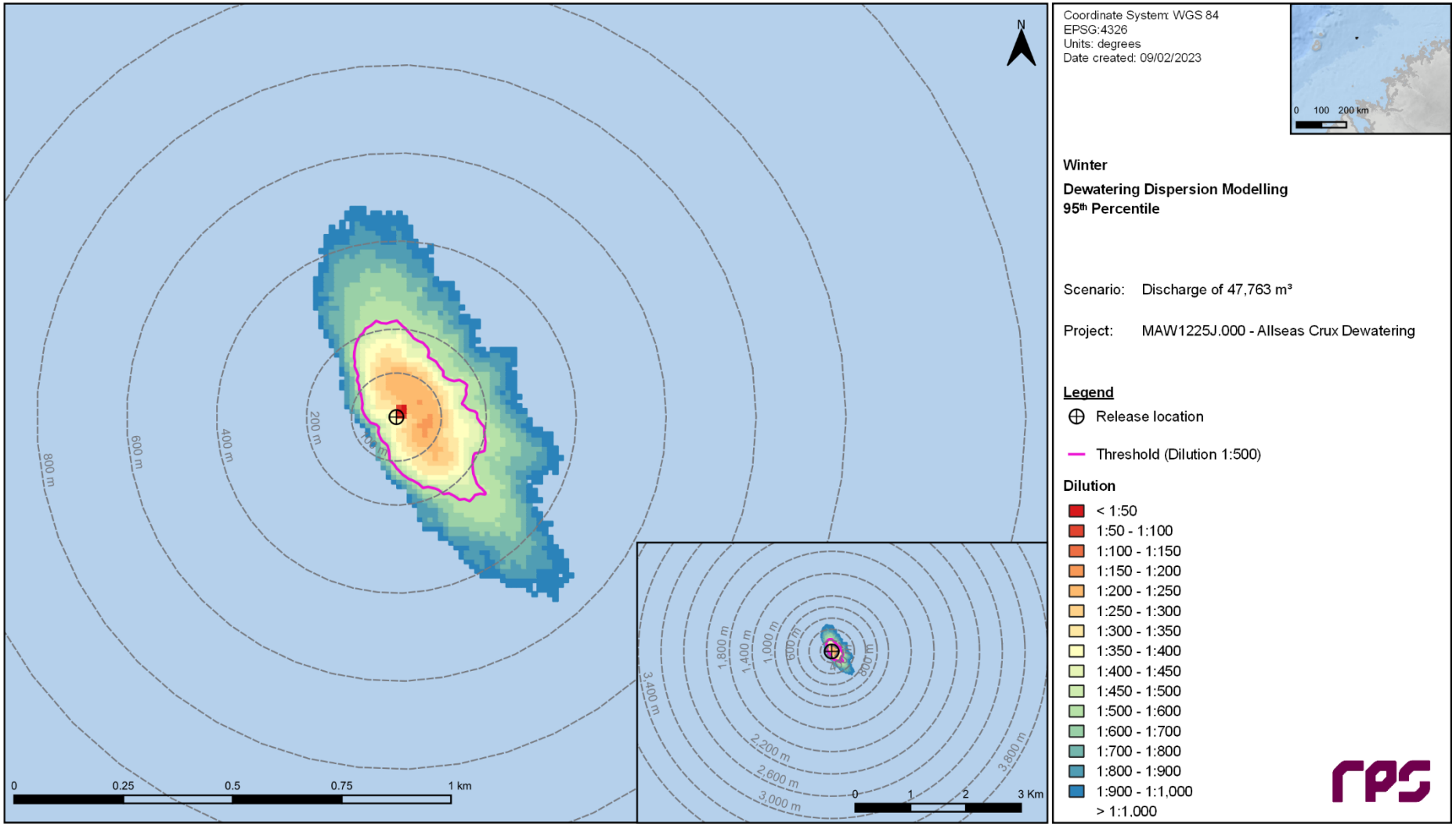

Figure 3-12 Spatial distribution of dilutions calculated at the 95th percentile from multiple simulations of the DEW discharge through a 10" port using current data from winter months. The magenta line designates the required level of dilution (500-fold).

4 CONCLUSIONS

- The potential effect zone that could result from the proposed dewatering practices for the Crux pipeline will vary among the FCG and DEW discharges and with the discharge configuration that is applied. Based on the requirement to dilute the combined dose of the treatment chemicals from 500 ppm to 1 ppm (i.e., 500-fold dilutions), the maximum distance that was calculated at the 95th percentile confidence level due to combination of near-field and far-field dilution was of the order of 430 m for the FCG discharge, varying seasonally, and 260 m for the DEW discharge for the smaller port sizes under consideration, if the discharge rate is at the maximum rate (0.3 m^3/s).
- Details of the FCG discharge that will influence rates of dilution include:
  - The port size that is used: The smaller port option (4”) would set up a high velocity jet (of the order of 37 m/s if discharge is at 0.3 m^3/s, reducing to 18.5 m/s if discharge is at 0.15 m^3/s) that would result in highly turbulent flow and initially high mixing and dilution with ambient water, with the momentum of the jet dissipating over distances of tens of metres to a few hundred metres. In contrast, the larger port would result in relatively sluggish discharge, only slightly faster than the prevailing current (0.49 to 0.99 m/s for discharge rates of 0.15 m^3/s to 0.3 m^3/s).
  - Neutral density of the discharge water that can be expected from cooling of the stored water to the ambient water at the seabed level, and hence there should be no influence of plume density on movement (neither sinking or rising). This will reduce the subsequent rate of dispersion after the plume has lost velocity and is moving with the ambient current.
  - Relatively slow current speeds near seabed relative to the discharge speed, hence with low mixing influence on the plume.
  - The dominance of tidal circulation near seabed, increasing the opportunity for build up at the turn of the tide and re-dosing of the plume as the plume passes back to the discharge source.
- By contrast, dilution of the DEW discharge will be influenced by:
  - Downward discharge of water with slight negative buoyancy, set up by being cooler than the ambient water near the surface. Although at slower velocity (~6 m/s) than the FCG discharge, the downward orientation of the denser water will result in the plume continuing to sink and entrain ambient water into the plume after the initial jet momentum is lost.
  - High available water depth below the DEW discharge point, which will allow the plume to sink until neutral buoyancy is achieved.
  - The downward orientation of the plume will direct the plume across the current, irrespective of the relative current direction. Consequently, in contrast to the FCG discharge, where build up was calculated over the turning of the tide, variation in the prevailing current speed will result in the downward plunging plume flagging in the vertical plane, with increased downward plunge at slower current speeds and hence increased vertical spreading of the discharge water during periods of sluggish current.
  - Reduced likelihood that the DEW plume would be double-dosed because the diluting plume will be positioned deeper than the source.
- The stochastic (far-field) modelling indicates wide variation in the distance required for dilution to reach 500-fold dilution for both discharge scenarios, depending upon the prevailing current. For the FCG discharge the initial port diameter will have a larger, overriding, influence, substantially larger than any seasonal differences.
- Current speeds in the upper water column that would affect the DEW discharges are frequently faster and directions are more variable, being affected by multiple sources, which will add complexity and variation to the path of diluting plumes. In contrast, tidal currents near the seabed that would affect the FCG discharges are relatively slow and follow a more restricted path.
- A further difference that was identified between the FCG and DEW discharge scenarios was that the far-field plumes are more likely to spread over a different axis. Trends in the currents acting near seabed around the FCG discharge are more likely to direct the plume in an east-west direction down the slope of the seabed, with a few degrees of difference in the axis among the seasons. However, the

DEW discharges are more likely to disperse over a north-west to south-east axis at any time of year, with some variability introduced by ocean currents acting near the sea surface.

- There are no shallow seabed features within the calculated effect zones of discharges, indicating that any effects will be on organisms within the effected water column. One caveat on this detail is that the modelling assumed that the FCG discharge was horizontal. The discharge plume could contact the seabed at < 500 mg/l if the discharge was directed at any angle downwards from horizontal. Angling of the discharge upwards would be of benefit, by reducing the potential for contact with the seabed until the plume has further diluted.

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Appendix J Drill Cuttings Dispersion Analysis Report

SHELL CRUX SUBSTRUCTURE EPCI

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Document Title:

DRILL CUTTINGS DISPERSION ANALYSIS REPORT

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Report

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Prepared by:

RPS

David Wright
Manager - Perth

Level 3, 500 Hay Street
Subiaco, WA 6008

T +61 8 9211 1111
E david.wright@rpsgroup.com

Prepared for:

McDermott

Lars Christensen
Project Engineer Manager

Level 24, Menara Hap Seng 3
No. 1 Jalan P. Ramlee, 50250 Kuala Lumpur

T +60 3 2856 5062
E lchristensen@mcdermott.com

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EXECUTIVE SUMMARY

RPS has been commission by McDermott Australia Pty Ltd (McDermott), on behalf of Shell Australia Pty Ltd (Shell), to undertake a sediment dispersion modelling study of discharged drill cuttings during the drilling of foundation jacket insert piles within the Crux gas field. The Crux gas field is in Australian Commonwealth waters, within permit AC/L10 in the East Browse basin. The title is operated by Shell Australia Pty Ltd (Shell) on behalf of the other joint venture (JV) participant SGH Energy.

The field lies in approximately 165 m of water, 620 km north-north-east of Broome (~300 km from mainland Australia). The title is located ~160 km north-east of the Shell-operated Prelude gas field for which a floating LNG (FLNG) facility is now in operation.

The remotely operated, not normally manned (NNM) platform concept for Crux dehydrates the gas and condensate streams and exports a multiphase stream to the Prelude FLNG. The platform has a 550 MMscfd capacity with five platform wells.

The principal aim of the study was to calculate the fate of discharged substructure drill cuttings, the likely area of coverage and bottom deposition (thickness and accumulated load), and the risk to sensitive receptors of contact from cuttings discharged during the drilling operation for the Jacket Main Insert Piles.

During the drilling campaign, Contractor intents to drill a total of 14 holes (12 nominal and 2 contingency) using only seawater, with no drilling fluids, using a conventional drilling method. The Crux drilling program is expected to result in the discharge of an estimated 1,397 m^3 of cuttings over 16.2 hours per hole. In total, 9.45 days will be required to drill all 14 holes. It is important to note that the assumptions used for the modelling have been developed during the planning phase, and the final drilling plan may vary the parameters modelled.

The potential area that may be influenced by the discharge of drill cuttings was assessed on both a monthly (May to October) and combined basis.

The main findings of the study are as follows:

Combined Results

- The results for each month were integrated to define the likely coverage area of bottom thickness above the thresholds for ‘any time’ or current conditions modelled.
- The modelling results demonstrated that larger particles (greater than 0.25 mm diameter) were predicted to settle typically within 250 m from the discharge location, while the currents transported the smaller sediments (less than 0.25 mm) further away from the discharge location.
- The maximum thickness (or height of mound) was predicted to be 32.21 mm adjacent to the discharge location.
- Modelling predicted a relatively wide zone of potential influence at the natural threshold level (0.058 mm), with drill cuttings not expected beyond ~11.8 km from the discharge location while covering an area ~40.45 km^2 (4,045 ha). As the nearby shoals are further away (~13 km) than this distance (according to *Contractor’s SOW, 2200-010-VA-0403-00003, Section V*), no remedial action or management of the drilling operation is considered necessary to prevent impact from the drilling on the nearby shoals.
- At the low (1 mm) and high (10 mm) exposure thresholds, drill cuttings were not expected beyond 986 m and 386 m, respectively. Total areas of coverage at the low (1 mm) and high (10 mm) exposure threshold were 2.09 km^2 (209 ha) and 0.28 km^2 (28 ha), respectively.
- Modelling indicates that sedimentation resulting from discharges of drill cuttings is not likely to have any impact above the natural threshold (0.058 mm) at the shoals closest to the discharge site.

Monthly Results

- The outcomes of the sediment dispersion modelling assessment are summarised as follows, for each month.

- Sediments larger than 0.25 mm in diameter are predicted to typically settle out within 250 m of the site, with displacement occurring on either side of the discharge in response to the prevailing currents.
- Finer sediments are forecast to disperse more widely, with the finest sediments contributing a lower proportion of sediment to deposits greater than 0.058 mm (natural threshold) thick.
- Deposits exceeding the 0.058 mm minimum thickness are calculated to extend up to between 3,691 m (October) and 11,844 m (June) from the discharge location.
- At the low (1 mm) exposure threshold, drill cuttings are expected to extend up to between 814 m (July) and 986 m (June) from the discharge location.
- Drill cuttings were modelled to extend up to between 300 m (May and July) and 386 m (June) at the high (10 mm) threshold.
- Deposits of finer sediments are consistently calculated to build up along the tidal axis on either side of the source rather than displace to a particular side, indicating that tidal currents will have influence over movement of the finer particles and that ocean currents will have a small impact on the net movement direction and distance travelled before settlement occurs.
- The directions in which sediments are calculated to settle vary only slightly among the monthly simulations, which is indicative of the high influence of tidal currents at the source and the relative lack of variation in ocean current conditions over the ten-year hindcast period.
- The maximum thickness (or height of mound) calculated at any location in any simulation is forecast to fall in the range of 19.87 mm (July) to 32.21 mm (September), adjacent to the discharge location, and quickly decrease with distance from the release location.
- The minimum and maximum predicted areas of sediment coverage at thicknesses greater than 0.058 mm are ~16 km^2 (June) and ~30.64 km^2 (August), respectively.
- At the low (1 mm) exposure threshold, the minimum and maximum areas of coverage are predicted to be greatly reduced and range between 1.42 km^2 (July) and 1.61 km^2 (October), respectively.
- At the high (10 mm) exposure threshold, they are reduced further, with minimum and maximum predicted areas of coverage ranging from 0.13 km^2 (May) to 0.19 km^2 (February), respectively.
- Modelling indicates that sedimentation resulting from discharges of drill cuttings is not likely to have any impact above the natural threshold (0.058 mm) at the shoals closest to the discharge site.

1 INTRODUCTION

1.1 Background

RPS has been commission by McDermott Australia Pty Ltd (McDermott), on behalf of Shell Australia Pty Ltd (Shell), to undertake a sediment dispersion modelling study of discharged drill cuttings during the drilling of foundation jacket insert piles within the Crux gas field. The Crux gas field is in Australian Commonwealth waters, within permit AC/L10 in the East Browse basin. The title is operated by Shell Australia Pty Ltd (Shell) on behalf of the other joint venture (JV) participant SGH Energy.

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The principal aim of the study was to calculate the fate of discharged substructure drill cuttings, the likely area of coverage and bottom deposition (thickness and accumulated load), and the risk to sensitive receptors of contact from cuttings discharged during the drilling operation for the Jacket Main Insert Piles.

During the drilling campaign, Shell intents to drill a total of 14 holes (12 nominal and 2 contingency) using only seawater, with no drilling fluids, using a conventional drilling method. The Crux drilling program is expected to result in the discharge of an estimated 1,397 m^3 of cuttings over 16.2 hours per hole. In total, 9.45 days will be required to drill all 14 holes. It is important to note that the assumptions used for the modelling have been developed during the planning phase, and the final drilling plan may vary the parameters modelled.

The potential area that may be influenced by the discharge of drill cuttings was assessed on both a monthly (May to October) and combined basis.

By showing the reach of the deposited drill cuttings, the modelling results may be used to confirm if there is a potential for loss of coral cover at nearby shoals (~13 km away) (according to *Contractor's SOW, 2200-010-VA-0403-00003, Section V*) with the current proposed drilling method and drill cutting quantities/properties.

Table 1.1 Location (drilling center) of the proposed Crux Development jacket foundation insert piles used for the drill cuttings dispersion modelling assessment.

Release site	Latitude (°S)	Longitude (°E)	Water depth (m)
Drill Center	12° 57’ 52.41”	124° 26’ 33.24”	168.5

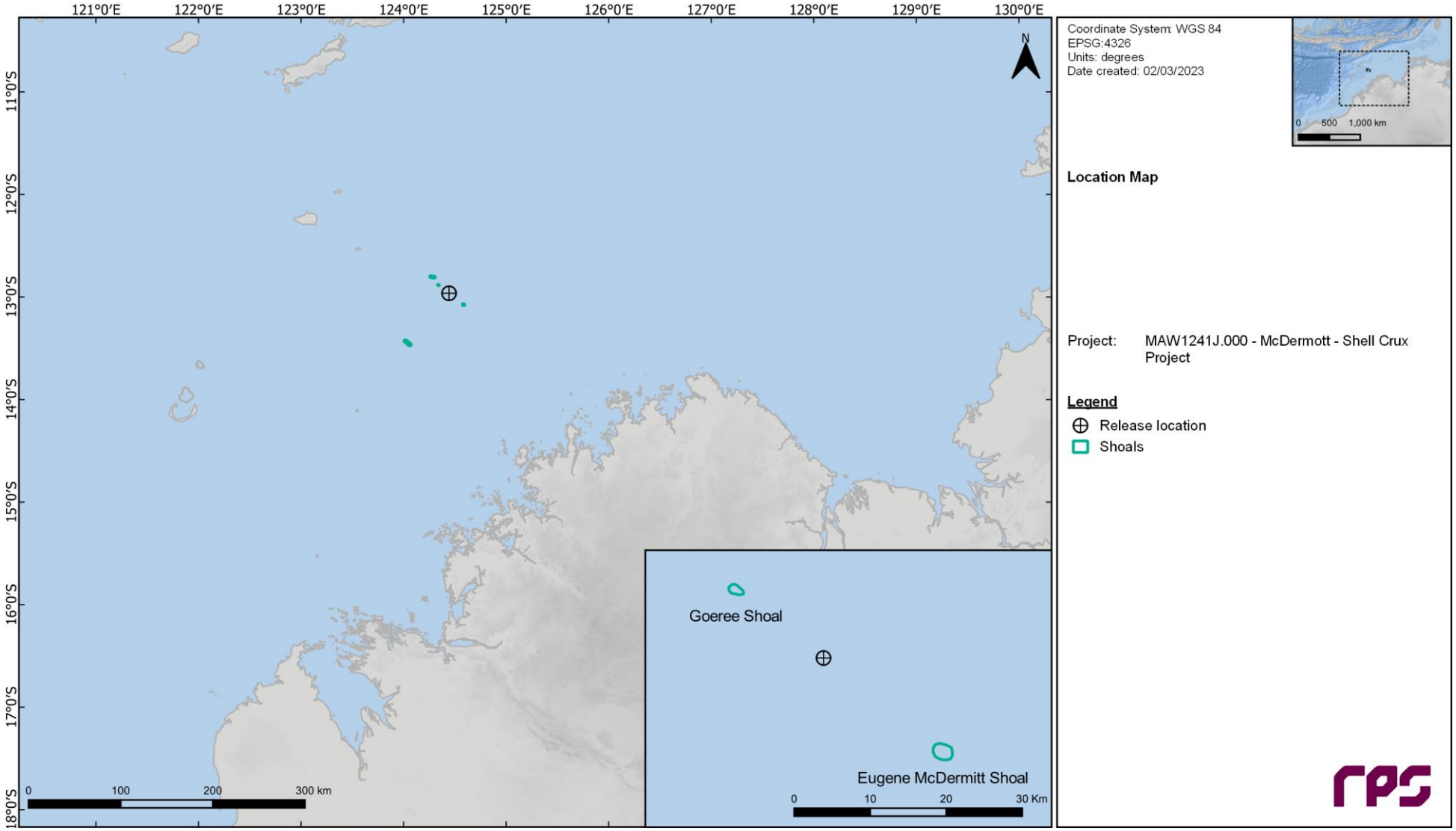

Figure 1.1 Location (drilling center) of the proposed Crux Development jacket foundation insert piles relative to the nearest submerged shoals.

