BAS-210 0024

Santos

Darwin Pipeline Duplication (DPD) Project – Offshore Pipeline Construction Environmental Management Plan (CEMP)

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

Rev	Owner	Reviewer/s Managerial / Technical / Site	Approver
	Project Environmental Lead	Project HSE Manager	Project Director

Rev	Rev Date	Author / Editor	Amendment
A	31/08/2022	Sam Billinghurst / Kat Thorne / Jeremy Coleman (RPS)	Issued for review
B	18/10/2022	Sam Billinghurst / Kat Thorne / Rebecca McGrath (RPS)	Issued for review
C	01/02/2023	Sam Billinghurst / Kat Thorne / Pennie Ginn/ Rebecca McGrath (RPS)	Issued for review
D	09/03/2023	Sam Billinghurst / Kat Thorne / Pennie Ginn/ Rebecca McGrath (RPS)	Issued for review

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Abbreviations, acronyms, glossary and units of measurements

Abbreviations and acronyms

Abbreviation/acronym	Definition
AAPA	Aboriginal Areas Protection Authority
ABN	Australian business number
ABWM	Australian Ballast Water Management Requirements
AFANT	Amateur Fishers Association of Northern Territory
AFZ	Australian Fishing Zone
AIMS	Australian Institute of Marine Science
ALARP	As low as reasonably practicable
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid sulphate soils
ASSDMP	Acid Sulphate Soils and Dewatering Management Plan
AUV	Autonomous underwater vehicle
AWR	Darwin air weapons range
AWTI	Above water tie-in
BHD	Backhoe dredge
BIA	Biologically important area
BOM	Bureau of Meteorology
BWMS	Ballast water management system
CAMBA	China-Australia Migratory Bird Agreement
CCS	Carbon capture and storage
CHARM	Chemical hazard assessment and risk management
CEMP	Construction Environment Management Plan
CMID	Common Marine Inspection Document
CMT	Crisis Management Team

Abbreviation/acronym	Definition
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CPRFPA	Charles Point Reef Fish Protection Area
CSD	Cutter suction dredge
CSV	Construction support vessel
DAFF	Department of Agriculture, Fisheries and Forestry
DAWE	Department of Agriculture, Water and the Environment
DCA	Department of Communications and the Arts
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DEPWS	Northern Territory Department of Environment, Parks and Water Security
DEWHA	Commonwealth Department of the Environment, Heritage, Water and the Arts
DGPS	Differential global positioning system
DGV	Default guideline value
DHAC	Darwin Harbour Advisory Committee
DIPL	Northern Territory Department of Infrastructure, Planning and Logistics
DITT	Northern Territory Department of Industry, Tourism and Trade
DLNG	Darwin Liquefied Natural Gas
DLRM	Department of Land Resource Management
DNRETAS	Department of Natural Resources and Environment Tasmania
DP	Dynamic positioning
DPA	Darwin Port Authority
DPD	Darwin Pipeline Duplication
DPIR	Department of Primary Industry and Resources
DPIRD	Department of Primary Industries and Regional Development
DoAWR	Department of Agriculture and Water Resources
ECAP	Environmental Compliance Assurance Plan
ECNT	Environment Centre Northern Territory
EDP	Exceptional Development Permits

Abbreviation/acronym	Definition
EIS	Environmental impact statement
ENVID	Environmental impact identification
EPA	Environmental Protection Authority
EP Act	Environmental Protection Act 2019
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPO	Environmental performance objective
EPS	Environmental performance standard
EMP	Environmental management plan
EMS	Environmental management strategy
ESD	Ecologically sustainable development
FCGT	Flood, clean, gauge and testing
FPSO	Floating production, storage and offloading
FPV	Fall pipe vessel
GEP	Gas export pipeline
GOMO	Guide for Offshore Marine Operations
GHG	Greenhouse gas
HAT	Highest astronomical tide
HFO	Heavy fuel oil
HSE	Health, safety and environment
HSEQ	Health, safety, environment and quality
HSEQ-MS	Health, safety, environment and quality management system
IACS	International Association of Classification Society
IFO	Intermediate fuel oil
ILT	Inline tee
IMCA	International Maritime Contractors Association
IMCRA	Interim Marine and Coastal Regionalisation of Australia
IMDG	International Maritime Dangerous Goods
IMS	Introduced marine species
IMR	Inspection, maintenance and repair activities
ITF	Indonesian Through Flow
JAMBA	Japan-Australia Migratory Bird Agreement

Abbreviation/acronym	Definition
KEF	Key ecological feature
KP	Kilometre point
LAT	Lowest astronomical tide
LBL	Long baseline acoustic positioning system
LoR	Limit of reporting
LMS	Listed migratory species
LNG	Liquified natural gas
LTS	Listed threatened species
MA	Management actions
MARPOL	International Convention for the Prevention of Pollution from Ships
MARS	Maritime Arrival Reporting System
MBES	Multibeam echosounder
MDO	Marine diesel oil
MFO	Marine fauna observer
MGO	Marine gas oil
MMNMP	Marine Megafauna Noise Management Plan
MNES	Matters of National Environmental Significance
MoC	Management of change
NEMP	Nearshore Environmental Monitoring Plan
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Agency
ODS	Ozone depleting substances
OPEP	Oil pollution emergency plan
PASS	Potential acid sulphate soils
PIG	Pipeline inspection gauge
PLET	Pipeline end termination
PLR	Pig launcher/receiver
PSV	Platform supply vessel
PTS	Permanent threshold shift
Q1, Q2, Q3 and Q4	Quarter 1, 2, 3 and 4

Abbreviation/acronym	Definition
RFPA	Reef Fish Protection Area
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SDS	Safety data sheet
SMPEP	Shipboard marine pollution emergency plan
SDV	Side dump vessel
SOPEP	Shipboard oil pollution emergency plan
SSC	Suspended sediment concentration
SSS	Side-scan sonar
TSDMMP	Trenching and Spoil Disposal Management and Monitoring Plan
TTS	Temporary threshold shift
USBL	Ultra-short baseline system
UXO	Unexploded ordnance

Glossary

Term	Definition
Biologically important area	Areas spatially defined and mapped by the Commonwealth Department of Environment (DoE) where aggregations of individuals of a species are known to display a biologically important behaviour such as breeding, foraging, resting or migration.
Consequence	Impact of an event or incident e.g. a loss, injury or concern. May be expressed qualitatively or quantitatively.
DLNG team	The DLNG contractors
Environmental Performance Standard	A statement of performance required of a management action.
Environmental Performance Objective	Measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks are of an acceptable level.
Impact	A positive or negative effect the DPD Project would have on the environment (including physical, ecological and socio-economic environments.
Licence	A licence granted under Part III or section 43 of the Energy Pipelines Act 1981 (NT)
Licensees	The registered holder of a licence
Measurement Criteria	A system of measurements that define whether a project is successful.

Term	Definition
Non-Indigenous	Refers to heritage artefacts or sites that are not deemed "sacred sites" per the *Northern Territory Aboriginal Sacred Sites Act 1989* or deemed Aboriginal or Macassan archaeological sites or artefacts per the *Heritage Act 2011* (NT).
Offshore Project Area	Offshore Project Area is the same area as the Project Area, except it extends between the boundary between Commonwealth and NT waters and the onshore termination point.
Onshore Project Area	Onshore Project Area is the same area as the Project Area, except it extends between the onshore termination point and the upstream weld of the beach valve.
Onshore termination point	The point (KP122.484, approximately 2 m above highest astronomical tide) to which the pipeline will be pulled ashore to by the shore pull activity.
Performance Criteria	The standards by which success of management actions is evaluated.
Pipeline	A pipe or system of pipes that has or have a maximum allowable operating pressure greater than 1050 kilopascals or a hoop stress (being a circumferential stress arising from internal pressure) that is, at one or more positions, greater than 20% of the specified minimum yield stress specified in the manufacturing standard with which the pipe complies and that are used or intended to be used for the conveyance of an energy-producing hydro-carbon, and includes: a. all structures for protecting or supporting a pipeline; and b. (b) all loading terminals, works and buildings and all fittings, pumps, tanks, appurtenances, and appliances, c. used in connection with a pipeline, but does not include: d. a pipeline as defined in the *Petroleum (Submerged Lands) Act 1981*; e. a pipeline constructed or to be constructed on land used for residential, business, agricultural, commercial, or industrial purposes, designed for use solely for the residential, business, agricultural, commercial or industrial purposes carried on that land and situated wholly within the boundaries of that land; or f. a pipeline or a pipeline of a class declared under section 4(2) to be a pipeline in respect of which a licence is not required
Pipeline management plan	Pipeline management plan in force, in relation to a pipeline, means: a. a pipeline management plan for the pipeline submitted by or for the pipeline licensee and accepted under these Regulations; or b. if the pipeline management plan is accepted in part – that part of the pipeline management plan that is accepted, as revised from time to time under these Regulations, but does not include a

Term	Definition
	pipeline management plan for which the acceptance has been withdrawn.
Project Area	The Project Area is an area extending 500 m either side of the pipeline, within which the Construction Activity will take place.
Residual risk	Risk remaining after implementation of mitigation measures.
Risk	A combination of the potential consequence of an event occurring and the likelihood of the consequence occurring.
Sensitive receptor	A receptor that could be subject to adverse impacts from the DPD Project.
Target	Specific and measurable performance requirements to achieve Environmental Performance Objectives.