1.2 Scope of Work

The scope of modelling included the following components:

1. Restoration from archive of a suitable three-dimensional, spatially varying current data set surrounding the proposed Crux Development location for a ten-year (2008-2017) hindcast period. The current data set included the combined influence of drift and tidal currents and was suitably long as to be indicative of interannual variability in ocean currents. The current data set was previously validated against the metocean data collected in the Crux development area.
2. Collation of seasonally varying vertical water density profiles at the Crux development area for use as input to the sediment dispersion model.
3. Summary of the drilling plan as discrete discharge characteristics representing each stage of the drilling program for input to the sediment dispersion model.
4. Establishment of a sediment dispersion model to repeatedly simulate all stages of the drilling program under different sample conditions, with each sample represented by a time sequence of current flow commencing on the first day of each calendar month (May to October, inclusive) within the ten-year hindcast of currents (i.e. 60 simulations from January 2008 to December 2017).
5. Analysis of the results of all simulations to map the distribution and thicknesses of discharged drill cuttings on the sea floor.

2 REGIONAL OCEAN CURRENTS

2.1 Overview

The area of interest for this study is typified by strong tidal flows over the shallower regions, particularly along the inshore region of the Kimberley Coast. However, the offshore regions with water depths exceeding 100-200 m experience significant large-scale drift currents. These drift currents can be relatively strong (1-2 knots) and complex, manifesting as a series of eddies, meandering currents, and connecting flows. These offshore drift currents also tend to persist longer (days to weeks) than tidal current flows (hours between reversals) and thus will have greater influence upon the net trajectory of sediment plumes over time scales exceeding a few hours.

Wind shear on the water surface also generates local-scale currents that can persist for extended periods (hours to days) and result in long trajectories. Hence, the current-induced transport of plumes can be variably affected by combinations of tidal, wind-induced, and density-induced drift currents. Depending on their local influence, it is important to consider all these potential advective mechanisms to rigorously understand patterns of potential transport from a given discharge location.

To appropriately allow for temporal and spatial variation in the current field, dispersion modelling requires the current speed and direction over a spatial grid covering the potential migration zone of plumes. Estimates of the net currents were derived by combining predictions of the drift currents, available from a mesoscale ocean model, with estimates of the tidal currents generated by an RPS model set up for the study area. These estimates are considered representative of the oceanographic currents that influence the Crux development area. Shell has also collected 12 months of metocean data in the Crux development area, with this data being used to validate the hydrodynamic model used in this modelling study. Refer to Section 2.4 for further discussion of the tidal and current model validation.

A composite modelled ocean current data product was derived by combining predictions of mesoscale circulation currents, available at daily resolution from global ocean models, with predictions of the hourly tidal currents generated by the RPS HYDROMAP model. By combining a drift current model with a tidal model, the influences of inter-annual and seasonal drift patterns, and the more regular variations in tide, were included.

2.2 Mesoscale Circulation

2.2.1 Overview

Large-scale and mesoscale ocean circulation (also referred to as drift currents) will be the dominant driver of long-term (> several days) transport of effluent plumes. Mesoscale ocean processes are generally defined as having horizontal spatial scales of 10-500 km, and periods of 10-200 days, and processes with scales greater than this are referred to as large-scale. The major persistent large-scale and mesoscale surface currents off Western Australia are presented in Figure 2.1. They are characterised as follows:

- Buoyancy driven circulation. The main buoyancy-driven feature in the region is the Indonesian Throughflow (ITF) which conducts warm water from the equator into the Indian Ocean. Buoyancy gradients across the continental shelf due to differential heating and cooling and/or surface runoff may also drive three-dimensional circulation patterns.
- Wind (Ekman) driven circulation. The Australian North West Shelf has an annual wind cycle (easterly winds during winter, south-westerly winds during summer) which drives seasonal variability in surface circulation patterns.
- Eddies and jets. These non-linear features evolve from the large-scale and mesoscale flow field interacting with the bathymetry. These are random features, and it is generally hard to predict their exact timing and location.

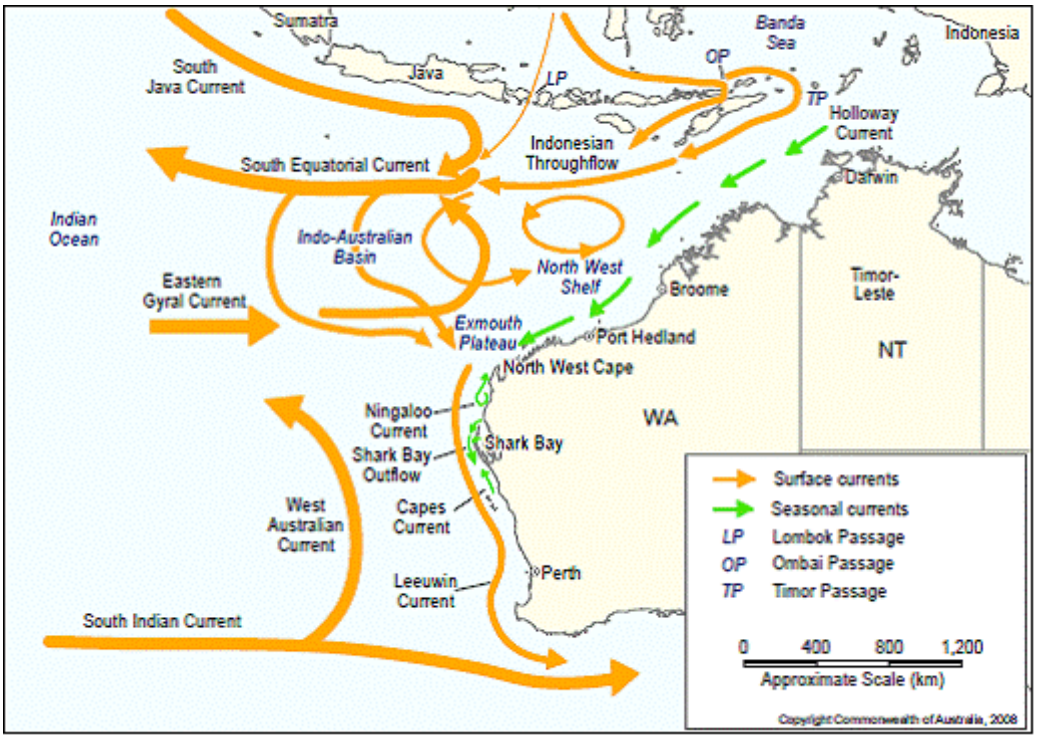

Figure 2.1 **A map of the major currents off the West Australian coast (DEWHA, 2008).**

2.2.2 Description of Mesoscale Model: HYCOM

Representation of the drift currents was available from the output of the global circulation model the Hybrid Coordinate Ocean Model (HYCOM; Bleck, 2002; Chassignet et al., 2007, 2009), created by the National Ocean Partnership Program (NOPP), as part of the US Global Ocean Data Assimilation Experiment (GODAE). The HYCOM model is a three-dimensional model that assimilates ocean observations of sea surface temperature, sea surface salinity and surface height, obtained by satellite observations, along with atmospheric forcing conditions from atmospheric models to predict drift currents generated by such forces as wind shear, density and sea height variations and the rotation of the earth.

The HYCOM model is configured to combine the three vertical coordinate types currently in use in ocean models: depth (z-levels), density (isopycnal layers), and terrain-following (σ-levels). HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain-following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas. Thus, this hybrid coordinate system allows for the extension of the geographic range of applicability to shallow coastal seas and unstratified parts of the world ocean. It maintains the significant advantages of an isopycnal model in stratified regions while allowing more vertical resolution near the surface and in shallow coastal areas, hence providing a better representation of the upper ocean physics. The model has global coverage with a horizontal resolution of 1/12th of a degree (approximately 7 km at mid-latitudes) and a temporal resolution of one day.

A hindcast data set of HYCOM currents was obtained for a ten-year period spanning 2008 to 2017 (inclusive).

2.3 Tidal Currents

2.3.1 Description of Tidal Model: HYDROMAP

As the HYCOM model does not include tidal forcing, and because the data is only available at a daily frequency, a tidal model was developed for the study region using RPS' three-dimensional hydrodynamic model, HYDROMAP.

The model formulations and output (current speed, direction, and sea level) of this model have been validated through field measurements around the world for more than 25 years (Isaji & Spaulding, 1984, 1986; Isaji et al., 2001; Zigic et al., 2003). HYDROMAP current data has also been widely used as input to forecasts and hindcasts of oil spill migrations in Australian waters. This modelling system forms part of the National Marine Oil Spill Contingency Plan for the Australian Maritime Safety Authority (AMSA; AMSA, 2002).

HYDROMAP simulates the flow of ocean currents within a model region due to forcing by astronomical tides, wind stress and bottom friction. The model employs a sophisticated dynamically nested-gridding strategy, supporting up to six levels of spatial resolution within a single domain. This allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, or of particular interest to a study.

The numerical solution methodology of HYDROMAP follows that of Davies (1977a, 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji & Spaulding (1984).

2.3.2 Tidal Grid Setup

A HYDROMAP model was established over a domain that extended approximately 3,300 km east-west by 3,100 km north-south over the eastern Indian Ocean. The grid extends beyond Eucla in the south and beyond Bathurst Island in the north (Figure 2.2).

Four layers of sub-gridding were applied to provide variable resolution throughout the domain. The resolution at the primary level was 15 km. The finer levels were defined by subdividing these cells into 4, 16 and 64 cells, resulting in resolutions of 7.5 km, 3.75 km, and 1.88 km. The finer grids were allocated in a stepwise fashion to areas where higher resolution of circulation patterns was required to resolve flows through channels, around shorelines or over more complex bathymetry. Approximately 98,600 cells were used to define the region.

Bathymetric data used to define the three-dimensional shape of the study domain was extracted from the CMAP electronic chart database and supplemented where necessary with manual digitisation of chart data supplied by the Australian Hydrographic Office. Depths in the domain ranged from shallow intertidal areas through to approximately 7,200 m.

2.3.3 Tidal Boundary Conditions

Ocean boundary data for the HYDROMAP model was obtained from the TOPEX/Poseidon global tidal database (TPXO7.2) of satellite-measured altimetry data, which provided estimates of tidal amplitudes and phases for the eight dominant tidal constituents (designated as K2, S2, M2, N2, K1, P1, O1 and Q1) at a horizontal scale of approximately 0.25°. Using the tidal data, sea surface heights are firstly calculated along the open boundaries at each time step in the model.

The TOPEX/Poseidon satellite data is produced, and quality controlled by the US National Atmospheric and Space Agency (NASA). The satellites, equipped with two highly accurate altimeters capable of taking sea level measurements accurate to less than ±5 cm, measured oceanic surface elevations (and the resultant tides) for over 13 years (1992-2005). In total, these satellites carried out more than 62,000 orbits of the planet. The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being the subject of more than 2,100 research publications (e.g., Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen, 2010). As such, the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

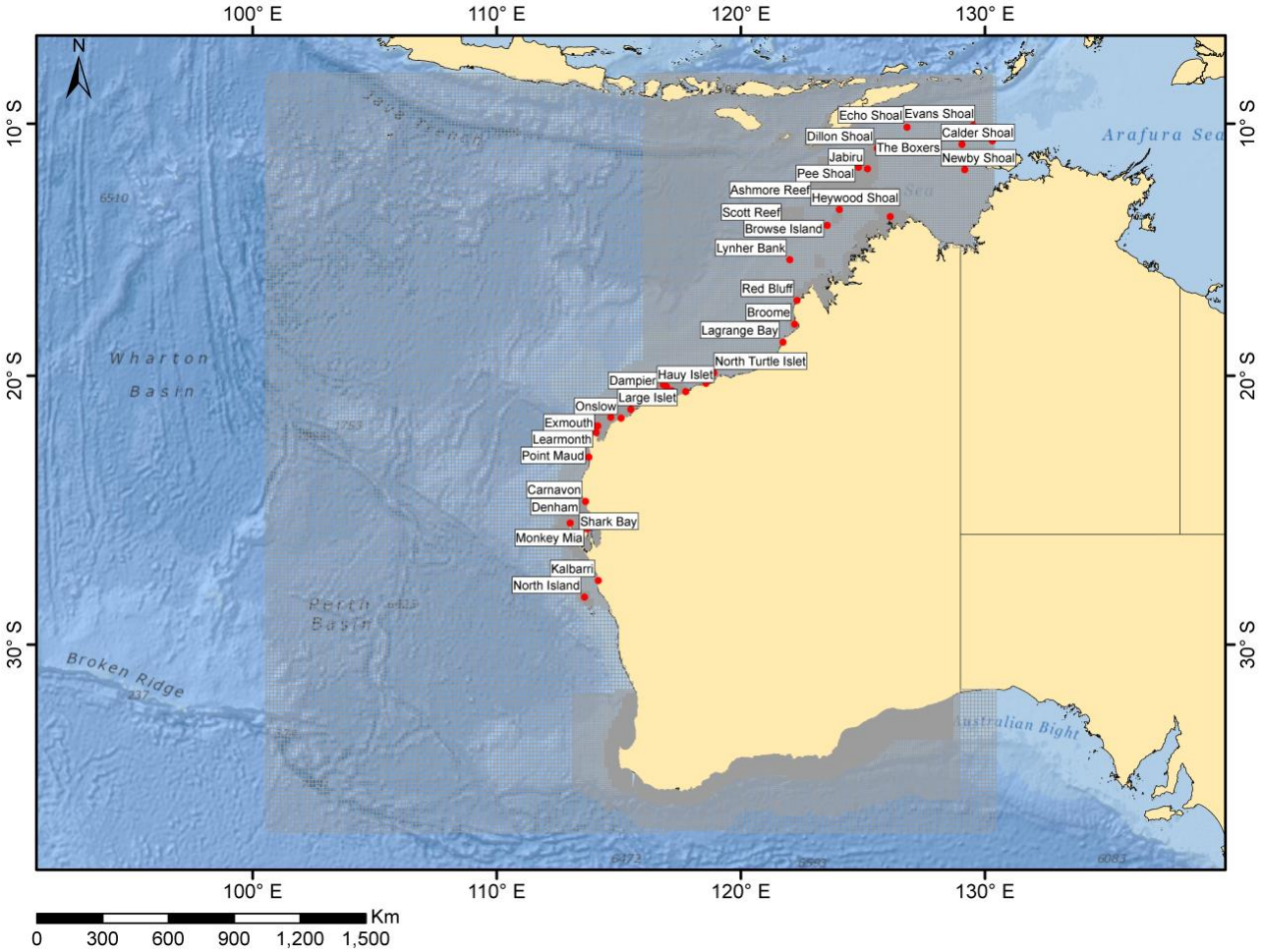

Figure 2.2 Hydrodynamic model grid (grey wire mesh) used to generate the tidal currents, showing the full domain in context with the continental land mass and the locations available for tidal comparisons (red labelled dots). Higher-resolution areas are indicated by the denser mesh zones.

2.4 Tidal and Current Model Validation

2.4.1 Overview

The suitability of the modelled tidal and drift current data products was evaluated by comparing the predicted currents to those measured at the Shell Crux development area. The following sections describe the sources of both the modelled and measured data, the comparison methodology, and the outcomes of the comparisons for both the tidal and drift current components.

2.4.2 Data Sources

A tidal model was developed for the study region using RPS' three-dimensional hydrodynamic model, HYDROMAP. HYDROMAP simulates the flow of ocean currents within a model region due to forcing by astronomical tides, wind stress and bottom friction. This model is described in Section 2.3.

A mesoscale ocean current data sets was selected for the study: HYCOM (Hybrid Coordinate Ocean Model) Consortium's global ocean model, HYCOM. This model is described in Section 2.2.2.

A data set of measured currents was collected by RPS at the Crux development area between April 2016 and May 2017 (RPS, 2017). This data set includes a series of point current measurements made at six depths through the water column using CM04 current meters mounted on a floating mooring. The measurement depths are approximately 20 m, 70 m, 110 m, 150 m, 165 m, and 167 m below the water surface. The temporal

resolution of the data is 1 minute. The raw data was quality-controlled by RPS and only data identified as high-quality was used for comparison to model data. For the measurements at a 20 m water depth, there is approximately a 7-week gap in the data between early September and late October 2016.

2.4.3 Model Validation Skill Measures

2.4.3.1 Motivation

The mesoscale and tidal current models were validated through quantitative and visual comparisons of measured and modelled data.

2.4.3.2 Statistical Analysis

A quantitative analysis of a model's skill at replicating the environmental conditions was conducted using the Index of Agreement (IOA), presented in Willmott (1981), and the Mean Absolute Error (MAE), discussed in Willmott (1982) and Willmott & Matsuura (2005). Other traditional error estimates, such as the correlation coefficient and the root mean square error (RMSE) are problematic and prone to ambiguities and bias (Willmott & Matsuura, 2005; Willmott, 1982). Consequently, they are not reported in isolation here.

The MAE is simply the average of the absolute values of the differences between the observed and modelled values. MAE is a more natural measure of average error (Willmott & Matsuura, 2005) and more readily understood. The IOA is determined using the following formula:

$$\mathrm{IOA} = 1 - \frac{\sum |X_{\mathrm{model}} - X_{\mathrm{obs}}|^2}{\sum \left(\left| X_{\mathrm{model}} - \overline{X_{\mathrm{obs}}} \right| + \left| X_{\mathrm{obs}} - \overline{X_{\mathrm{obs}}} \right| \right)^2}$$

In this equation, X represents the variable being compared and X^{bar} represents the mean of that variable over time.

A perfect agreement can be said to exist between the model and field observations if the IOA gives a measure of one, and complete disagreement will produce an IOA measure of zero (Wilmott, 1981). Although it is difficult to find guidelines for what values of the IOA might represent a good agreement, Willmott et al. (1985) suggests that values meaningfully larger than 0.5 represent good model performance. Clearly, the higher the IOA and the lower the MAE, the better the model performance.

An important point to note regarding both, and in fact most, measures of model performance, is that slight phase differences in the series can result in a seemingly poor statistical comparison, particularly in rapidly changing series such as tidal direction or water elevation where the tidal range is large. It is therefore always important to consider both the statistics and the visual representation of the comparison (Willmott et al., 1985). Statistical comparison of current direction can be misleading; skill measures of direction can become biased where the directional fluctuations are near 0-360°. Therefore, we have based the quantitative assessment on the U and V current components and not magnitude and direction.

2.4.3.3 Time Series Analysis

In addition to bulk statistical measures, model performance for the measurement period was assessed visually with the aid of scatterplots and rose plots. The scatterplots show the correlation between the x- and y-components of the measured and modelled data. The rose plots show the frequency of current direction by sector, and magnitude by colour, to allow comparison of current direction between modelled and measured data.

The model performance was also evaluated against time series plots of water level, U (east-west) velocity component, V (north/south) velocity component, current speed, and current direction data. This approach is valuable because statistical measures of model skill can heavily penalise errors in phase (i.e. time lags) even when the dynamics of flow are broadly reproduced.

2.4.4 Tidal Elevation Validation

For verification of the tidal elevation predictions, the model output was compared against independent predictions of tides using the XTide database (Flater, 1998). The XTide database contains harmonic tidal constituents derived from measured water level data at locations around the world. Of more than 80 tidal stations within the HYDROMAP model domain, 18 sites near the Crux development area were used for comparison.

Time series comparisons were completed for a six-month period from January to June 2010. The statistics are summarised in Table 2.1 and indicate excellent model performance in this region. Water level time series for these locations are shown in Figure 2.3, Figure 2.4 and Figure 2.5 for a one-month period (March 2010). All comparisons show that the model produces a very good match to the known tidal behaviour for a wide range of tidal amplitudes and clearly represents the varying diurnal and semi-diurnal nature of the tidal signal.

For the purposes of understanding the limitations in accuracy of the tidal predictions, the RMSE and MAE in Table 2.1 should be noted. On average, the model predictions are within 0.1-0.3 m of XTide predictions based on known constituent data at any point in time. Often the error is mostly attributable to errors of phase in the tidal signal, with the magnitude of the tidal rise and fall over each tide well represented. However, in the application of the data predictions to operational circumstances, the potential errors should be considered.

The model skill was further evaluated through a comparison of the predicted and observed tidal constituents, derived from an analysis of model-predicted time-series at each location. A scatter plot of the observed and modelled amplitude (top) and phase (bottom) of the five dominant tidal constituents (S2, M2, N2, K1 and O1) is presented in Figure 2.6. The red line on each plot shows the 1:1 line, which would indicate a perfect match between the modelled and observed data. Note that the data is generally closely aligned to the 1:1 line demonstrating the high quality of the model performance.

Table 2.1 Statistical comparison of predicted surface elevation data from HYDROMAP and XTide at 18 locations in the tidal model domain (January to July 2010).

Tide station	Longitude (°E)	Latitude (°S)	IOA	CC	MAE (m)	RMSE (m)
Ashmore Reef	123.02	12.22	0.99	0.99	0.14	0.18
Browse Island	123.55	14.10	0.97	0.97	0.36	0.45
Calder Shoal	129.07	10.85	0.97	0.97	0.17	0.21
Cape Legendre	116.83	20.35	0.99	0.99	0.12	0.14
Dillon Shoal	125.60	11.00	0.97	0.95	0.18	0.22
Echo Shoal	126.82	10.15	0.97	0.94	0.17	0.21
Evans Shoal	129.53	10.08	0.98	0.98	0.11	0.14
Goodrich Bank	130.32	10.70	0.99	0.97	0.13	0.16
Heywood Shoal	124.05	13.47	0.98	0.96	0.27	0.33
Jabiru	125.20	11.83	097	0.95	0.22	0.27
Loxton Shoal	128.72	09.60	0.99	0.98	0.10	0.13
Lynedoch Bank	130.82	10.03	0.98	0.98	0.12	0.15
Lynher Bank	122.02	15.47	0.98	0.97	0.26	0.31
Newby Shoal	129.18	11.87	0.98	0.96	0.23	0.27
Pee Shoal	124.83	11.77	0.97	0.94	0.23	0.27
Scott Reef	121.80	14.05	0.99	0.98	0.16	0.19
The Boxers	128.35	11.45	0.97	0.96	0.16	0.20
Troughton Island	126.13	13.75	0.97	0.95	0.27	0.33

Notes:

IOA	Index of Agreement – values close to 1 represent a high level of agreement.
CC	Correlation Coefficient – values close to 1 represent very good correlation.
MAE	Mean Absolute Error – the lower the value, the smaller the error.
RMSE	Root Mean Square Error – the lower the value, the smaller the error.

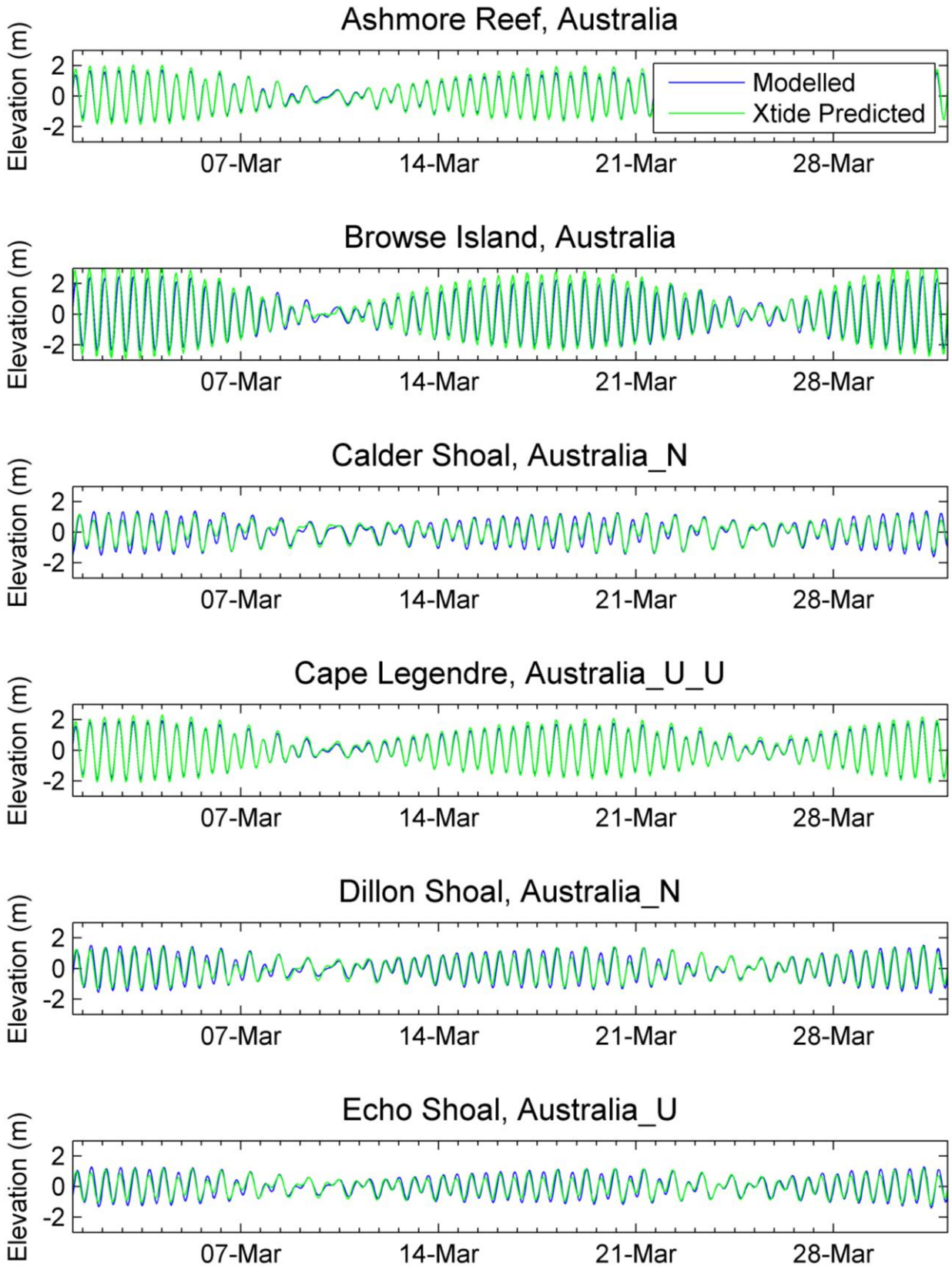

Figure 2.3 Time series comparisons between predicted surface elevation data from HYDROMAP (blue line) and XTide (green line) at six locations in the tidal model domain (March 2010).

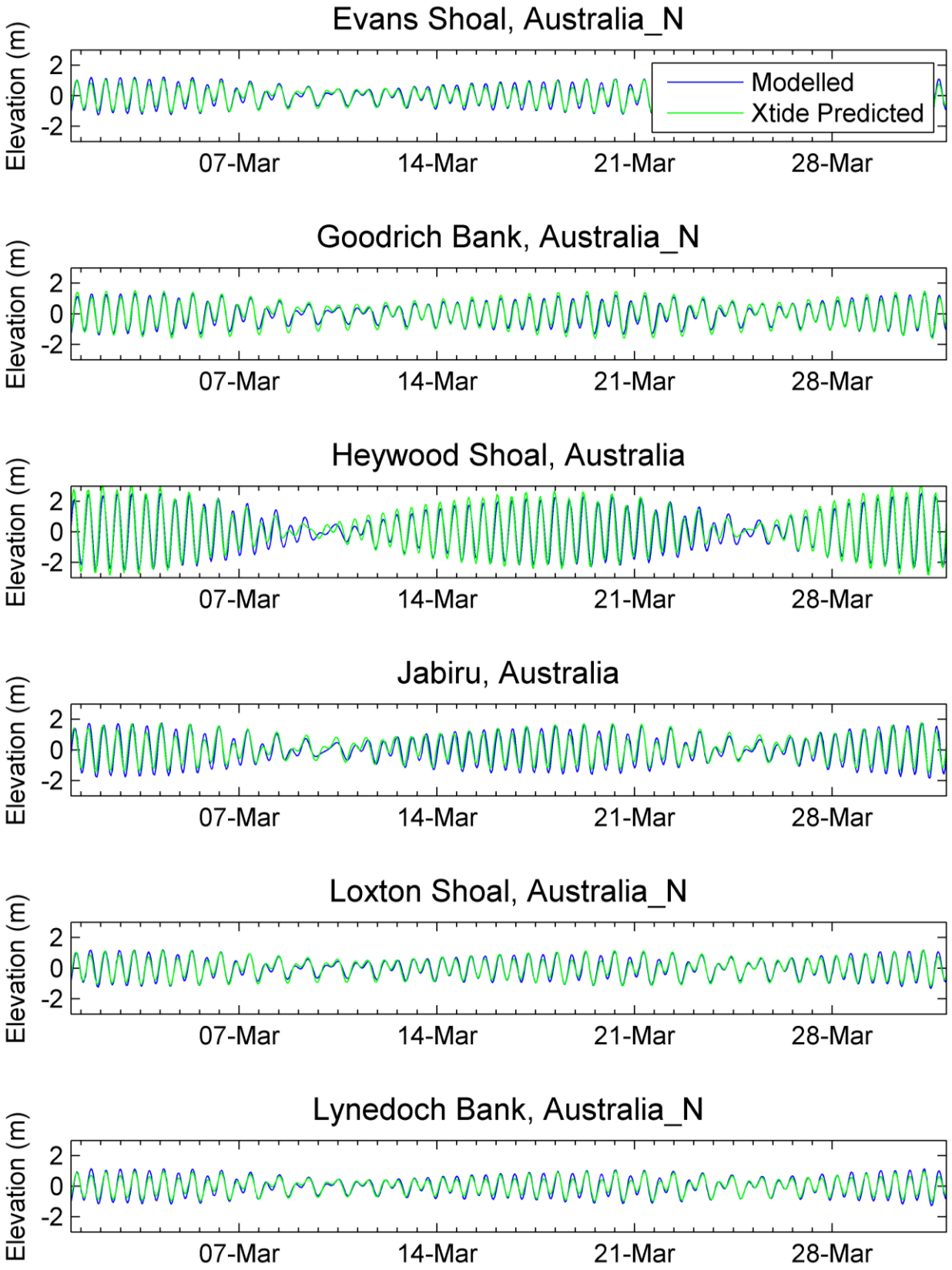

Figure 2.4 Time series comparisons between predicted surface elevation data from HYDROMAP (blue line) and XTide (green line) at six locations in the tidal model domain (March 2010).

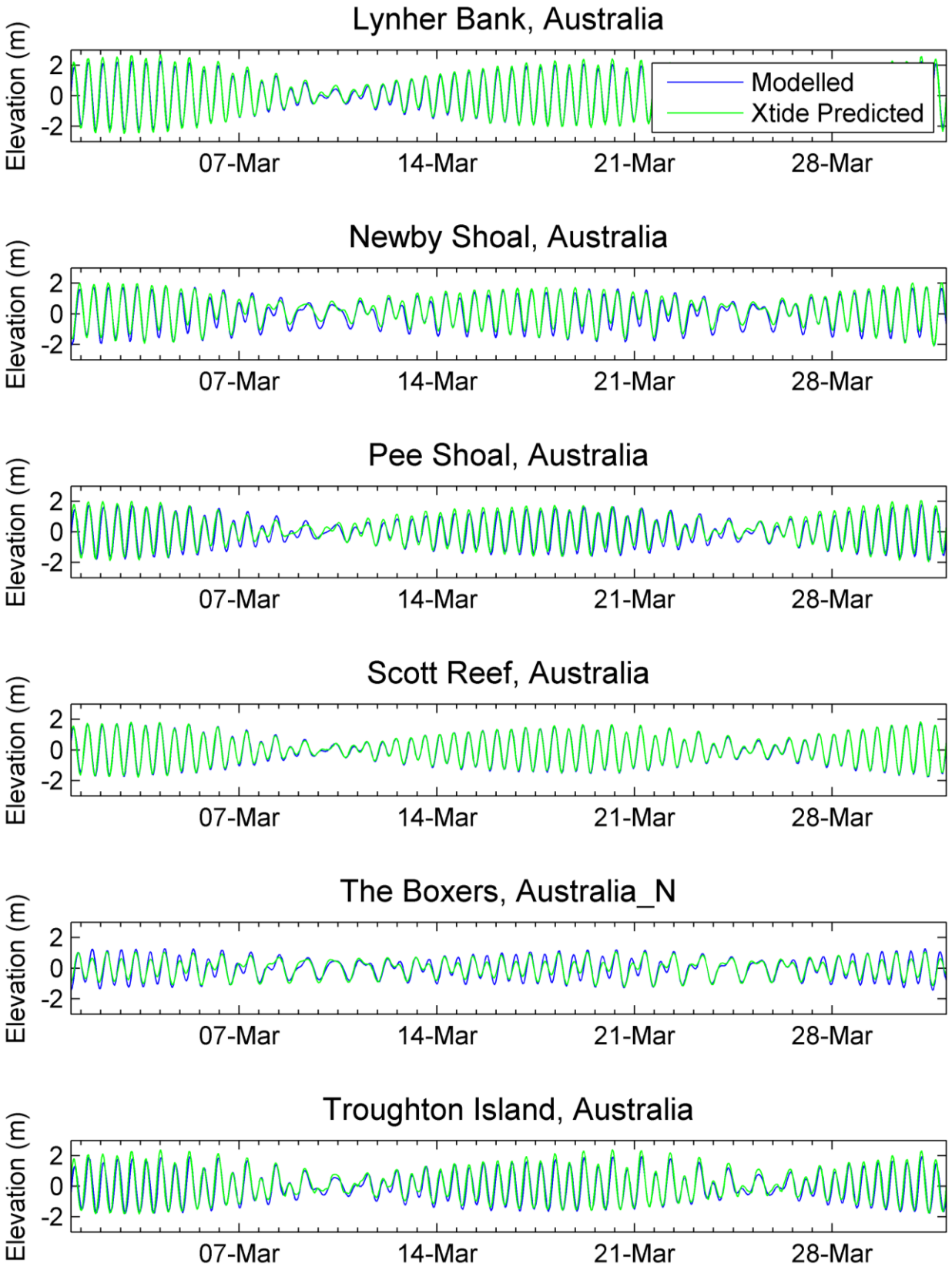

Figure 2.5 **Time series comparisons between predicted surface elevation data from HYDROMAP (blue line) and XTide (green line) at six locations in the tidal model domain (March 2010).**