Units of measurement

Unit	Definition
°	degrees
%	per cent
µS	microSiemens
MA	centimetre
dB	decibels
dB(A)	A-weighted sound pressure level in decibels
kHz	kilohertz
km	kilometre
km2	square kilometre
m	metre
m2	square metre
mg/L	milligrams per litre
nm	nautical mile (1.856 km)
ppt	parts per thousand

1 Introduction

1.1 Project overview

Santos NA Darwin Pipeline Pty Ltd (Santos) is the operator of the existing Bayu-Undan to Darwin Gas Export Pipeline (GEP). The Bayu-Undan to Darwin GEP is a dry natural gas export pipeline transporting gas from the Bayu-Undan field located in Timor-Leste waters to the Darwin Liquefied Natural Gas (DLNG) facility at Wickham Point peninsula near Darwin, Northern Territory (NT), Australia. The Bayu-Undan to Darwin GEP has been operational since 2005. In anticipation of the end of the Bayu-Undan field's commercial production in 2022/2023, the Barossa field is being developed to supply gas to the DLNG facility. The supply of backfill gas to the DLNG facility was originally planned to be achieved through the installation of a 262 kilometre (km) Barossa GEP to a tie-in point on the existing Bayu-Undan to Darwin GEP.

In recognition of potential Carbon Capture and Storage opportunities at the Bayu-Undan field, Santos has approved an alternative solution to transport backfill gas to the DLNG facility through the construction of an additional segment of pipeline to extend the Barossa GEP to the DLNG facility, instead of tying into the Bayu-Undan to Darwin GEP. Construction of this segment of pipeline is referred to as the Darwin Pipeline Duplication (DPD) Project, as it will be installed parallel to the existing Bayu-Undan to Darwin GEP. The effective 'duplication' of the existing Bayu-Undan to Darwin GEP is considered the optimal route to minimise potential environmental and social impacts.

The pipeline will run from a location where the Barossa GEP approaches the existing Bayu-Undan pipeline and continue through Darwin Harbour to the beach valve location at the DLNG facility at Wickham Point (**Figure 2-1**). Santos' DPD Project includes a ~23 km segment in Commonwealth waters and ~100 km segment in NT waters and lands adjacent to the existing Bayu-Undan to Darwin pipeline route. The DPD Project pipeline will be located for the most part 50 – 100 m from the existing Bayu-Undan to Darwin pipeline, to minimise potential environmental and social impacts. The Project Area for the DPD Project includes a 2 km buffer around the pipeline route in NT waters, the onshore construction area at the DLNG facility and an offshore spoil disposal ground, and buffer, for the trench spoil disposal (**Figure 2-1**).

Pre-lay trenching is required to meet a number of objectives, including providing pipeline protection and stability (in combination with rock installation), reducing pipeline spanning and ensuring compliance with shipping channel clear water requirements. Sections of the pipeline route within the harbour, with a combined length of up to ~16.5 km, will be trenched using various equipment with the remainder of the pipeline laid directly on the seabed. Rock sourced from a local quarry will be used to backfill in some areas where anchor protection or additional stabilisation is required.

1.2 Purpose

This CEMP has been prepared to detail and provide guidance on environmental management requirements, to ensure the DPD Project pipeline construction activities in NT jurisdiction and on NT lands are undertaken in an environmentally responsible manner and in line with regulatory requirements.

This CEMP will be submitted with the DPD Project Supplementary Environmental Report (BAS-210 0020) (SER) under the NT *Environment Protection Act 2019* (EP Act) and supporting regulations. This CEMP will be provided to the relevant Minister in support of the Pipeline Management Plan (PMP) required to construct a pipeline under the *Energy Pipelines Act 1981* (NT), *Petroleum (Submerged Lands) Act 1981* (NT) and supporting regulations. This CEMP will also be provided to DCCEEW to support the preliminary documentation submission under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). This CEMP also meets the content requirements for an

Environment Plan under the *Petroleum (Submerged Lands) Act 1981* (NT) and supporting regulations, specifically the *(Management of Environment) Regulations 1999*.

The purpose of this CEMP is to meet the relevant requirements of the:

- Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) as administered by Department of Climate Change, Energy, the Environment and Water (DCCEEW), including relevant management and recovery plans and conservation advice for Matters of National Environmental Significance (MNES) and Commonwealth Marine Reserves Network Management Plans.
- NT EP Act and Environment Protection Regulations 2020, as administered by the NT EPA (2015).
- NT Draft Guideline for the Preparation of an Environmental Management Plan (NT EPA, 2015)
- NT Energy Pipelines Act 1981, and Energy Pipelines Regulations 2001 as administered by NT Department of Industry, Tourism and Trade (DITT)
- NT Petroleum (Submerged Lands) Act 1981 and supporting regulations (NT Petroleum (Submerged Lands) (Application of Commonwealth Laws) Regulations 2004 and Petroleum (Submerged Lands) (Management of Environment) Regulations 1999).

This CEMP details the environmental impacts and risks associated with the activity and demonstrates how these will be managed. The CEMP provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events, to ensure impacts and risks are continuously reduced to and maintained at an acceptable level. The environmental management of the activity described in the Offshore CEMP complies with the Santos Environment, Health and Safety Policy (**Attachment 1**) and with all relevant legislation (**Section 3**). All relevant stakeholder consultation performed has been considered in the development of this CEMP (**Section 9**).

1.3 Scope

This CEMP addresses the construction of the section of the DPD pipeline from the shore pull onshore termination point (location described in **Table 2-1**) to the boundary between NT and Commonwealth waters. Spoil disposal activities at the nominated DPD spoil disposal area are also covered under this CEMP. This CEMP is termed the DPD Project Offshore Pipeline CEMP (Offshore CEMP) as it covers primarily activities supporting installation of pipeline in marine waters, with some activities at the shoreline and onshore at the DLNG facility. The construction of the remaining section of pipeline between the onshore termination point and the upstream weld of the beach valve will be subject to the DPD Project Onshore Pipeline CEMP (BAS-210 0025) (Onshore CEMP).

A summary of activities relevant to each CEMP is provided in **Table 1-1**.

This CEMP is an overarching management plan for the Santos Barossa DPD Project team including the DPD Project contractors (Allseas, Deme Van Ord and subcontractors) and covers construction activities from the 3 nm Commonwealth waters boundary to the shore pull onshore termination point. Under this management plan there are three additional management plans that address specific activities during construction (**Figure 1-1**). These are the:

- Trenching and Spoil Disposal Monitoring and Management Plan (TSDMMP) (BAS-210 0023) that addresses all trenching and spoil disposal activities from the 3 nm Commonwealth waters boundary to the onshore termination point
- Acid Sulphate Soil and Dewatering Management Plan (ASSDMP) (BAS-210 0049) that addresses all activities associated with acid sulphate soils (ASS) or potential ASS (PASS) from lowest astronomical tide (LAT) to the upstream weld of the beach valve

- Marine Megafauna Noise Management Plan (MMNMP) (BAS-210 0045) that addresses all activities associated with noise impacts to marine megafauna from the 3 nm Commonwealth/NT waters boundary to the onshore termination point.