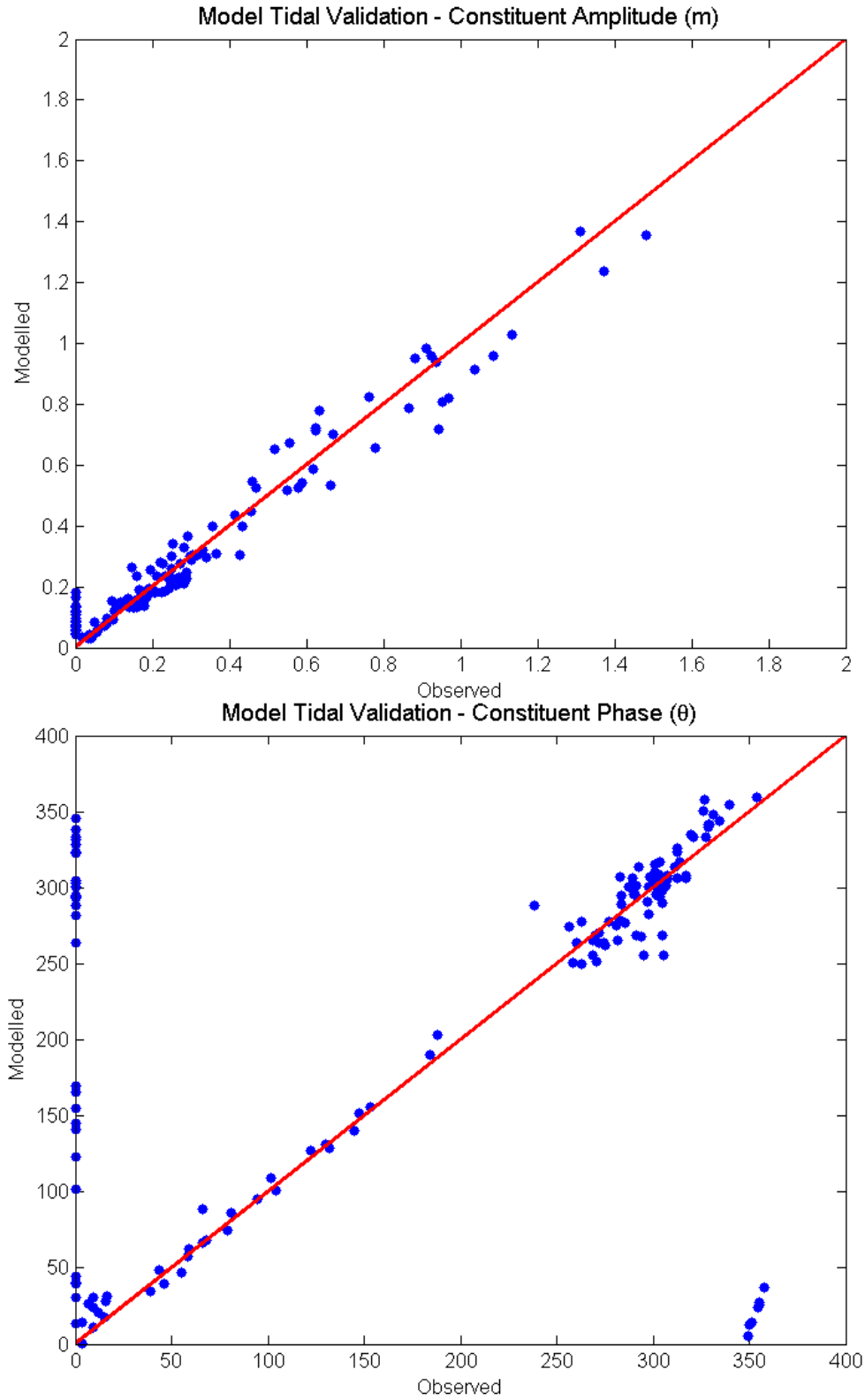

Figure 2.6 **Comparisons between predicted tidal constituent amplitudes (top) and phases (bottom) from HYDROMAP and XTide at all stations in the tidal model domain. The red line indicates a 1:1 correlation between the respective data sets.**

2.4.5 Composite Current Data Set Validation: HYDROMAP + HYCOM

A composite modelled ocean current data product was derived by combining predictions of mesoscale circulation currents, available at daily resolution from the HYCOM ocean model, with predictions of the hourly tidal currents generated by the RPS HYDROMAP model.

To verify the modelled current predictions, the composite model outputs at the Crux development area were compared against the unfiltered site-specific current measurements. The model results were validated through both quantitative and visual comparisons between measured and modelled data at each depth where both data sets were available.

Time series comparison of composite model outputs and measured current magnitude, direction, and U/V velocity components at water depths of 20 m, 70 m and 110 m are presented in Figure 2.7, Figure 2.8, and Figure 2.9, respectively, for one month during winter (June 2016) and summer (December 2016). The time series comparisons reveal that the composite model offers a good match with the measured U/V velocity components at all water depths in both winter and summer, with the magnitudes and timings of the peaks and troughs matching well.

The IOA and MAE values derived from comparisons of the U/V velocity components at water depths of 20 m, 70 m and 110 m over the full measurement period are presented in Table 2.2. The IOA for each velocity component is high at all water depths, reflecting the good match in the magnitudes and timings of the peaks and troughs in the composite model data and measured data. The MAE for the U/V velocity components is relatively low at approximately 0.1 m/s for all water depths, indicating that the magnitude and range of the velocity components match well; however, a slight overprediction of the current magnitude is evident at times.

To compare directionality, roses for the composite model outputs and measured currents at 20 m, 70 m and 110 m water depths over the full measurement period are shown in Figure 2.10. The roses show that the composite model current direction is a good match with the measured direction. A shift in the dominant current direction from a north/south alignment in the measured data set to a northwest/southeast alignment in the composite model data set is evident at the 20 m water depth, and to a lesser extent also at the 70 m water depth. However, the range and variability in the measured current direction is captured by the composite model data, which matches best with the measured data at the water depth of 110 m.

Based on the validation performance, the composite model data set is a good model of standard conditions at the Crux development area and will adequately resolve local and regional circulation patterns. As such, the model is considered suitable for use in the numerical modelling studies conducted as part of the Crux project.

Table 2.2 Statistical comparison of predicted (HYDROMAP+HYCOM) and observed current speeds along orthogonal component axes at the Crux development area (2016-2017).

Skill measure	Index of agreement (IOA)			Mean absolute error (MAE) (m/s)		
Depth (m)	**20**	**70**	**110**	**20**	**70**	**110**
U component	0.72	0.75	0.76	0.11	0.11	0.11
V component	0.82	0.80	0.78	0.11	0.10	0.10

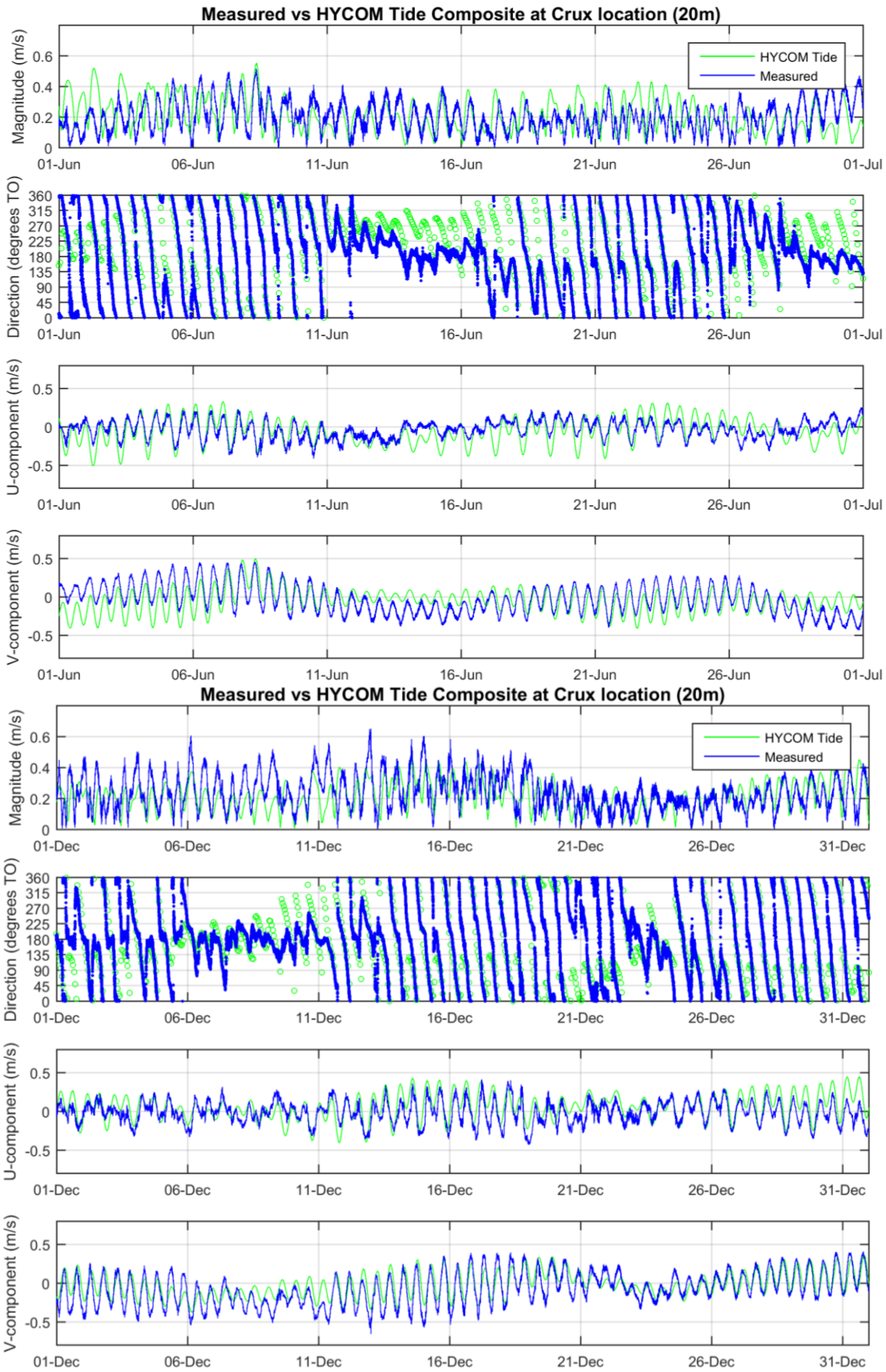

Figure 2.7 **Time series comparisons between predicted (HYDROMAP+HYCOM, green line) and measured (blue line) current data at the Crux development area at a depth of approximately 20 m for June 2016 (top panel) and December 2016 (bottom panel).**

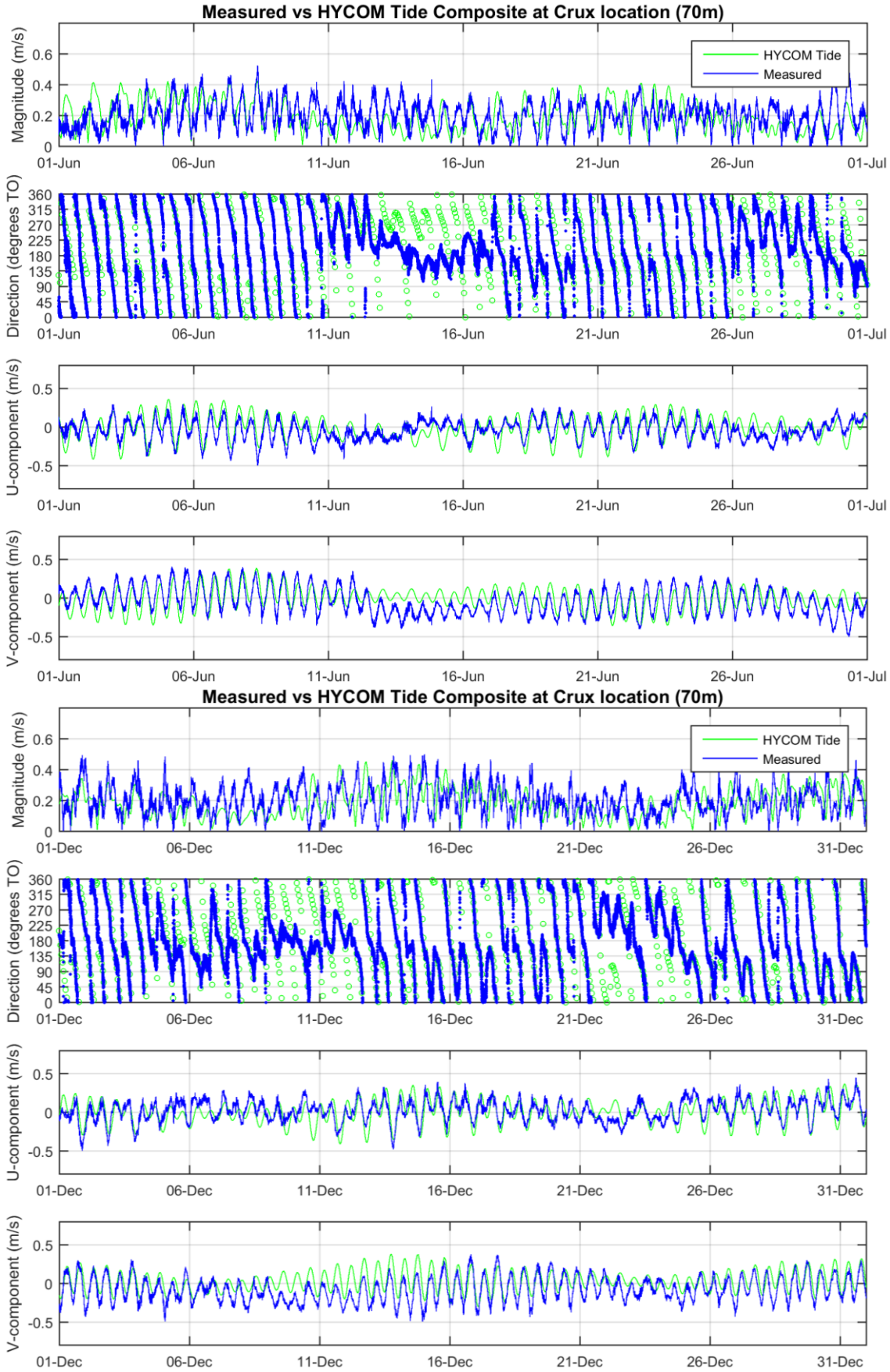

Figure 2.8 **Time series comparisons between predicted (HYDROMAP+HYCOM, green line) and measured (blue line) current data at the Crux development area at a depth of approximately 70 m for June 2016 (top panel) and December 2016 (bottom panel).**

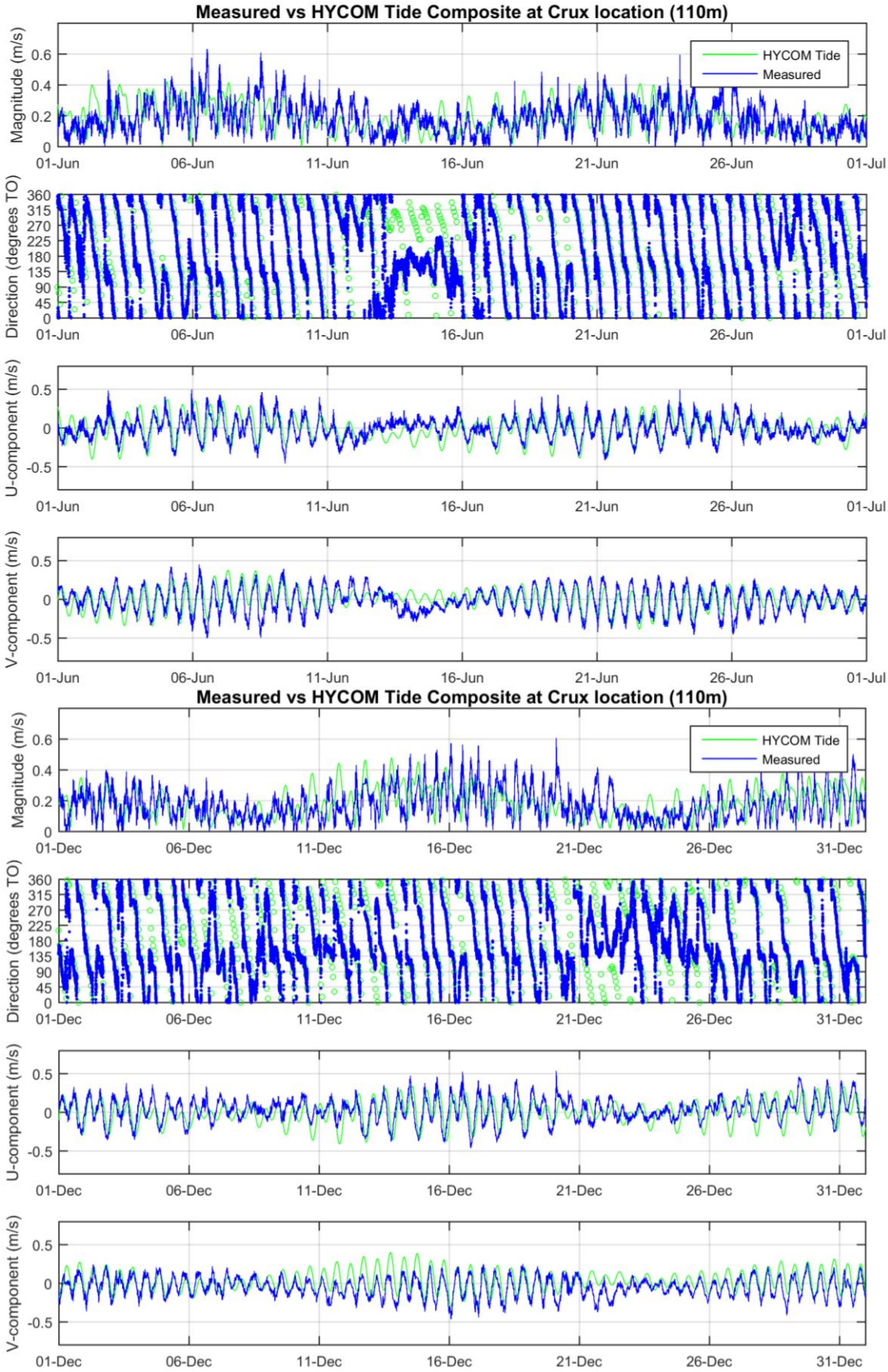

Figure 2.9 Time series comparisons between predicted (HYDROMAP+HYCOM, green line) and measured (blue line) current data at the Crux development area at a depth of approximately 110 m for June 2016 (top panel) and December 2016 (bottom panel).