Table 1-1: DPD Project Activities within the Project Area covered by the CEMPs

Phases	Activities		
	Offshore CEMP	**Onshore CEMP**	**Outside scope of CEMPs**
Surveys	+ Offshore Surveying during construction + Environmental surveys during construction	Onshore surveying during construction	+ Low impact pre-construction surveys required to gather information for Project planning and approvals are out of scope for the CEMPs. These surveys include, but are not limited to, environment, heritage, geotechnical, geophysical and unexploded ordinance (UXO) surveys. + Any surveys in Commonwealth waters.
Pre-lay works	+ Installation of offshore pipeline from the onshore termination point to the 3 nm Commonwealth/NT waters boundary + Targeted trenching (~16.5 km in total) and spoil disposal from the onshore termination point to the 3 nm Commonwealth/NT waters boundary + Spoil disposal at nominated spoil disposal grounds with some in situ placement at the shore-crossing + Pre-lay span rectification + Cable crossings along the pipeline route + Installation of site buildings and generators + Construction of the site access road + Installation of traffic plates over the existing Bayu-Undan pipeline	Onshore trenching of the onshore pipeline from the upstream weld of the beach valve to the onshore termination point and onshore stockpile of trench material for use as trench backfill. This will involve: + Excavation of trench from the upstream weld of the beach valve to site pad + Extension of trench to the onshore termination point through the site pad once no longer in use + Storage of any identified ASS / PASS on limestone pads and treated with lime prior to reuse or disposal to landfill	Any pre-lay works within Commonwealth waters.

Phases	Activities		
	Offshore CEMP	**Onshore CEMP**	**Outside scope of CEMPs**
	+ Preparation of the site pad, including installation of geotextile and site hard stand areas, installation of holdback anchor, linear winch, trench and shore pull wire.		
Pipeline installation and pre-commissioning	+ Pipelay activities + In-line tee installation + Pipeline shore pull + Rock backfill + Post-lay span rectification + Testing and pre-commissioning the offshore pipeline + Post-lay trenching + Pipelay contingencies	+ Installation of the onshore pipeline from the upstream weld of the beach valve to the onshore termination point + Testing and pre-commissioning the onshore pipeline + Tie-in onshore pipeline to the offshore pipeline at the onshore termination point	+ Any installation or pre-commissioning within Commonwealth waters, including: + DPD Project Pipeline end termination (PLET) installation + Spool installation (between DPD Project PLET and Offshore Barossa GEP to PLET) + Installation of the beach valve and the pipeline between the beach valve and the DLNG facility + Installation of the shore crossing CP monitoring system
Demobilisation	+ Removal of the pre-commissioning spread + Removal of the hard stand and geotextile + Re-contouring of the site as applicable + Removal of causeway/s	+ Backfilling onshore pipeline trench + Site returned to pre-construction condition	
Operations	N/A	N/A	+ Operations + Inspection maintenance and repair
Decommissioning	N/A	N/A	+ Decommission pipeline + Removal of subsea infrastructure

Phases	Activities		
	Offshore CEMP	Onshore CEMP	Outside scope of CEMPs
			+ Onshore decommissioning and rehabilitation + As-left/ post-surveys

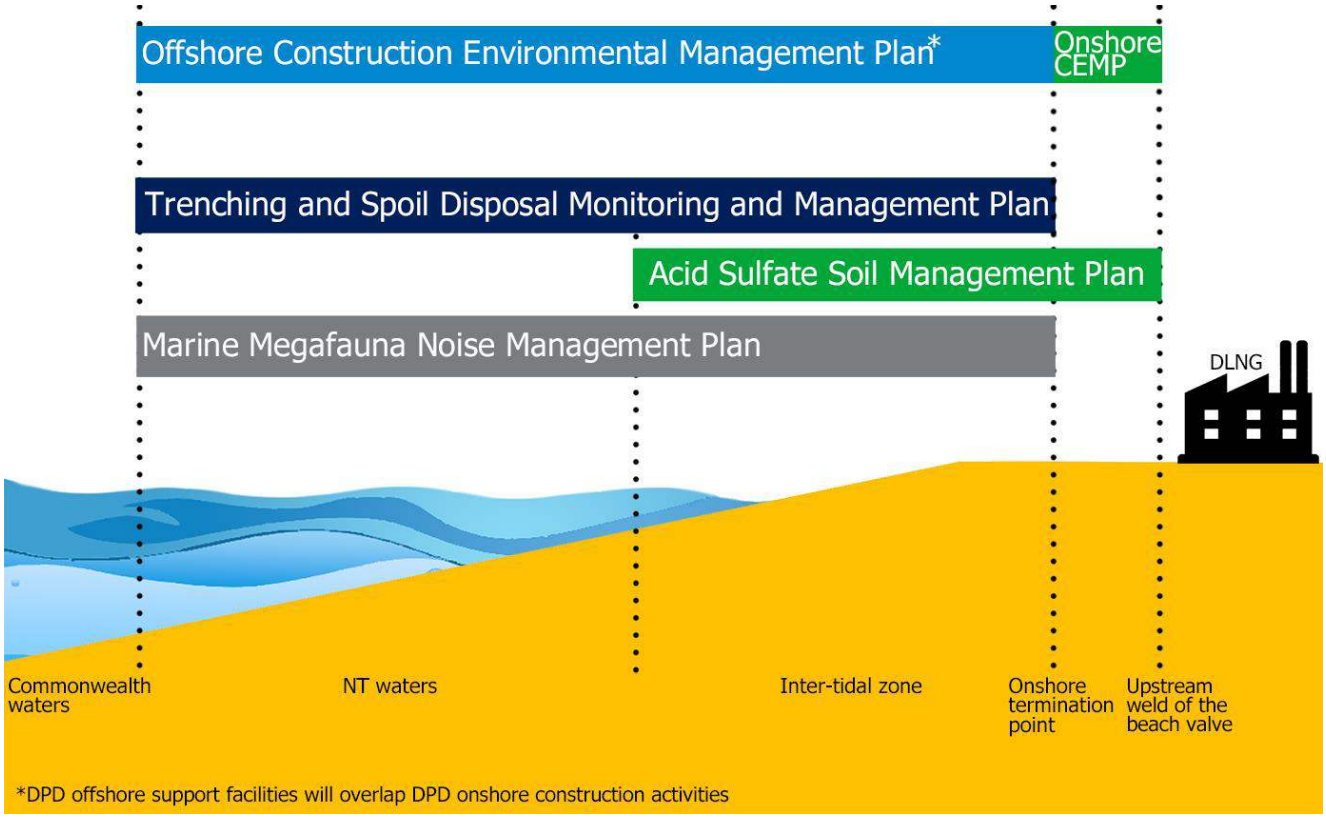


Figure 1-1: Conceptual model of management plan geographical scopes

1.4 Plan structure

This CEMP has been prepared and structured in accordance with the Guideline for the Preparation of an Environmental Management Plan (in draft) (NT EPA, 2015) and the Commonwealth Petroleum (Submerged Lands) (Management of Environment) Regulations (1999). The guideline requirements and where they have been addressed within the CEMP are detailed in **Table 1-2**.

Table 1-2: Construction Environmental Management Plan Structure

Regulatory requirement		Relevant CEMP Section
Petroleum (Submerged Lands) (Management of Environment) Regulations 1999	**NT EPA: Draft Guideline for the Preparation of an Environmental Management Plan 2015**	
-	Project Overview Proponent details Key contacts	Section 1: Introduction
Description of the activity	Clear and comprehensive project description	Section 2: Detailed Activity Description
-	Legal and other obligations	Section 3: Legal and Other Obligation

Regulatory requirement		Relevant CEMP Section
Petroleum (Submerged Lands) (Management of Environment) Regulations 1999	**NT EPA: Draft Guideline for the Preparation of an Environmental Management Plan 2015**	
-	Environmental management framework	Section 4: Environmental Management Framework
Description of the environment	Existing environment	Section 5: Existing Environment
Description of environmental effects and risks	Conceptual Site Model Environmental risk assessment	Section 6: Risk Assessment The requirement for a Conceptual Site Model is addressed within the risk assessment.
Environmental performance, objectives, and standards	Environmental Management Strategies	Section 7: Environmental Management Strategies
Implementation strategy for the environment plan	-	Section 8: Implementation Strategy
Reporting etc. arrangements Other information in the environment plan	Corrective actions and contingencies Auditing, Reporting and Review Training and awareness	Section 8: Implementation Strategy
-	Communication	9: Stakeholder consultation

1.5 Proponent

1.5.1 Details of the proponent

Santos, as the operator of the Barossa Joint Venture, has applied to the DITT for two pipeline licences for the nearshore section of the DPD pipeline:

+ Coastal and Territorial Waters Licence for the section of the pipeline under the jurisdiction of the *Petroleum (Submerged Lands) Act 1981* (NT) (i.e. between the NT Coastal Waters Limit and the Territorial Sea Baseline)
+ Inland Waters Licence for the section of pipeline under the jurisdiction of the *Energy Pipelines Act 1981* (NT) (i.e. between the Territorial Sea Baseline and the upstream weld of the beach valve).

Both licences are applicable to the section of pipeline within the scope of the Offshore CEMP. The proposed proponent details are provided in **Table 1-3**, with the nominated operator shown in bold.

Table 1-3: Proponent details for Barossa DPD Project's pipeline licences

Title	Proponent (nominated operator in bold)	ABN	Interest	Contact details
+ Coastal and Territorial Waters Licence + Inland waters licence	Santos NA Barossa Pty Ltd	44 109 974 932	25.0%	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: barossa.regulatory@santos.com
	Santos Offshore Pty Ltd	38 005 475 589	25.0%	
	SK E&S Australia Pty Ltd	55 158 702 071	37.5%	Business Address: Level 6, 60 Martin Place, Sydney NSW 2000, Australia Telephone number: (02) 21213304 Fax number: None Email address: hyunjoon-kim@sk.com
	JERA Barossa Pty Ltd	18 654 004 387	12.5%	Business Address: Level 9 Brookfield Place, 125 St Georges Terrace, Perth, Western Australia, 6000

1.5.2 Details of nominated liaison person

Name: Dr Lachlan MacArthur

Title: Environmental Approvals Adviser

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

Telephone number: (08) 6218 7100

Email: Barossa.regulatory@santos.com

1.5.3 Notification procedure in the event of changed details

If there is a change in the nominated operator or a change in the contact details for the operator or liaison person, Santos will notify the DITT and provide the updated details.

1.6 Document review, revision and availability

This CEMP has been prepared for submission in draft form with the SER (BAS-210 0020) and other supporting documents to the NT EPA, under the EP Act and to DCCEEW under the EPBC Act, and will be updated to reflect any relevant regulatory conditions associated with the DPD Project approvals.

This CEMP will also be provided to the relevant Minister in support of the PMP required to construct a pipeline under the NT *Energy Pipelines Act 1981* (NT) and Energy Pipelines Regulations 2001. A pipeline licensee for a pipeline for which a PMP is in force must submit to the Minister a proposed revision of

the PMP in the event of a change, or proposed change, of circumstances or operations under Regulation 33, when requested by the Minister under Regulation 34 or at the end of each five-year period under Regulation 35.

Further, this CEMP will also be provided to the relevant Minister to meet the requirements of an Environmental Plan under the NT *Petroleum (Submerged Lands) Act 1981* and supporting regulations (NT Petroleum (Submerged Lands) (Application of Commonwealth Laws) Regulations 2004 and Petroleum (Submerged Lands) (Management of Environment) Regulations 1999). Under these regulations, a revision is required in the event of a change, or proposed change, of circumstances or operations under Regulation 17, when requested by the Designated Authority under Regulation 18 or at the end of each five-year period under Regulation 19.

Santos will review and update the document as required based on regulatory feedback and any regulatory conditions on the DPD Project approval as applicable. The final CEMP will be made publicly available on an Australian website.

2 Detailed activity description

2.1 Overview

Table 2-1 provides the key attributes of the construction activity covered by this CEMP. A detailed activity description is provided in **Section 2.3.**

Table 2-1: Attributes of the Activity[1]

Attribute	Summary
Activity location	The DPD pipeline will extend from the pipeline end termination at kilometre point 0 in Commonwealth waters to the upstream weld of the beach valve (KP 122.692) onshore at the DLNG facility. The scope of this CEMP is limited to the section of pipeline within NT waters and lands, from ~KP 23 to KP 122.484 (the onshore termination point). The onshore termination point is two metres above highest astronomical tide (HAT). The nominal coordinates of the KPs are provided in **Table 2-2**. The location of the Project Area within which construction activities covered within this plan will occur, is shown in **Figure 2-1** with further detail on the Project Area provided in **Figure 2-2**. Support facilities and activities for the offshore pipeline construction by the offshore pipeline installation contractors will occur in areas overlapping those used by the onshore pipeline installation contractors to manage the installation of the pipeline section from the onshore termination point (KP122.484) to the upstream weld of the beach valve (KP 122.692), which are outside the scope of this CEMP.
Pipeline characteristics	Approximately 100 km of pipeline will be installed under this CEMP from ~KP 23 to the onshore termination point (KP 122.484). The pipeline diameter from the pipeline end termination (KP 0) up to an-inline tee (approximately 60 km offshore) is 26 inches, after which the pipeline increases to 34 inches. Pipeline will be constructed from carbon steel with an external anti-corrosion coating and sacrificial anodes to maintain the pipeline integrity and a concrete coating to provide stability and protection.
Key activities	+ Pre-lay works phase: - Targeted trenching along sections of the pipeline route (~16.5 km in total) from the onshore termination point to near the outer boundary of the Darwin Harbour Region Management Area (**Figure 2-3**) - Spoil disposal at nominated spoil disposal ground (**Figure 2-3**) with some *in-situ* placement at shore-crossing to reduce ASS Risk - Pre-lay span rectification - Installation of cable crossings along the pipeline route

[1] The scope of this CEMP is limited to the section of pipeline within NT waters.

Attribute	Summary

	+ Pipeline installation and pre-commissioning phase:
	  - Pipelay activities
	  - In-line tee installation
	  - Pipeline shore pull
	  - Trench backfill using rock
	  - Post-lay span rectification
	  - Testing and pre-commissioning the offshore pipeline
	Tie-in offshore pipeline to the onshore pipeline at the onshore termination point

Vessels	**Trenching**
	+ Backhoe Dredge (BHD) assisted by Split Hopper Barge + Cutter Suction Dredge (CSD) + Trailer Suction Hopper Dredge (TSHD)
	Pipelay and Rock Installation
	+ Shallow water pipelay barge (SWPLB) + Deep water pipelay vessel + Pipe supply vessels (PSV) + Construction support vessel/survey (CSV) + Nearshore CSV/survey (Span Rectification) + BHD for rock installation + Fall pipe vessel (FPV) for rock installation + Rock Barge for rock transport
	Support Operations
	+ Multicat (Shallow water anchor handling for SWPLB and CSD) + Anchor handling tugs (AHTs) + Supply boat for all vessels + Crew boat (crew changes) + Survey vessels + Environmental monitoring vessels
Vessel fuel	Vessels will use Group II hydrocarbon fuels such as marine gas oil (MGO) or marine diesel oil (MDO).
Proposed schedule	A probable DPD construction sequence and schedule is discussed in **Section 2.4**. The construction activities will likely span a cumulative period of 15 months in the field.

The locations for activities along the DPD Pipeline are described using 'kilometre points' (KP), where KP0 is the beginning of the DPD Project pipeline from the "pipeline end termination point" (PLET) in Commonwealth waters.

Table 2-2: DPD Pipeline start and end locations

Location	Kilometre point	Easting	Northing
Boundary between Commonwealth and NT waters	~KP23	618,128.53	8,663,104.10
Shore pull onshore termination point	KP122.484	702,272.73	8,614,606.40
Upstream weld of the beach valve	KP122.692	702,472.29	8,614,655.73

*Coordinates in GDA 94, MGA zone 52

2.2 Offshore Project Area

DPD Project construction activities in NT jurisdiction will occur within a Project Area defined in **Figure 2-1**. The Project Area extends 2 km either side of the DPD pipeline route and additionally includes the spoil disposal ground. Activities undertaken within the Project Area that are not associated with the DPD Project are beyond the scope of this CEMP.