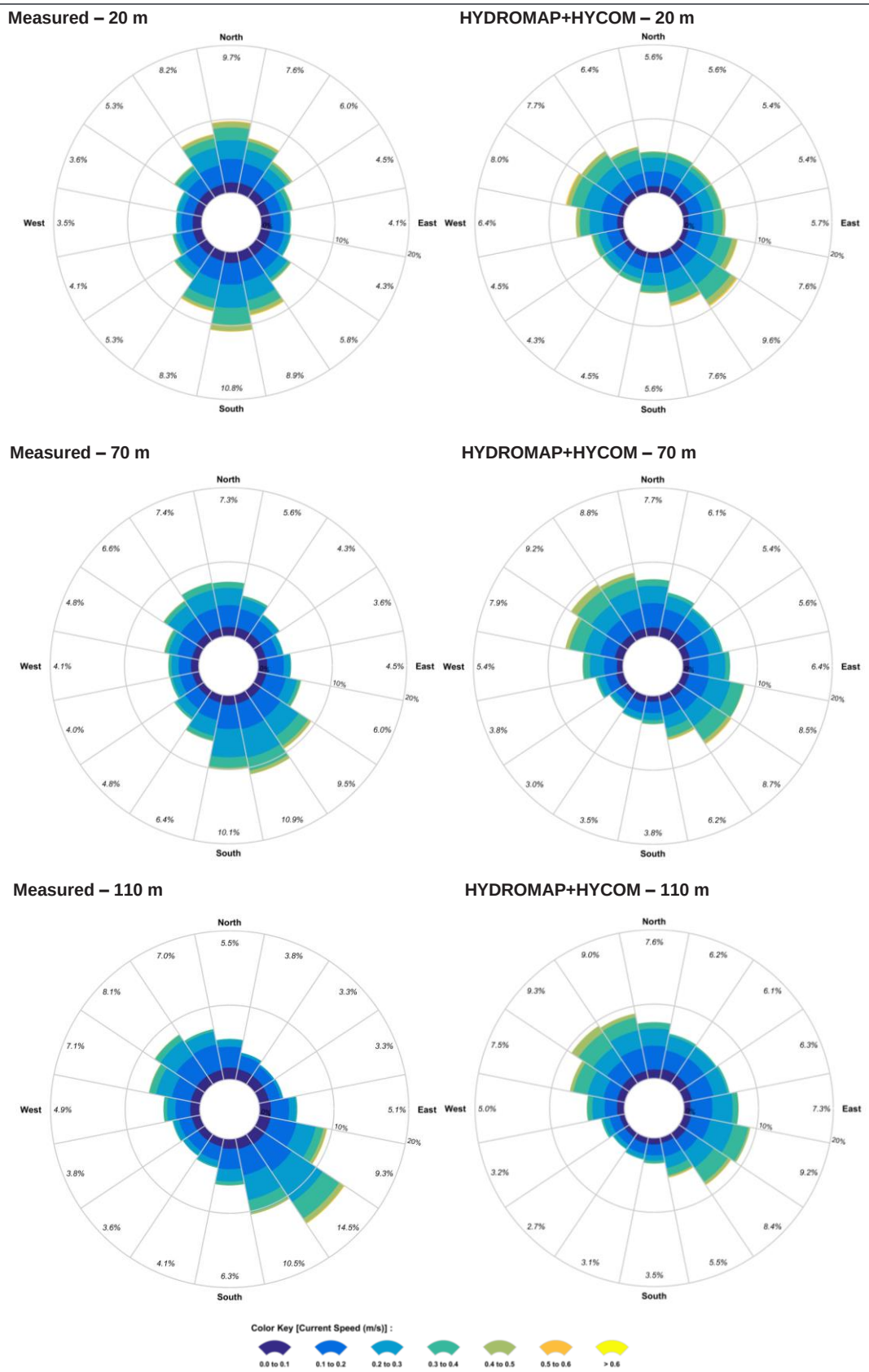

Figure 2.10 Comparative distributions for measured (left column) and predicted (HYDROMAP+HYCOM; right column) current data at the Crux development area (2016-2017) at depths of approximately 20 m (top row), 70 m (middle row) and 110 m (bottom row). The colour key shows the current magnitude, the compass direction provides the direction towards which the current is flowing, and the size of the wedge gives the percentage of the record.

2.5 Currents at Crux Insert Pile Location (Drill Center)

Table 2.3 displays the monthly average and maximum near-surface and near-seabed current speeds calculated from the combination of HYCOM ocean currents and HYDROMAP tidal currents near the Crux Insert Pile location (Drill Center). Figure 2.11 and Figure 2.12 show the monthly near-surface and near-seabed current roses, respectively.

The data shows that the current speeds vary between seasons. In general, during summer (December to February) both near-surface and near-seabed currents are strongest (maximum near-surface speed of 1.51 m/s in January and maximum near-seabed speed of 0.60 m/s in December).

Table 2.3 Monthly average and maximum near-surface and near-seabed current speeds (2008-2017, inclusive) derived from the combined HYCOM and HYDROMAP databases near to the Crux Insert Pile location (Drill Center).

Month	Near-surface current speed		Near-seabed current speed	
	Average (m/s)	Maximum (m/s)	Average (m/s)	Maximum (m/s)
January	0.28	1.51	0.19	0.53
February	0.27	0.86	0.21	0.57
March	0.25	0.71	0.22	0.52
April	0.24	0.82	0.21	0.57
May	0.23	0.68	0.20	0.58
June	0.23	0.67	0.19	0.55
July	0.22	0.77	0.20	0.50
August	0.23	0.67	0.21	0.50
September	0.23	0.60	0.21	0.50
October	0.23	0.61	0.21	0.52
November	0.22	0.65	0.19	0.53
December	0.24	0.70	0.19	0.60
Maximum	**0.28**	**1.51**	**0.22**	**0.60**
Minimum	**0.22**	**0.60**	**0.19**	**0.50**

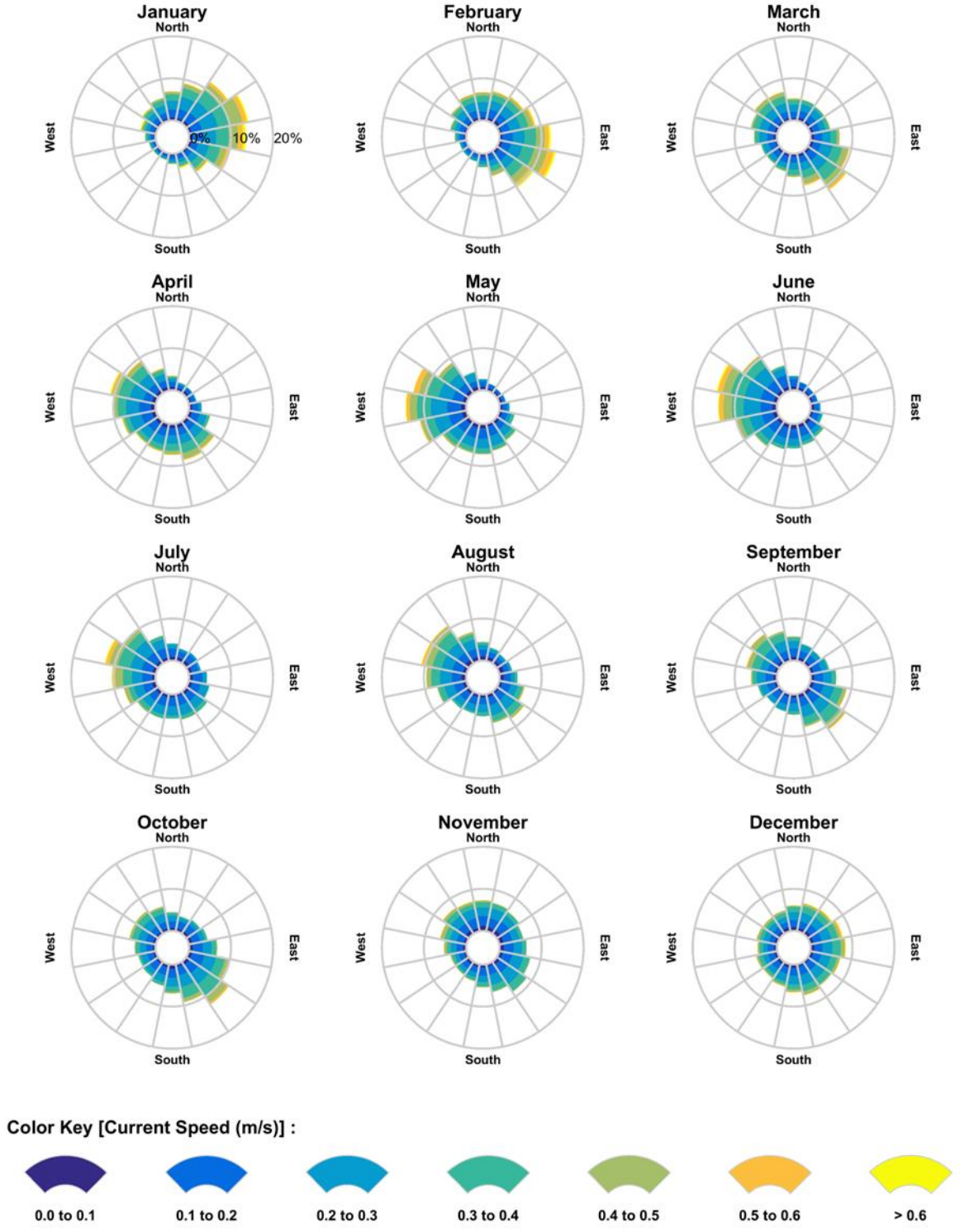

Figure 2.11 Monthly near-surface current distribution (2008-2017, inclusive) derived from the combined HYCOM and HYDROMAP databases near to the Crux Development location. The colour key shows the current magnitude, the compass direction provides the direction towards which the current is flowing, and the size of the wedge gives the percentage of the record.

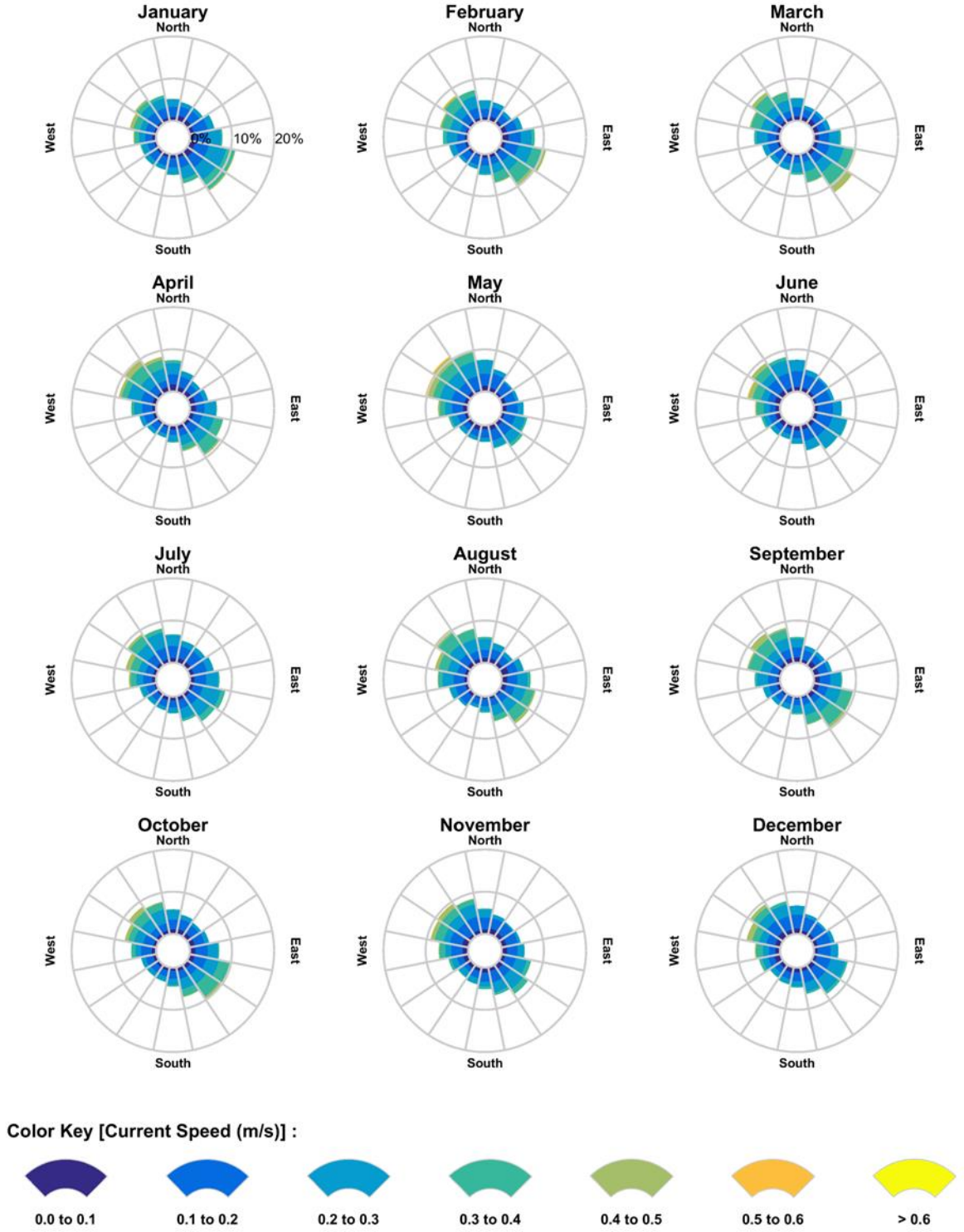

Figure 2.12 Monthly near-seabed current distribution (2008-2017, inclusive) derived from the combined HYCOM and HYDROMAP databases near to the Crux Development location. The colour key shows the current magnitude, the compass direction provides the direction towards which the current is flowing, and the size of the wedge gives the percentage of the record.

3 MODELLING METHODS

3.1 Sediment Dispersion Model: MUDMAP

MUDMAP is a three-dimensional plume model used by industry and regulators to aid in assessing the potential environmental effects from operational discharges such as drill cuttings, drilling fluids and produced formation water. The model has been applied to hundreds of assessments in over 35 countries, including Australia.

The model itself is an enhancement of the Offshore Operators Committee (OOC) model and calculates the fates of discharges through three distinct stages, as defined by laboratory and field studies (Koh & Chang, 1973; Khondaker, 2000):

- Stage 1: Convective descent stage – free fall of the combined mass of fluids and cuttings.
- Stage 2: Dynamic collapse stage – the collapse of the combined mass as it meets the seabed (or water surface).
- Stage 3: Passive dispersion stage – the transport and dispersion of discharged fluids and particles by local currents. For drill cuttings and mud particles that have higher density than seawater, this phase also calculates sinking and settlement to the seabed.

Each stage plays an integral role on different time and distance scales. The governing equations and solutions of MUDMAP were built on the formulae originally developed by Koh & Chang (1973) and extended by the work of Brandsma & Sauer Jr (1983), known as the OOC model, for Stages 1 and 2 of plume motion.

The far-field calculation (passive dispersion stage) employs a particle-based, random walk procedure. The model predicts the dynamics of the discharge material and resulting seabed concentrations and bottom thicknesses over the near-field (i.e. the immediate area of the discharge) and the far-field (the wider region). Figure 3.1 shows a conceptual diagram of the dispersion and fates of drill cuttings and fluids discharge to the ocean and an idealised representation of the three discharge phases.

Settling under currents is selective for particle size, with the larger particles (rocks, gravel to sand) tending to settle quickly, forming a pile that aligns with the predominant current axis. Smaller particles (especially silts and clays) tend to remain suspended for exponentially longer time periods and will therefore be dispersed more widely by local currents. Dispersion of the finer discharged material will tend to be enhanced with increased current speeds and water depth, and with greater variation in current direction over time and depth.

MUDMAP can simulate up to six classes of material (each with up to 6 sub-categories, for a total of 36 sub-categories). Each material class can be set up with a unique density and particle-size distribution. During the dispersion stage, particles are transported in three dimensions according to the current data and horizontal and vertical dispersion coefficients at each time step, following the governing equations.

MUDMAP has been extensively validated and applied for discharge operations in Australian coastal and ocean waters, and around the world (e.g., Burns et al., 1999; Spaulding, 1994; King & McAllister, 1997, 1998).

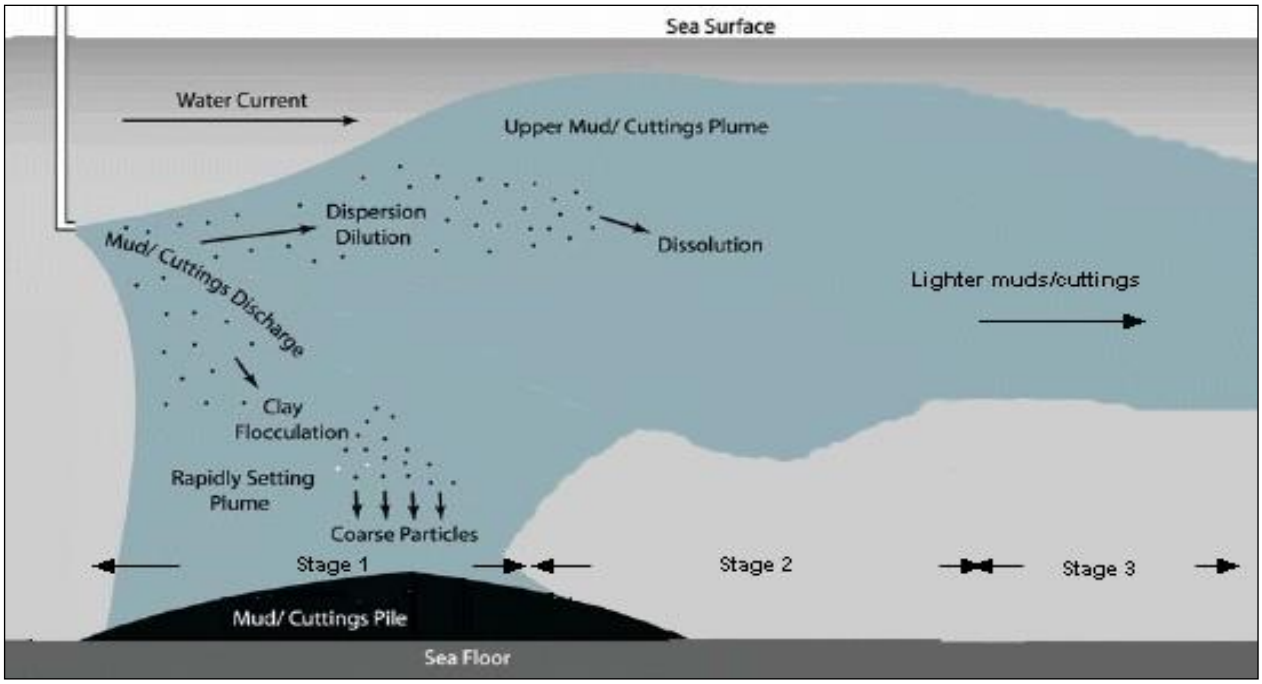

Figure 3.1 Conceptual diagram showing the general behaviour of cuttings and muds discharged to the ocean and the idealised representation of the three discharge phases (Neff, 2005). Please note this diagram is not representative of the actual discharges modelled in this study.

3.2 Discharge Program

During foundation drilling operations a series of discharges of drill cuttings and seawater to the marine environment will occur as drilling progresses.

Shell proposes to drill a total of 14 holes (12 nominal and 2 contingency) using only seawater, with no drilling muds, and using a conventional drilling method (Table 3.1). Each hole will be drilled with a marine riser in-place which will enable the drill cuttings and seawater to be circulated back to a fixed platform drilling deck.