The Project Area consists of the three key 'areas', being:

+ Offshore NT waters (i.e., NT waters outside Darwin Harbour Region Management Area). Note this includes the proposed location for spoil disposal;
+ Darwin Harbour (i.e., waters within the Darwin Harbour Management Area); and
+ Shore crossing location including the short onshore section of the pipeline to the upstream weld beach valve. Note activities between the onshore termination point and the upstream weld of the beach valve are not covered under this CEMP (refer to **Section 1.3**) with the exception of DPD offshore support facilities e.g. site offices and laydown area.

The Project Area within the NT waters has not been amended since the Darwin Pipeline Duplication (DPD) Project – NT EPA Referral (BAA-201 0003; Santos, 2021). However, there has been a refinement to the onshore area for the DPD Project to include the temporary access road, part of which previously fell outside of the Project Area. The Project Area is shown in **Figure 2-1** with further detail of the shore crossing at the DLNG facility, including support facilities, shown in **Figure 2-2**.

The locations for activities along the DPD Project pipeline are described using 'kilometre points' (KP), where KP 0 is the beginning of the DPD Project pipeline from the "pipeline end termination point C" (PLET C) in Commonwealth waters.

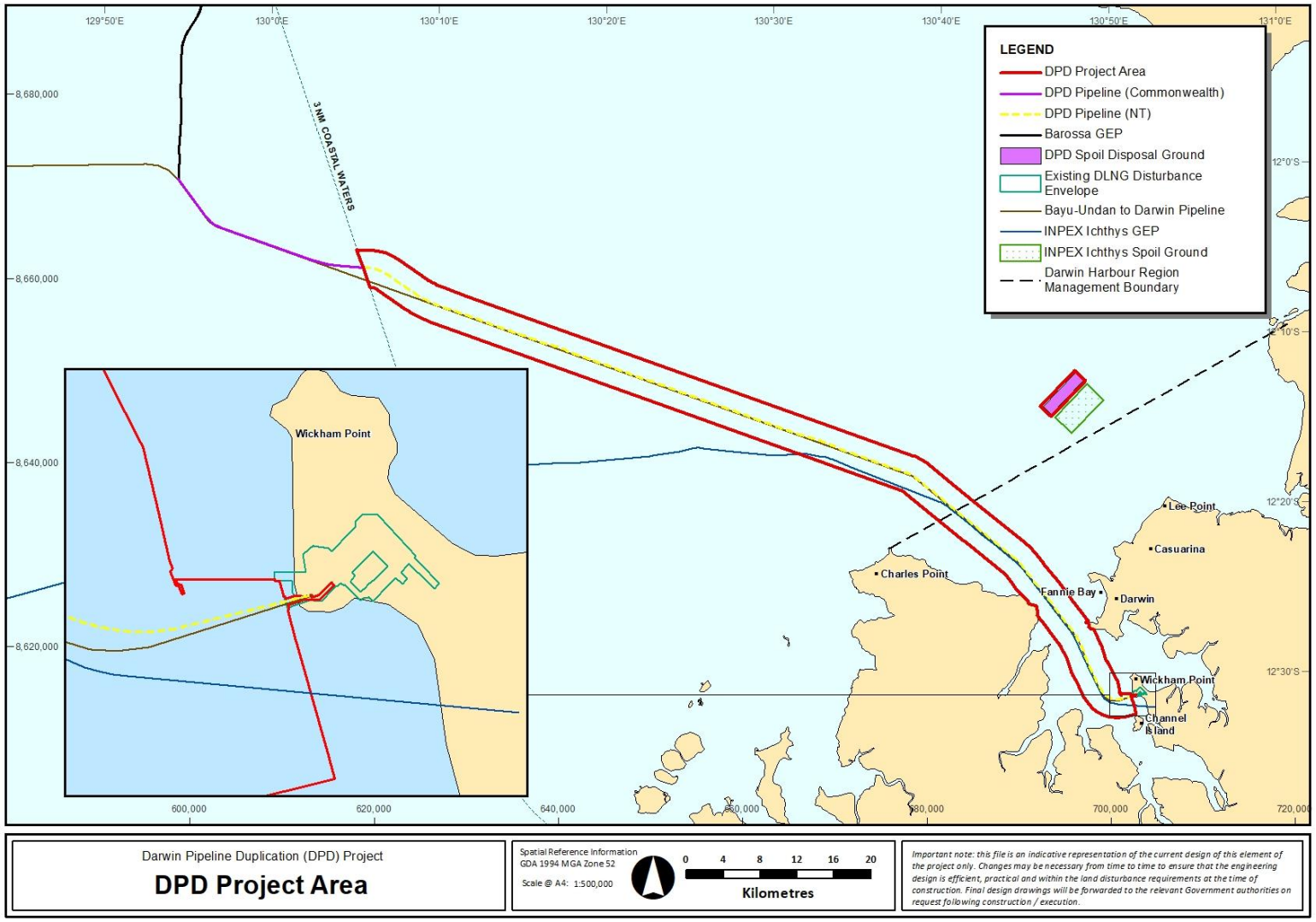


Figure 2-1: DPD Project Area

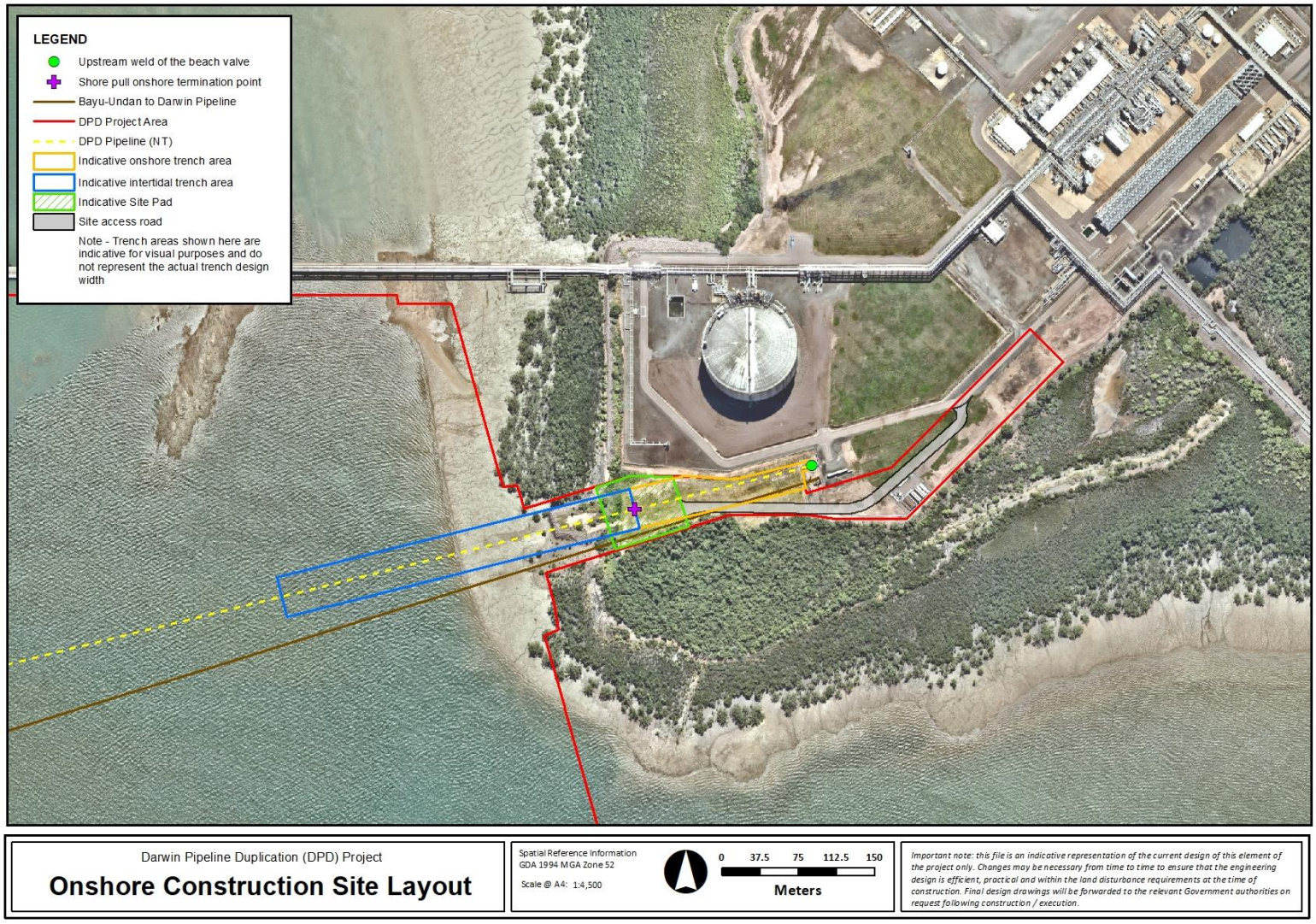


Figure 2-2: Shore crossing and indicative onshore layout within the Project Area