The drill cuttings and seawater will be discharged from the drilling deck discharge point. It is assumed that each hole will be drilled sequentially as part of a single programmed operation. The drilling plan for the Jacket Main Insert Piles involves 16.2 hours per hole drilled for the surface discharges. In total, 9.45 days of actual drilling will be required to complete the 14 holes.

Table 3.1 Summary of the estimated volumes of discharged drill cuttings for each hole drilled.

Hole	Hole diameter (cm)	Discharge method	Cuttings volume discharged (m^3)	Discharge duration (hours)
Jacket Main Insert Pile	300	Cuttings brought to drilling rig, then discharged to surface	1,397	16.2

Note: Only discharged solids used as model input.

3.3 Discharge Input Data

The input data used to setup the MUDMAP dispersion model included, for each hole:

- Volume and discharge duration of the cuttings.
- Particle size distribution and settling velocities of discharged cuttings.
- Bulk density of the discharged cuttings.
- Temperature and salinity profiles of the receiving waters.
- Diameter and orientation of the discharge pipe.
- Height/depth of the discharge point relative to mean sea level.
- Depth-varying current data to represent physical forcing.

Table 3.2 provides a summary of the discharge configuration and the estimated volumes of drill cuttings used as input into the discharge model. The estimated volumes of drill cuttings are considered representative of that expected to be discharged from drilling of the Jacket Main Insert Piles. The discharges for all 14 holes incorporated a total of 19,558 m^3 over a period of 9.45 days.

Each model simulation represented the sequential completion of all holes drilled, with constant rates and depth of discharges to represent the drilling program. Discharge was represented in the model to occur over the defined discharge duration; however, the simulations were run for an additional “run-on” period of ~7 days to allow for assessment of dispersion of finer sediment fractions.

In the configuration of the model, bulk densities ranging from ~1,350 kg/m^3 (0-125 m below seabed) to ~1,650 kg/m^3 (>125 m below seabed) were assumed for the drill cuttings.

McDermott, on behalf of Shell, provided particle size distribution (PSD) data measured by Fugro from downhole samples which were collected as part of a geotechnical investigation in the Crux field. Samples were collected at various depths downhole and across multiple sample locations. To set up the sediment dispersion models, the measured data was binned over 4 depth ranges (0-25 m, 25-65 m, 65-125 m and >125 m) and averaged across the multiple sample locations. The models were set up with six main particle classes to represent coarse gravel, fine gravel, coarse sand, medium sand, fine sand, and clays and silts (Table 3.3).

It is worth noting that particle size has a greater influence on the rate of settling than density (Neff, 2005). Therefore, when setting up the material for discharge in the model, each particle size class was distributed across up to six sub-categories with specific settling velocities. The settling velocities for the various size sub-categories were derived from empirical data provided by Dyer (1986), as summarised in Table 3.4.

Table 3.2 Key inputs to the drill cuttings dispersion modelling.

Parameter	Data
Timing/commencement	First day of each calendar month (May to October, inclusive)
Geographic coordinates (GDA2020 datum)	Drill center: 12° 57' 52.414" S 124° 26' 33.238" E
Drilling method	Conventional
Discharge material	Comingled stream of seabed material, seawater, and air
Bulk density of seabed material (when in-situ)	1.35-1.65 MT/m^3
Density of comingled discharge stream	~1.15 MT/m^3
Flowrate of comingled discharge stream	510 m^3/hr (seabed material – 85 m^3/hr)
Density of drilling muds	N/A
Discharge depth	Sea surface
Discharge pipe orientation	Horizontal
Discharge pipe diameter	~300 mm
Duration to drill single hole	16.2 hrs
Drill hole diameter	3.3 m
Number of holes	12 (nominal) + 2 (contingency) = 14 total
Length of holes	120 m (primary) + 42 m (insert) + 1.5 m (over-drill) = 163.5 m total
Volume of seabed material discharge (per pile)	1,397 m^3
Volume of seabed material discharge (14 piles)	19,558 m^3
Water depth	168.5 m
Particle size distribution	Data supplied by Shell

Table 3.3 Proportional contribution of the particle size classes for discrete depth intervals.

Material class	0-25 m interval (%)	25-65 m interval (%)	65-125 m interval (%)	>125 m interval (%)
Coarse Gravel	4.4	6.2	0.2	3.0
Fine Gravel	3.3	5.6	2.6	6.0
Coarse Sand	6.9	9.8	12.8	12.5
Medium Sand	16.7	18.4	28.2	31.0
Fine Sand	34.1	17.0	23.6	17.5
Clays and Silts	34.6	43.0	32.6	30.0

Table 3.4 Discharge particle characteristics and size distribution of cuttings assumed for modelling of depth intervals.

Sediment characteristics						
Class	**Grain size (mm)**	**Settling velocity (cm/s)**	**0-25 m interval**	**25-65 m interval**	**65-125 m interval**	**>125 m interval**
Coarse Gravel	75	93.9	3.0	4.2	0.0	0.0
	37.5	66.4	1.4	2.0	0.2	3.0
Fine Gravel	19	47.2	1.6	2.2	0.4	2.0
	9.5	33.3	1.7	3.4	2.2	4.0
Coarse Sand	4.8	23.4	2.0	1.8	2.8	4.0
	2.4	16.3	4.9	8.0	10.0	8.5
Medium Sand	1.2	11.0	6.4	9.0	13.0	13.5
	0.60	7.0	4.0	4.0	6.8	7.5
	0.43	5.2	6.3	5.4	8.4	10.0
Fine Sand	0.30	3.6	15.9	8.4	13.8	12.0
	0.15	1.3	12.6	4.2	5.4	2.5
	0.075	0.35	5.7	4.4	4.4	3.0
Clays and Silts	0.049	0.15	3.9	3.0	3.2	2.5
	0.035	0.078	4.6	3.2	3.2	2.5
	0.025	0.041	4.3	4.6	3.8	4.5
	0.018	0.019	2.0	2.8	2.6	3.0
	0.013	0.010	2.3	3.0	3.2	3.0
	0.009	0.005	2.6	3.8	3.2	3.0
	0.007	0.0027	2.0	4.0	3.4	4.0
	0.005	0.0013	1.9	3.0	1.6	1.5
	0.003	0.00069	2.0	2.8	1.8	1.5
	0.002	0.00033	2.1	2.6	1.6	1.5
	0.001	0.00012	7.0	10.2	5.0	3.0

3.4 Grid Configuration

A uniformly sized rectangular grid covering a 20 km (longitude, x-direction) by 20 km (latitude, y-direction) region around the discharge location was employed to calculate the concentration of drill cuttings in the water column and on the seafloor. The resolution of each grid cell was approximately 20 m (x) x 20 m (y) x 10 m (z).

3.5 Mixing Parameters

The horizontal and vertical dispersion coefficients are used in dispersion modelling to represent the mixing and diffusion processes caused by turbulence, which are sub-grid processes at the scale of the hydrodynamic model drivers. The dispersion coefficients are expressed in units of rate of area change (m^2/s). Increasing the horizontal dispersion coefficient will increase the horizontal spread of the discharge plume and decrease the centreline concentrations. Increasing the vertical dispersion coefficient spreads the discharge further across the vertical layers.

The horizontal turbulent diffusion of the plume is dependent on the hydrodynamic conditions (i.e. wind, wave and current) and the physical scale of the plume compared to the scales of the oceanic processes that disperse the plume. For a plume of approximately 10-100 m width, dispersion occurs primarily through small-scale

horizontal swirling motions and vertical mixing, with a horizontal dispersion rate of the order of 0.1 m^2/s. As the plume grows to a scale of 1-10 km, it begins to be subject to mesoscale eddies and horizontal dispersion rate becomes of the order of a few to tens of m^2/s. At even larger scales, the plume would be larger than the mesoscale eddies and eddy mixing becomes the dominant mechanism, with a rate of horizontal dispersion of 100-1,000 m^2/s.

For this project, with an open ocean environment and length scales of 10 m to 1 km, a horizontal diffusion rate of 0.25 m^2/s was applied. A value of 0.10 cm^2/s was set for the vertical dispersion coefficient to account for the influence of turbulence within the water column, as well as wave-induced turbulence. The values are based on previous experience and informed by studies by Copeland (1996).

3.6 Stochastic Outcomes

A stochastic modelling approach was followed for the assessment of drill cuttings discharge in this study, with 60 replicate simulations carried out over the ten-year hindcast period (one per calendar month). The results of all replicate simulations for each calendar month were combined and statistically analysed to develop the distribution of outcomes based on time and event. These statistics were then presented as contours of maximum occurrence.

Note: considering the stochastic methodology applied, the sedimentation results are presented as a statistical summary of the range of outcomes of maximum bottom thickness or bottom concentration levels across all replicate simulations for each month assessed.

3.7 Reporting Thresholds

The MUDMAP model can track and predict sediment concentrations and thickness to very low levels that may not be of practical and ecological significance; therefore, a series of minimum detectable levels and impact thresholds were defined for reporting of the model-predicted outcomes.

Table 3.5 presents a summary of the natural and impact threshold levels used in this study for assessment of sedimentation.

Table 3.5 Natural and impact threshold levels for bottom thickness.

Parameter	Natural threshold level (mm)	Impact threshold level (mm)	
		Low exposure	High exposure
Bottom thickness – multiple (14) holes drilled	0.058	1	10

A study by Glen (1997) found that the maximum natural sedimentation rate for Northwest Australia is 223.21 cm per thousand years (ka). As a conservative measure, a minimum threshold thickness of 0.058 mm was calculated from the maximum natural sedimentation rate of 2.23 mm/year (or 0.0061 mm/day) multiplied by the combined discharge duration (9.45 days).

Impact thresholds of 1 mm (low exposure) and 10 mm (high exposure) have been applied in this study, and are based on available literature and are considered industry standard. A study by Trannum et al. (2009) showed a significant decrease of species, abundance of individuals, Shannon-Wiener diversity, and biomass of marine animals with increasing depth of WBM cuttings (3-24 mm) on sediment in the microcosms. Therefore, a conservative 1 mm impact threshold was selected as representative of low exposure. A study by Kjeilen-Eilertsen et al. (2004) showed that deposition greater than 9.6 mm is likely to cause smothering impacts on benthic ecosystems, including corals. It is also worth noting that a study by Smit et al. (2008) established a thickness threshold of greater than 6.5 mm would be needed before potential harm to benthic macrofauna. This sediment thickness threshold is based on data from shallow-water fauna.

It is important to note that the predicted sedimentation is quoted as the level above any background sedimentation process relevant to the Crux location. Moderate levels of sediment mobility are expected in this

region due to the drift and tidal current magnitudes, and therefore it is expected that these results are conservative (i.e. more sedimentation predicted than would be the case).

4 RESULTS

4.1 Overview

Discharges of drill cuttings were modelled for the Jacket Main Insert Piles drilling program, which is expected to involve the drilling of 14 holes: 12 nominal and 2 contingencies. Discharges of drill cuttings from the drilling of the holes will occur at the surface (see Section 3.2). The drilling program was assumed to have a total of 16.2 hours per hole. Shell intends to drill 14 holes from one drill center (one location), requiring approximately 9.45 days in total to drill.

The modelling results for the drillings of the 14 holes are presented in Section 4.2. This section contains the monthly (May to October) results and the integration (combined) of all model results to assess the regional coverage of all discharge operations.

If drilling were to occur at alternative locations within the Crux development area, similar sedimentation outcomes may be expected given the likelihood of similar metocean conditions. However, drilling in areas of more complex bathymetry, particularly near the shoals within the Crux development area, may result in patterns of sedimentation being more clearly influenced by that bathymetry.

4.2 Drill Cuttings (14 Holes)

4.2.1 Discussion of Combined (May to October) Results

The results for each month were integrated to define the likely coverage area of bottom thickness above the thresholds for 'any time' or current conditions modelled.

The discharge of drill cuttings during drilling operations will consist of particles (53 to 67%, depending on the depth drilled) that will settle out rapidly through the full water depth (168.5 m) over periods ranging from minutes (~3) to hours (~13). Over these periods of time sediments may be transported a few hundred meters to several kilometres, respectively, by drift currents that might be flowing across the tidal axis. A further 20% of the drill cuttings will settle out over a period of days to weeks while the remaining 13 to 27% are unlikely to ever settle out.

Figure 4.1 shows the maximum bottom thickness above the natural threshold level (0.058 mm) from a single replicate simulation during August. This simulation – selected as the replicate in which sediment travels farthest (~11.8 km) from the discharge location in the direction (west-northwest) of the closest shoal – was not representative of typical conditions and was one of only a small number (<7%) of replicate simulations with bottom thicknesses of >0.058 mm at >7 km from the discharge location.

A cross-section transect showing an instantaneous concentration of sediment through the water column for the selected replicate simulation in August is presented in Figure 4.2. The distribution of sediments through the water column clearly shows that the heavier (larger) sediments settle out quickly to the seafloor, while the lighter sediment remain in suspension settling at a slower rate and remaining higher in the water column.

Table 4.1 shows the combined distribution of sediment thickness calculated for deposits of drill cuttings. The results presented in the figure are aggregates of all stochastic simulations commencing throughout the ten-year hindcast period.

The modelling results demonstrated that larger particles (greater than 0.25 mm diameter) were predicted to settle typically within 250 m from the discharge location, while the currents transported the smaller sediments (less than 0.25 mm) further away from the discharge location.

Table 4.1 shows the predicted maximum bottom thickness, area of coverage and the maximum distance from the discharge location to the minimum drill cuttings thresholds (0.058 mm, 1 mm, and 10 mm).

The maximum thickness (or height of mound) was predicted to be 32.21 mm adjacent to the discharge location (Table 4.1).

Modelling predicted a relatively wide zone of potential influence at the natural threshold level, with thicknesses of 0.058 mm or greater expected up to ~11.8 km from the discharge location while covering an area ~40.45 km^2 (4,045 ha). This potential zone of influence was more localised at the low (1 mm) and high (10 mm)

exposure thresholds, with drill cuttings not expected beyond 986 m and 386 m, respectively. Total areas of coverage at the low (1 mm) and high (10 mm) exposure threshold were 2.09 km^2 (209 ha) and 0.28 km^2 (28 ha), respectively.

Modelling indicates that sedimentation resulting from discharges of drill cuttings is not likely to have any impact above the natural threshold (0.058 mm) at the shoals closest to the discharge site.

4.2.2 Discussion of Monthly Results

The outcomes of the sediment dispersion modelling assessment are summarised, for each month, in Table 4.2, with maximum values presented for sediment bottom thickness, areas of coverage above the 0.058 mm, 1 mm and 10 mm thresholds, and maximum distances from the site to these thresholds.

Figure 4.4 to Figure 4.9 show the distributions of sediment thickness calculated for deposits of drill cuttings on the seafloor for operations commencing on the first day of each calendar month (May to October). The results presented in each monthly figure are aggregates of all stochastic simulations commencing in all corresponding months during the ten-year hindcast period.

Sediments larger than 0.25 mm in diameter are predicted to typically settle out within 250 m of the discharge, with displacement occurring on either side of the discharge in response to the prevailing currents. Finer sediments are forecast to disperse more widely, with the finest sediments contributing a lower proportion of sediment to deposits greater than 0.058 mm (natural threshold) thick. Deposits exceeding the 0.058 mm minimum thickness are calculated to extend up to between 3,691 m (October) and 11,844 m (June) from the discharge site. At the low (1 mm) exposure threshold, drill cuttings are expected to extend up to between 814 m (July) and 986 m (June) from the discharge site. Drill cuttings were modelled to extend up to between 300 m (May and July) and 386 m (June) at the high (10 mm) threshold.

Deposits of finer sediments are consistently calculated to build up along the tidal axis on either side of the source rather than displace to a particular side, indicating that tidal currents will have influence over movement of the finer particles and that ocean currents will have a small impact on the net movement direction and distance travelled before settlement occurs. The directions in which sediments are calculated to settle vary only slightly among the monthly simulations, which is indicative of the high influence of tidal currents at the source and the relative lack of variation in ocean current conditions over the ten-year hindcast period.

The maximum thickness (or height of mound) calculated at any location in any simulation is forecast to fall in the range of 19.87 mm (July) to 32.21 mm (September), adjacent to the discharge location, and quickly decrease with distance from the release point. The minimum and maximum predicted areas of sediment coverage at thicknesses greater than 0.058 mm are ~16 km^2 (June) and ~30.64 km^2 (August), respectively. At the low (1 mm) exposure threshold, the minimum and maximum areas of coverage are predicted to be greatly reduced, and range between 1.42 km^2 (July) and 1.61 km^2 (October), respectively. At the high (10 mm) exposure threshold, they are reduced further, with minimum and maximum predicted areas of coverage ranging from 0.13 km^2 (May) to 0.19 km^2 (February), respectively.

Modelling indicates that sedimentation resulting from discharges of drill cuttings is not likely to have any impact above the natural threshold (0.058 mm) at the shoals closest to the discharge site.

4.2.3 Combined (May to October) Results

Table 4.1 Predicted bottom thickness, areas of coverage above the 0.058 mm, 1 mm and 10 mm thresholds, and maximum distances to these thresholds resulting from the combined drill cuttings discharges at the surface for the proposed Crux program. The results are calculated across all simulations during the May to October period.

Period	Maximum bottom thickness (mm)	Maximum total area of coverage (km^2) above threshold			Maximum distance (m) from discharge to threshold		
		0.058 mm	1 mm	10 mm	0.058 mm	1 mm	10 mm
May to October	32.21	40.45	2.09	0.28	11,844	986	386

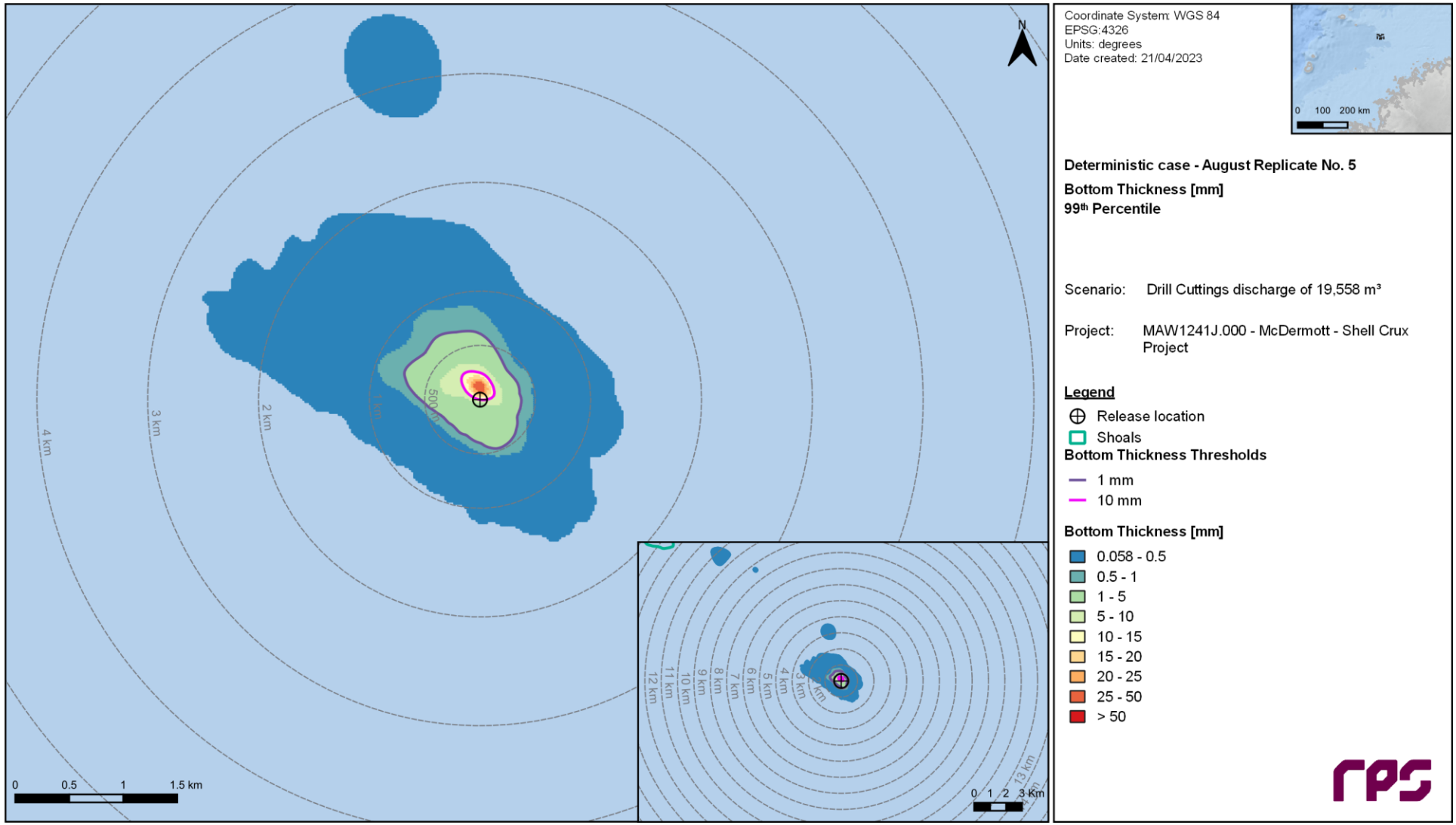

Figure 4.1 **Predicted maximum bottom thickness resulting from the replicate simulation in August in which sediment travels the farthest (~12 km) from the discharge location in the direction of the closest shoal.**

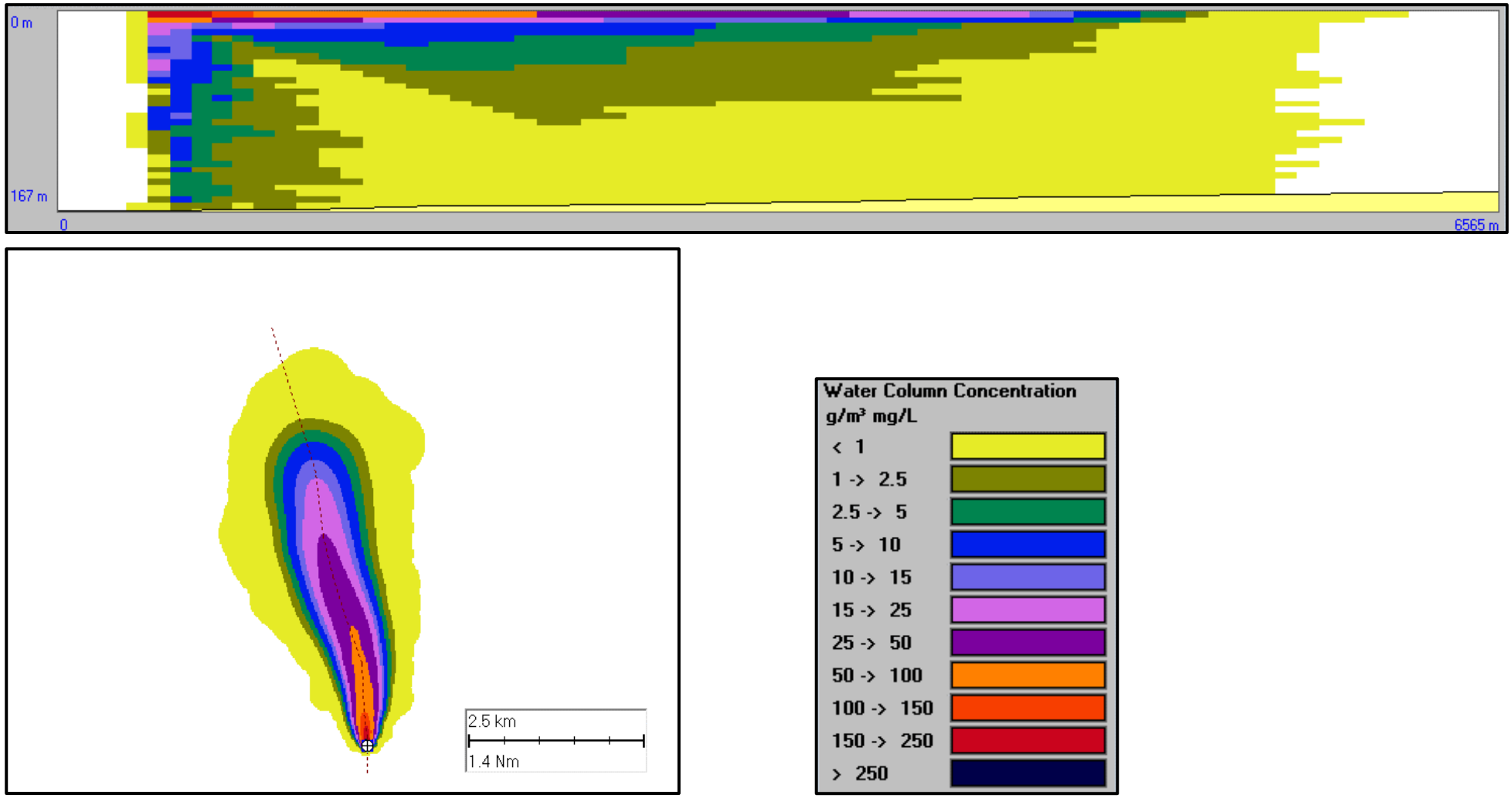

Figure 4.2 Cross-section transect of sediment distribution through the water column for the selected replicate simulation in August.

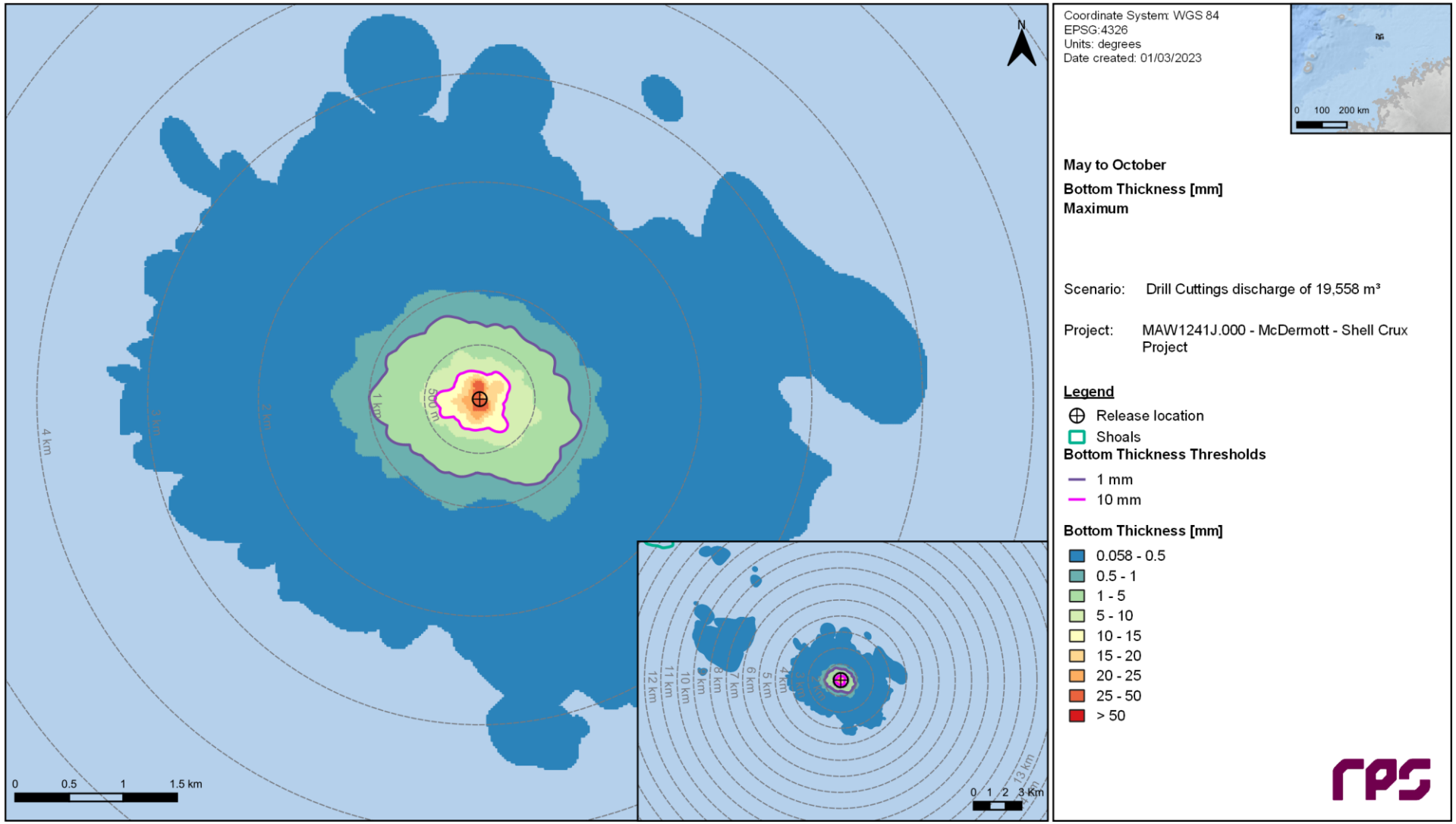

Figure 4.3 **Predicted maximum bottom thickness resulting from the combined drill cuttings discharges at the surface for the proposed Crux program. The results are calculated across all simulations during the May to October period.**

4.2.4 Monthly Results

Table 4.2 Predicted bottom thickness, areas of coverage above the 0.058 mm, 1 mm and 10 mm thresholds, and maximum distances to these thresholds resulting from the combined drill cuttings discharges at the surface for the proposed Crux program. The results are calculated across all simulations commencing on the first day of each calendar month during the assessed period.

Month	Maximum bottom thickness (mm)	Maximum total area of coverage (km^2) above threshold			Maximum distance (m) from discharge to threshold		
		0.058 mm	1 mm	10 mm	0.058 mm	1 mm	10 mm
May	30.26	16.69	1.43	0.13	9,473	920	300
June	24.36	16.00	1.32	0.15	11,844	986	386
July	19.87	16.16	1.42	0.19	9,029	814	300
August	29.62	30.64	1.43	0.17	11,407	896	364
September	32.21	21.02	1.43	0.14	4,038	890	312
October	21.71	19.51	1.61	0.16	3,691	951	362

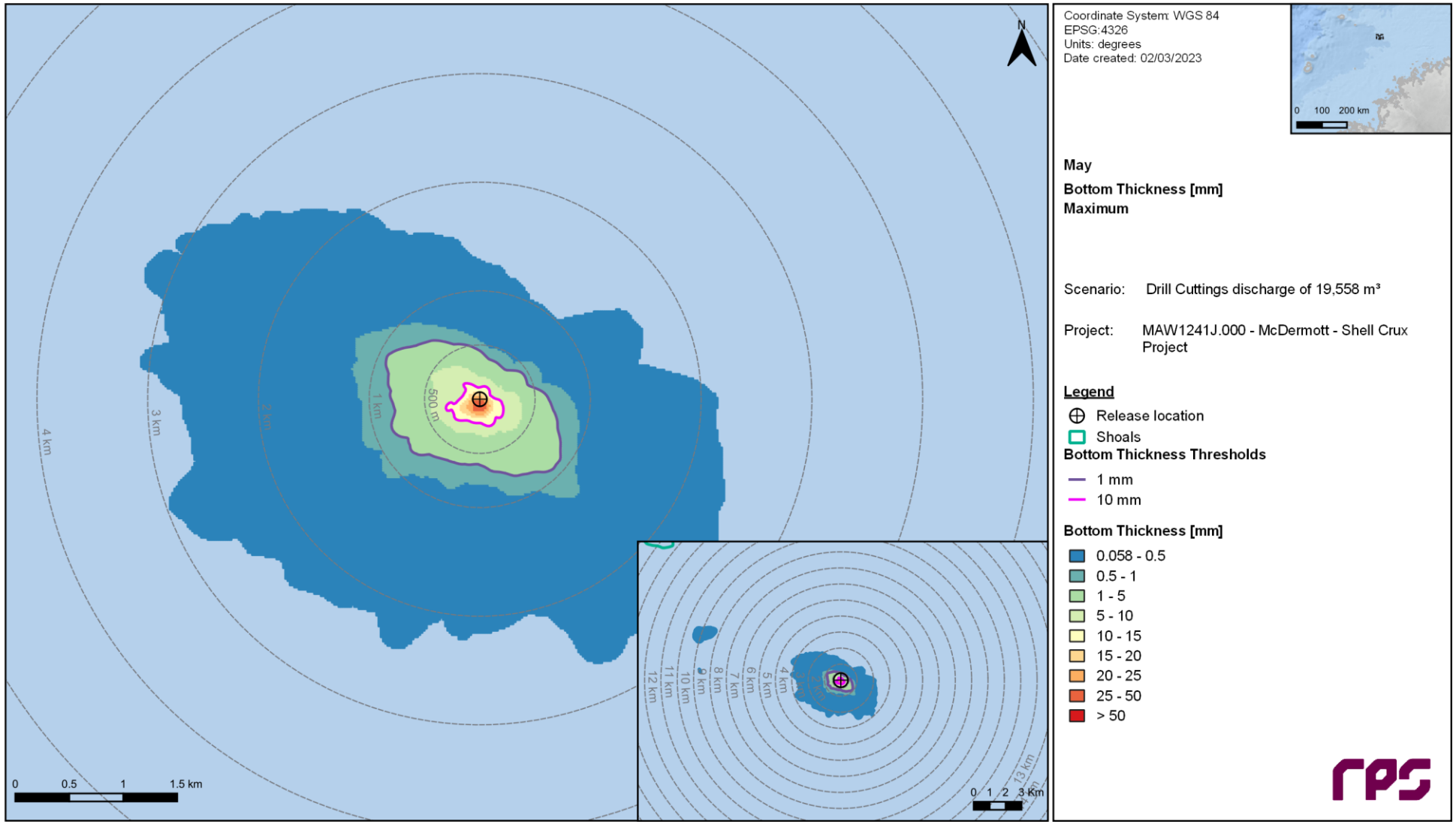

Figure 4.4 Predicted maximum bottom thickness resulting from the May drill cuttings discharges at the surface for the proposed Crux program.

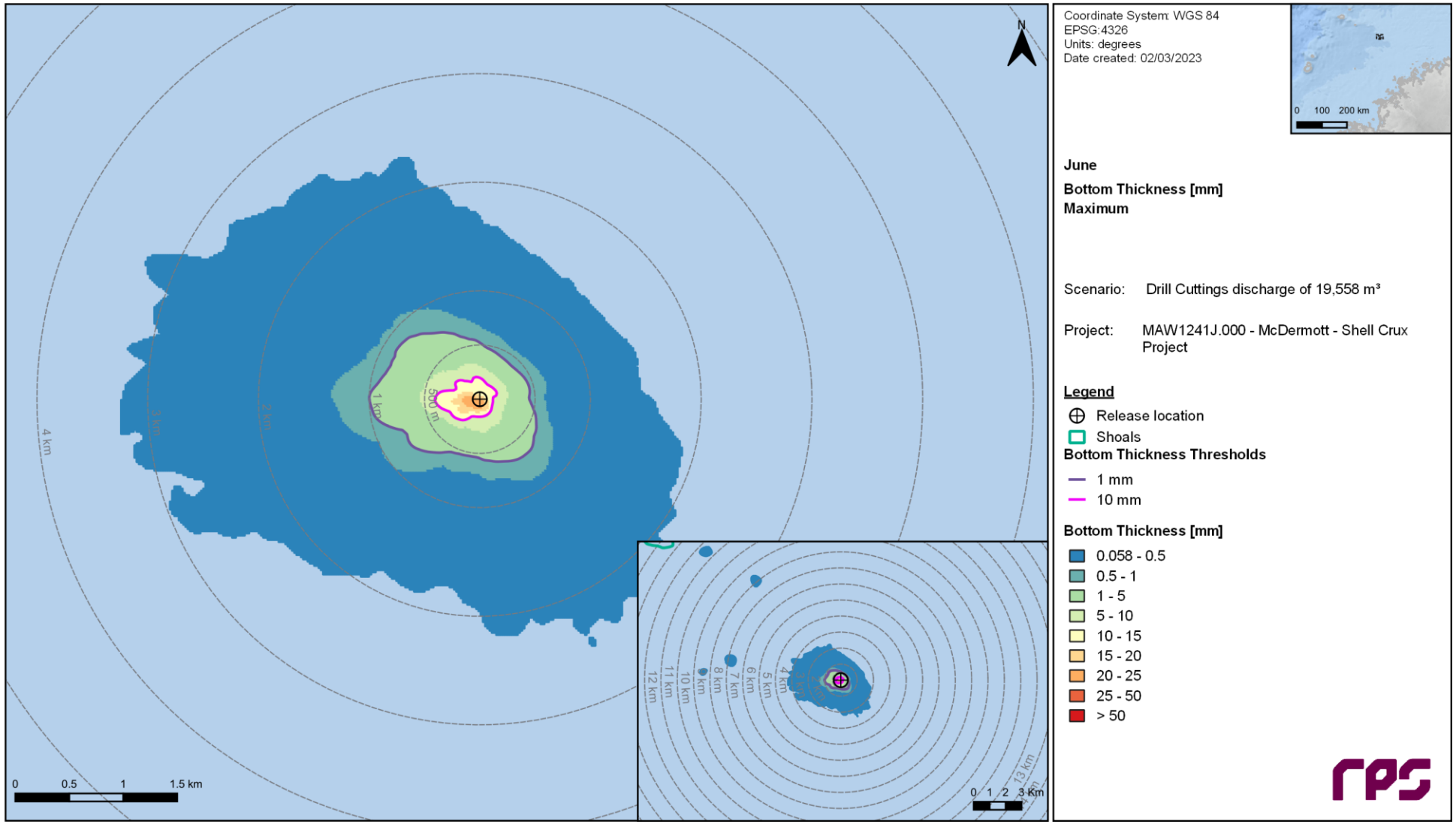

Figure 4.5 Predicted maximum bottom thickness resulting from the June drill cuttings discharges at the surface for the proposed Crux program.