2.3 General detail of construction

2.3.1 Pre-lay works

For the offshore section of the DPD Project pipeline (i.e. from approximately the outer boundary of Darwin Harbour to the NT water limit) the pipeline will be installed directly on the seabed. Route optimisation has been conducted to avoid seabed features. Given pipeline stability is improved when the pipeline can be placed as flat as possible, some seabed intervention will be required as part of pre-lay rectification and/or stabilisation activities.

While carbon steel pipe with concrete coating provides substantial protection to the DPD Project pipeline from external impacts, in shallower waters, including sections within Darwin Harbour, the DPD Project pipeline will require stabilisation due to exposure to waves, currents and tidal movement, and will need further impact protection from third-party activities (i.e. anchors). As such, in some areas the DPD Project pipeline will be installed and buried in a trench on the seafloor for stabilisation and protection.

2.3.1.1 Pipeline pre-lay trenching

Locations of proposed trenching along the pipeline are shown in **Figure 2-3.** There are various trench types that may be used depending on the overall design requirements. Proposed indicative trench designs for the DPD Project are shown in **Figure 2-4**.

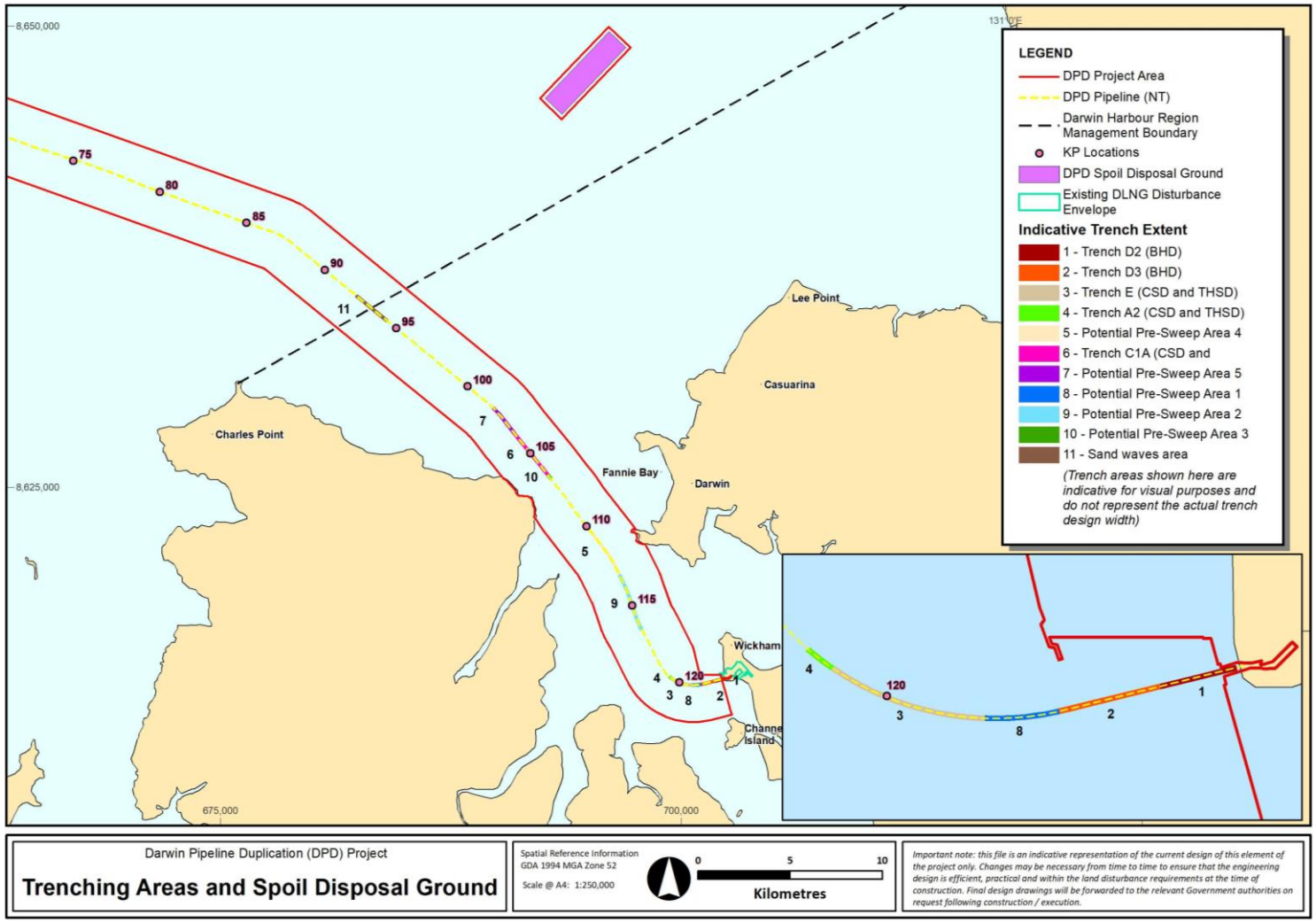
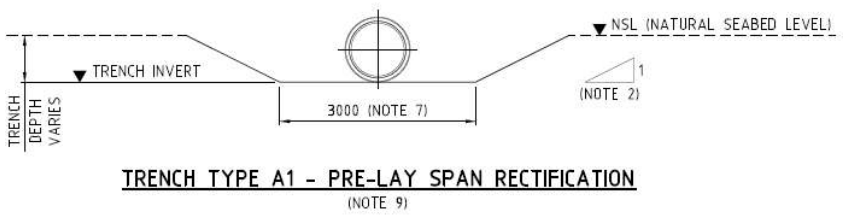
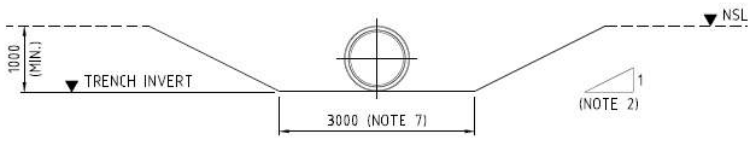


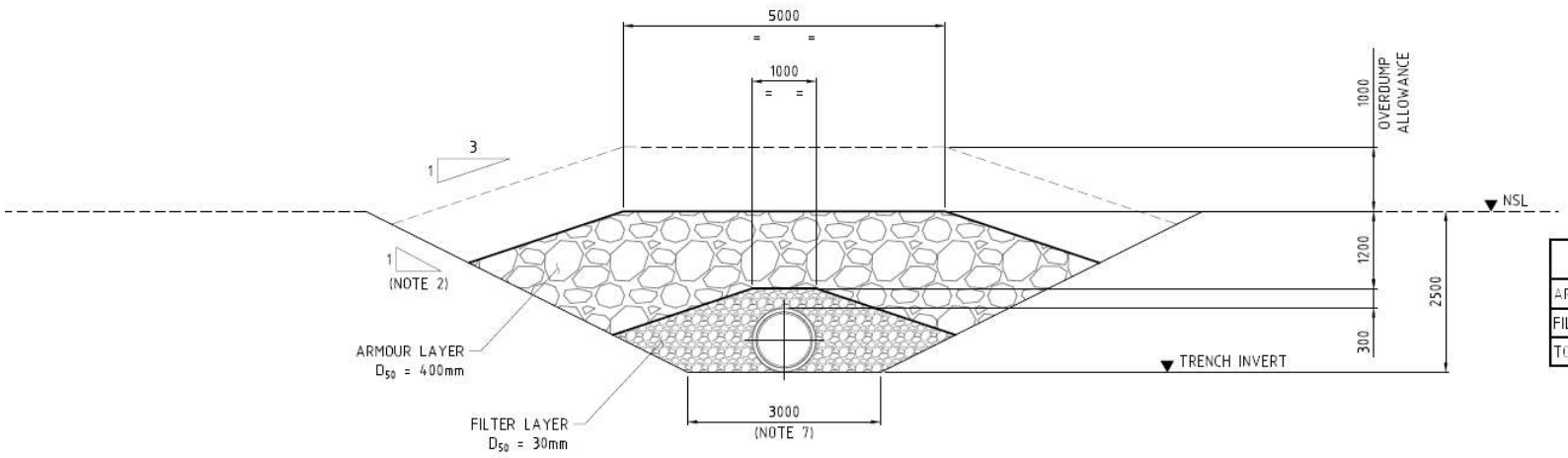
Figure 2-3: Indicative trench locations



TRENCH TYPE A1 - PRE-LAY SPAN RECTIFICATION
(NOTE 9)