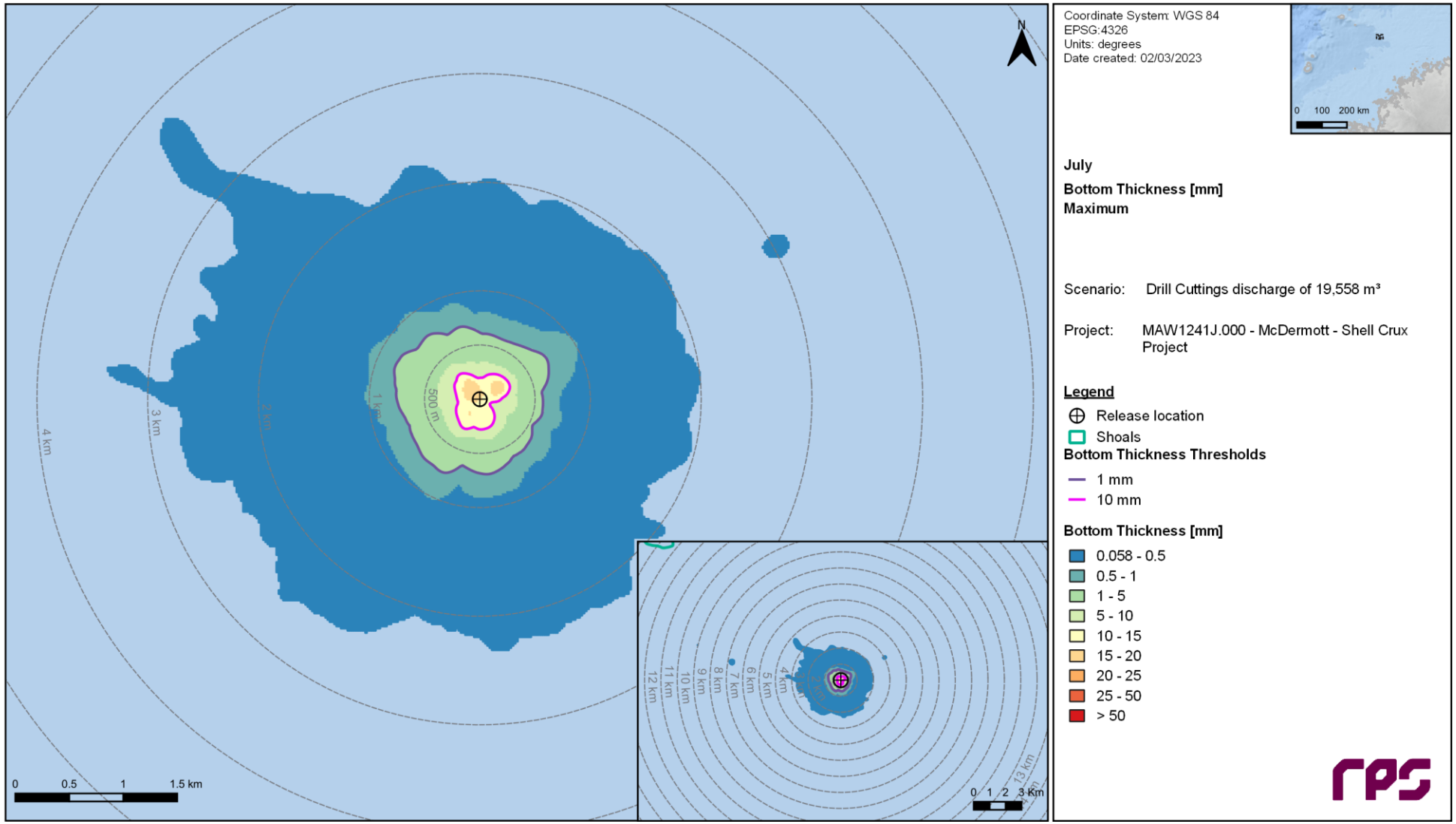

Figure 4.6 Predicted maximum bottom thickness resulting from the July drill cuttings discharges at the surface for the proposed Crux program.

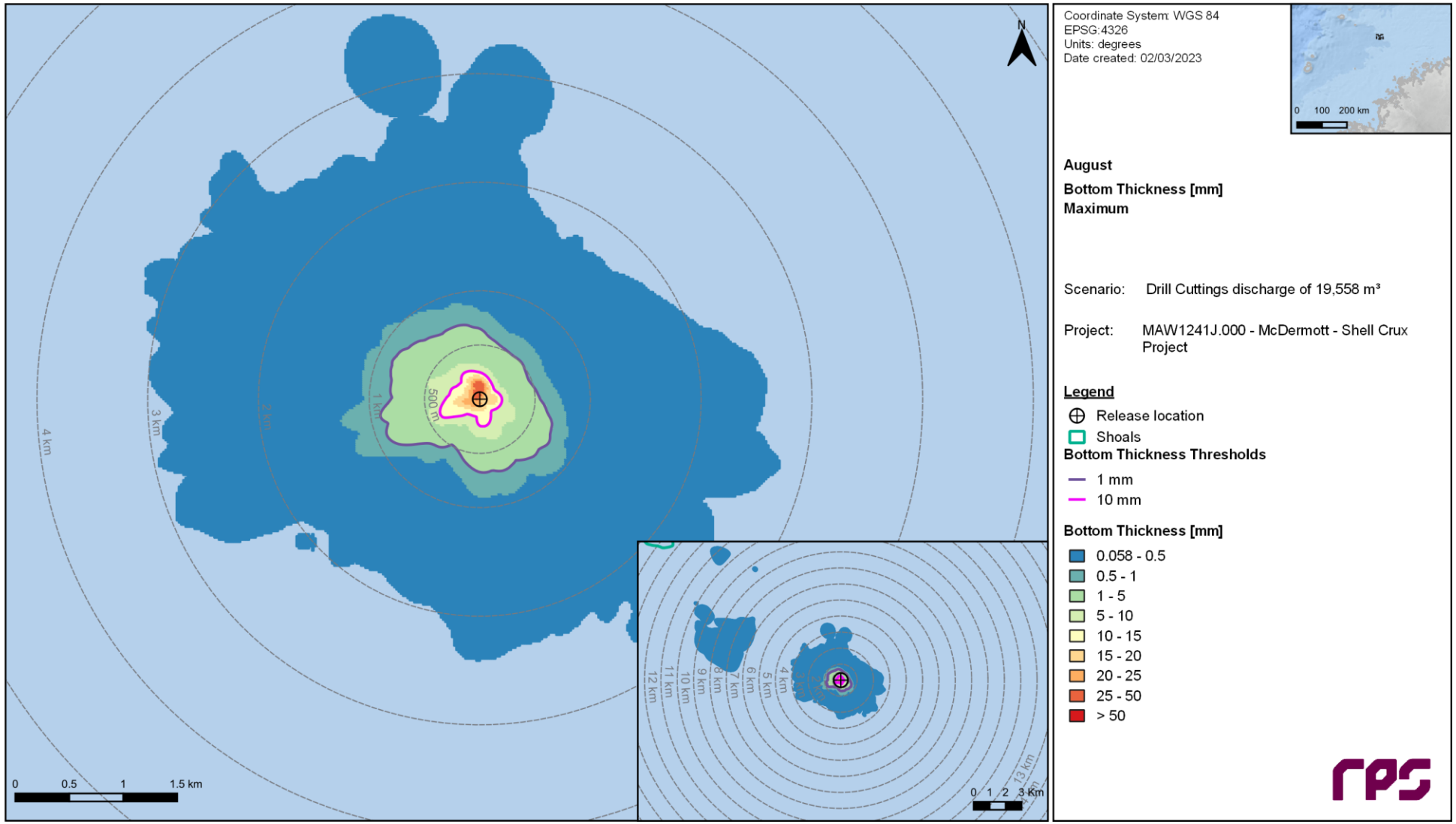

Figure 4.7 Predicted maximum bottom thickness resulting from the August drill cuttings discharges at the surface for the proposed Crux program.

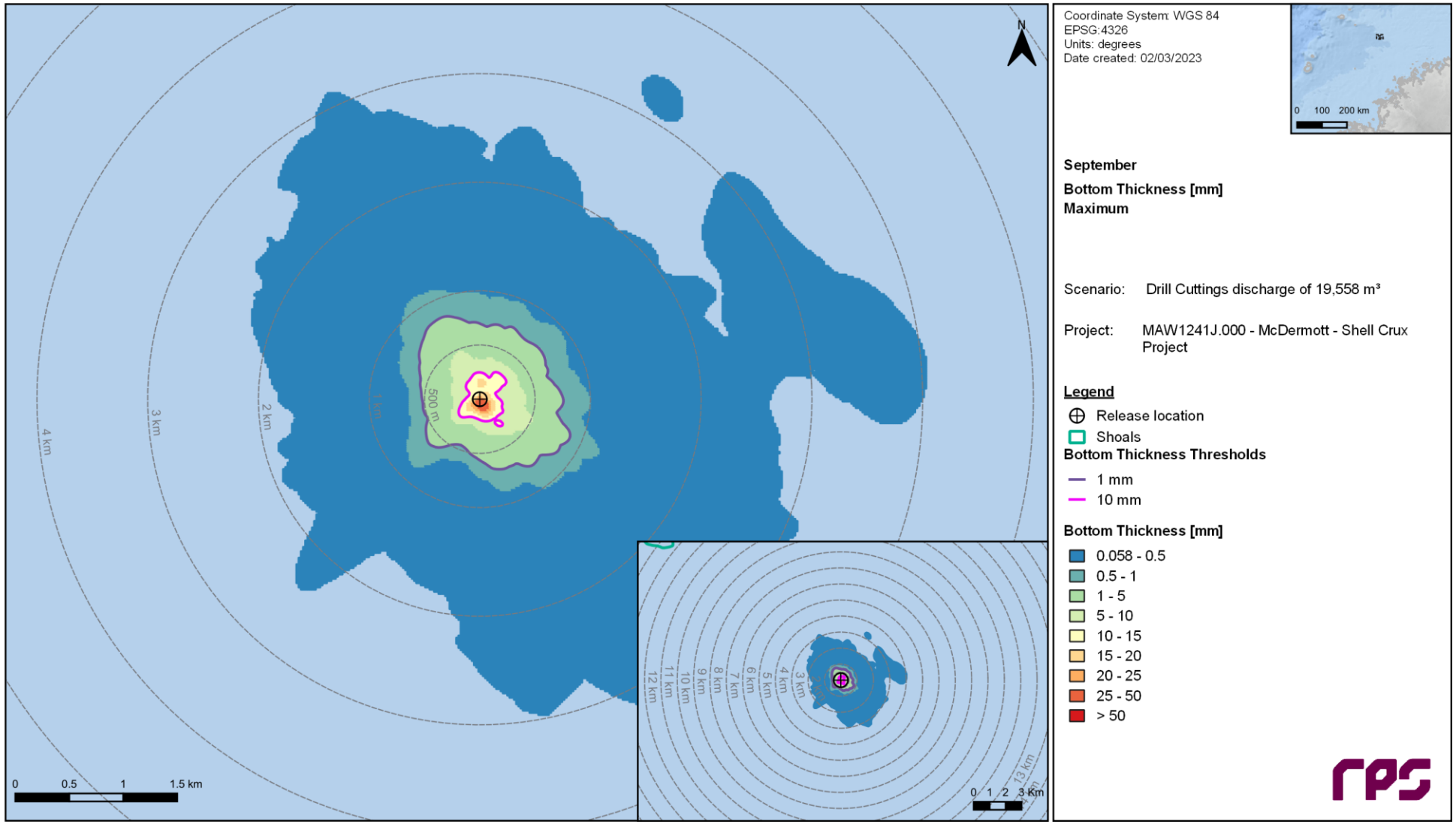

Figure 4.8 Predicted maximum bottom thickness resulting from the September drill cuttings discharges at the surface for the proposed Crux program.

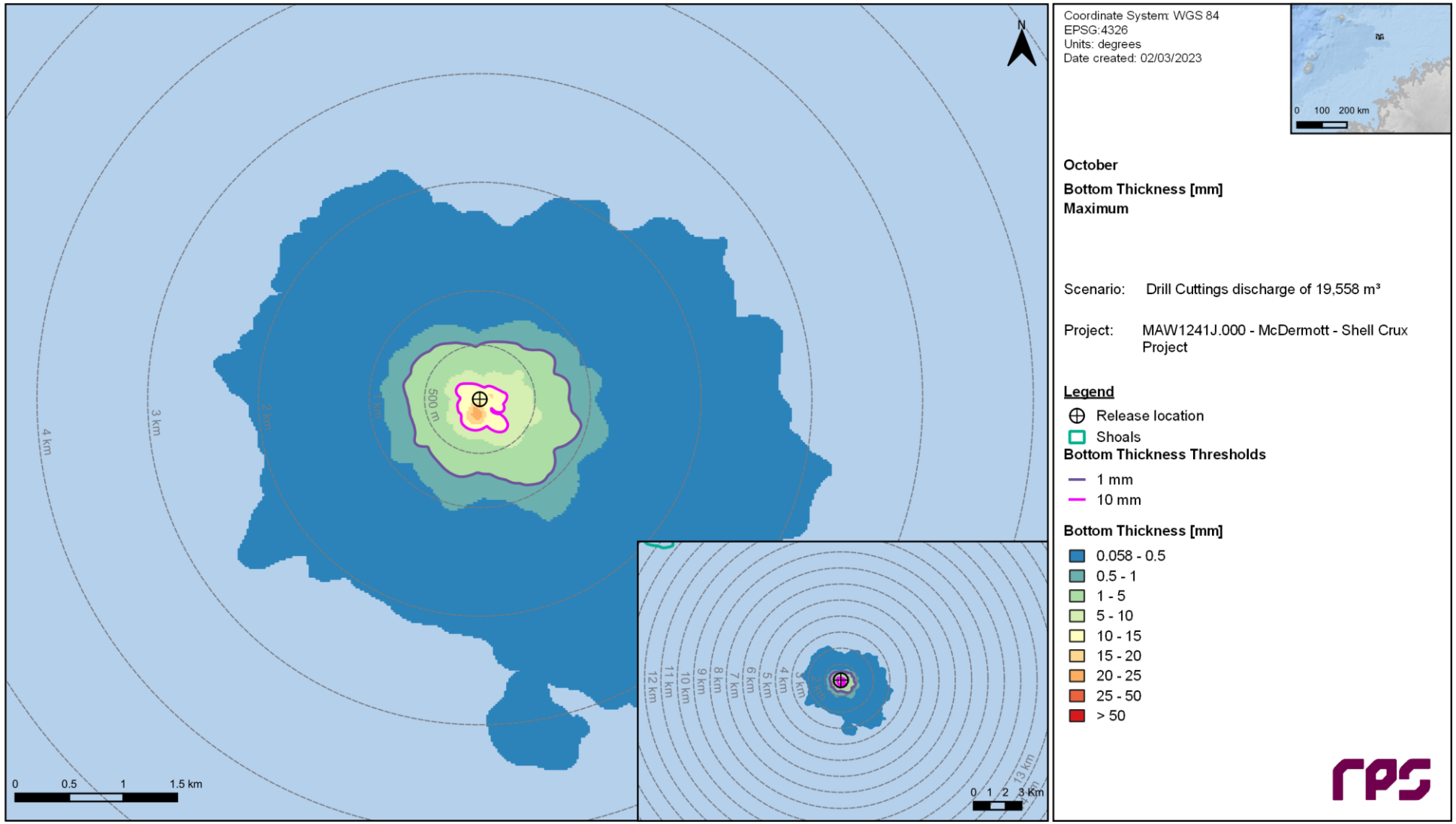

Figure 4.9 Predicted maximum bottom thickness resulting from the October drill cuttings discharges at the surface for the proposed Crux program.

5 CONCLUSIONS

The main findings of the study are as follows:

- Modelling indicated that larger particles (>0.25 mm diameter) would typically settle out within 250 m of the discharge location, while drift currents would transport the smaller sediments (<0.25 mm diameter) further away from the discharge location.
- The maximum thickness (or height of mound) was predicted to be 32.21 mm adjacent to the discharge location.
- Drill cuttings were not expected beyond ~11.8 km from the discharge location at thicknesses greater than the natural threshold (0.058 mm). This distance was greatly reduced to 986 m and 386 m at the low (1 mm) and high (10 mm) exposure thresholds, respectively.
- As the nearby shoals are further away (~13 km) than these distances (according to *Contractor's SOW, 2200-010-VA-0403-00003, Section V*), no remedial action or management of the drilling operation is considered necessary to prevent impact from the drilling on the nearby shoals.
- Total areas of coverage at the natural (0.058 mm), low (1 mm) and high (10 mm) exposure threshold were ~40.45 km^2 (4,045 ha), 2.09 km^2 (209 ha) and 0.28 km^2 (28 ha), respectively.
- Modelling indicates that sedimentation resulting from discharges of drill cuttings is not likely to have any impact above the natural threshold (0.058 mm) at the shoals closest to the discharge site.
- The outcomes of the sediment dispersion modelling assessment were also analysed for each month (May to October).
- The monthly results presented show a breakdown of the combined analysis and, due to the tidally dominated environment, show very similar distributions of drill cuttings on the seabed.

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CRUX PROJECT
DOCUMENT REVIEW OBSERVATIONS & COMMENTS SHEET

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Item	Identification (page,section, etc.)	Comments	Reviewer	Response		
				Agreed	Comments	Actioned by
1	3.2	For clarity -can "density of seabed material ...." be replaced by "bulk density of seabed material ....."	Ruth Fearon	Yes	Text updated in table 3.2	Marc Zapata