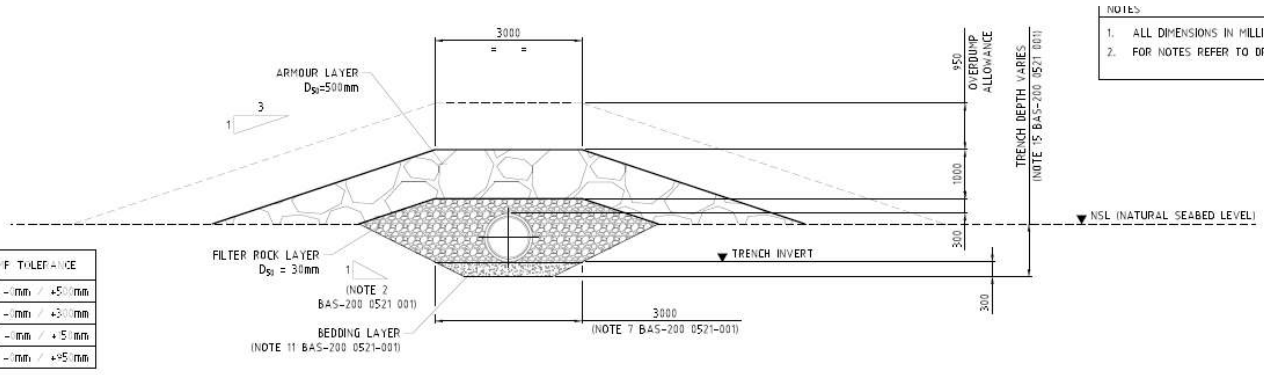


TRENCH TYPE A2 - CLEARWATER
(NOTE 8)



VERTICAL ROCK DUMP TOLERANCE	
ARMOUR LAYER	-0mm / +700mm
FILTER LAYER	-0mm / +300mm
TOTAL ROCK DUMP	-0mm / +1000mm

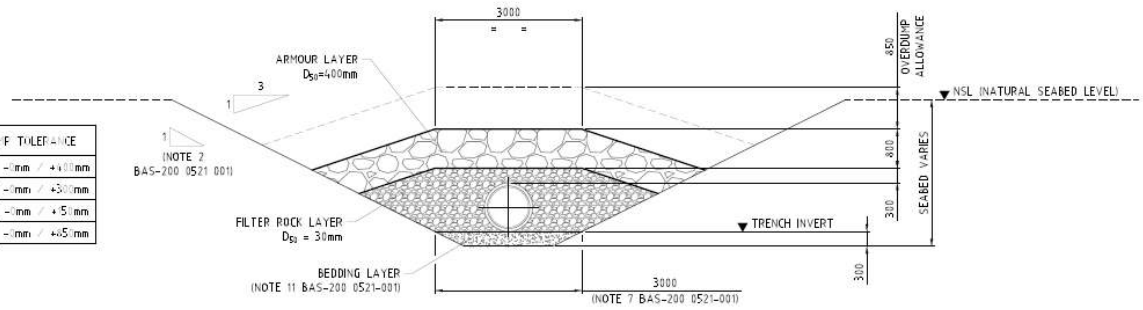
TRENCH TYPE C1a - 20Te ANCHOR PROTECTION
(NOTE 13)



VERTICAL ROCK DUMP TOLERANCE	
ARMOUR LAYER	-0mm / +500mm
FILTER LAYER	-0mm / +300mm
BEDDING LAYER	-0mm / +50mm
TOTAL ROCK DUMP	-0mm / +950mm

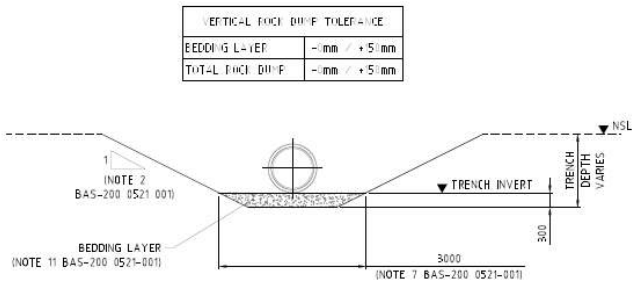
NOTES
1. ALL DIMENSIONS IN MILLIMETRES (mm) U.N.O.
2. FOR NOTES REFER TO DRAWING No. BAS-200 0521 001.

TRENCH TYPE D1 - SHORE CROSSING



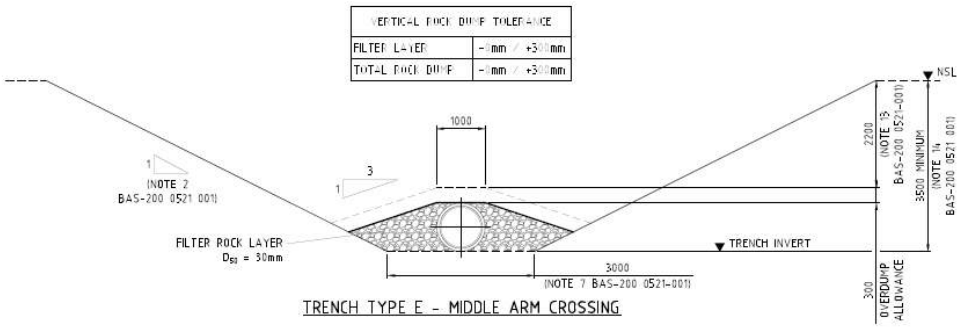
VERTICAL ROCK DUMP TOLERANCE	
ARMOUR LAYER	-0mm / +400mm
FILTER LAYER	-0mm / +300mm
BEDDING LAYER	-0mm / +50mm
TOTAL ROCK DUMP	-0mm / +850mm

TRENCH TYPE D2 - SHORE CROSSING



VERTICAL ROCK DUMP TOLERANCE	
BEDDING LAYER	-0mm / +50mm
TOTAL ROCK DUMP	-0mm / +50mm

TRENCH TYPE D3 - SHORE CROSSING



VERTICAL ROCK DUMP TOLERANCE	
FILTER LAYER	-0mm / +300mm
TOTAL ROCK DUMP	-0mm / +300mm

TRENCH TYPE E - MIDDLE ARM CROSSING

Figure 2-4: Indicative trench designs for the DPD Project

2.3.1.1.1 Darwin Harbour trenching

The pre-lay trenching associated with the DPD Project pipeline installation will involve the excavation of a trench along sections of the pipeline route in Darwin Harbour (**Figure 2-3**) within an indicative trunkline corridor of 50 m width. A Trailer Suction Hopper Dredge (TSHD), Cutter Suction Dredge (CSD) and Backhoe Dredge (BHD) have been proposed for the pre-lay trenching works. Material will be excavated and disposed of at the spoil disposal ground, adjacent to the INPEX spoil disposal ground, as shown in **Figure 2-1**.

Closer to shore a BHD will be used (**Figure 2-3**). Rock breaking tools may be used by the BHD for rock breaking. The BHD will be supported in shallow waters on spuds and will empty spoil onto split hopper barges. These barges are self-propelled or will be towed to the spoil disposal ground, where barges 'split' and spoil is released.

No blasting or rock fragmentation is proposed for the activity, however there may be some requirement for mechanical rock breaking using a BHD mounted hammer or Xcentric ripper at localised rock areas during trenching.

An indicative window for trenching activities is presented in **Section 2.4**. Depending on the final construction schedule, a maintenance dredging campaign may be required to ensure the trench is in specification for pipe lay. It is likely that only isolated pockets along the trench would require maintenance trenching.

Further information on trenching activities, impact assessment and monitoring/management measures is provided in the TSDMMP (BAS-210 0023).

2.3.1.1.2 Shore crossing

A combination of land-based excavators from onshore and a BHD from offshore will be used to dig the trench through the inter-tidal area of the shore crossing at the DLNG facility. To support this, some temporary shoreline modifications may be required, including the construction of a temporary causeway/s so the excavators can operate further from the current shoreline. The temporary causeway/s would be built with rock and fill (**Section 2.3.1.3**).

Experience from the original Bayu-Undan to Darwin pipeline shore crossing works identified that the intertidal zone has potential to contain ASS. Some of the material excavated during the crossing construction was shown to have potential for ASS, which if left exposed to the air would have required treatment with lime. However, the ASS material recovered at the shore crossing was placed below the waterline, so no treatment was ultimately required.

If ASS or potential acid sulphate soils (PASS) are identified during trenching activities, these will be managed by keeping the ASS/PASS material submerged. ASS/PASS material will be placed as close to LAT as possible to keep the material wet under most tidal states which will result in natural dispersion with the tides. PASS in both the intertidal zone and above highest astronomical tide (HAT) is anticipated to have sufficient acid-buffering capacity to avoid the generation of ASS.

Further information on ASS/PASS, impact assessment and monitoring/management measures is provided in the ASSDMP (BAS-210 0049).

2.3.1.1.3 Spoil disposal

Trenching for the DPD Project pipeline installation will result in the requirement to dispose of an estimated 325,000 m³ of spoil however up to750,000 m³ has been considered as a contingency. The proposed spoil disposal ground for trenched material is located to the north of Darwin Harbour, within the Beagle Gulf, approximately 12 km north-west of Lee Point. This location has been selected with

consideration of technical, environmental, cost and safety aspects. The selected site is adjacent to the spoil disposal ground approved for use by INPEX for the Ichthys Gas Field Development Project (refer to **Figure 2-1**).

While most of the spoil material will be disposed of within the spoil disposal ground, material excavated at the shore crossing and up to the onshore termination point using land-based excavators will be placed as close to LAT as possible, resulting in the material being saturated across most tidal states. The material will naturally disperse via tidal action and any material remaining at high tide will be removed by BHD and disposed to the offshore DPD spoil disposal ground. This will be done to manage ASS risk and is further detailed in the ASSDMP (BAS-210 0049).

2.3.1.2 Onshore site set-up

Site works within the onshore portion of the Project Area will be required to support the offshore DPD Project construction activities up to the upstream weld of the beach valve (**Figure 2-5**). Earthworks will be required to facilitate the set-up of the onshore site and allow positioning of equipment including removal of rock associated with an existing marine offloading facility (rock groyne), construction of a shore pull and Flood/Clean/Gauge/Testing (FCGT) site pad and the creation of a temporary access road. The construction of the onshore site and onshore component of the shore crossing shall allow for shore pull activities, FCGT activities, onshore trenching and pipelay activities, and equipment layout for contingency operations, including but not limited to allowing for wet buckle dewatering to be performed whilst the pull head is attached to the winch wire.

To facilitate parallel activities at the site pad and shore crossing areas during trenching and pipeline installation of the onshore section, a temporary road will be built through the DLNG site. This will facilitate access to the shore crossing from the south side of the proposed pipeline route.

2.3.1.3 Rock causeway/s

Santos expects that a temporary rock causeway/s `will be required to assist with the pre-lay trenching at the shore crossing. In the event these structures are required, they will be located at the shore crossing. Approximately 1600m^3 of rocks will be required to be imported from the quarry for construction of the causeway. Revetment rocks will mostly be sourced from the location (approximately 1500m^3). A small layer of gravel or rocks will be applied as a top layer to allow machinery egress. The temporary causeways will cover a footprint of up to approximately 132 m long and 22 m wide either side of the pipeline, with an average height of 1 m.

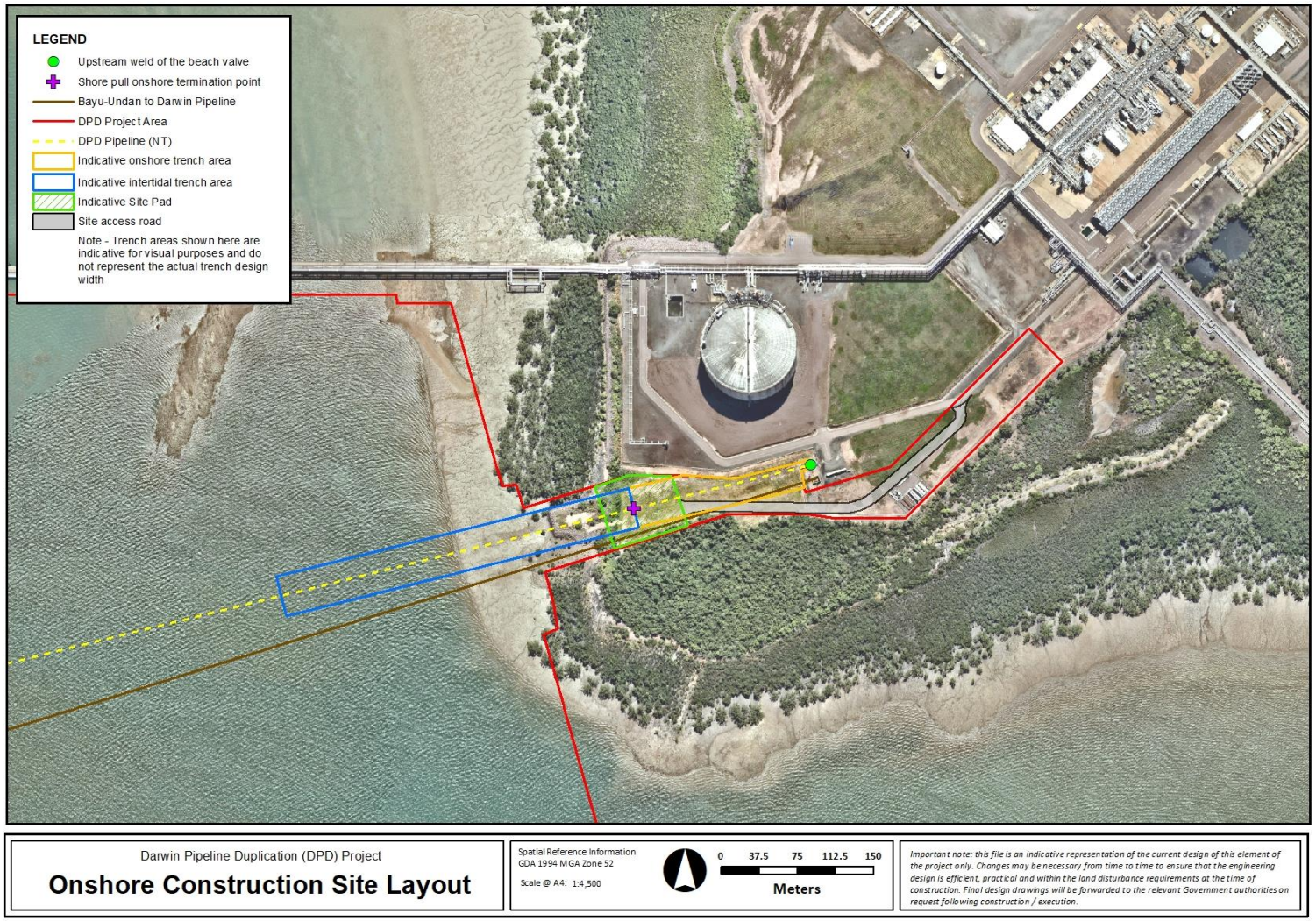


Figure 2-5: Onshore construction site layout

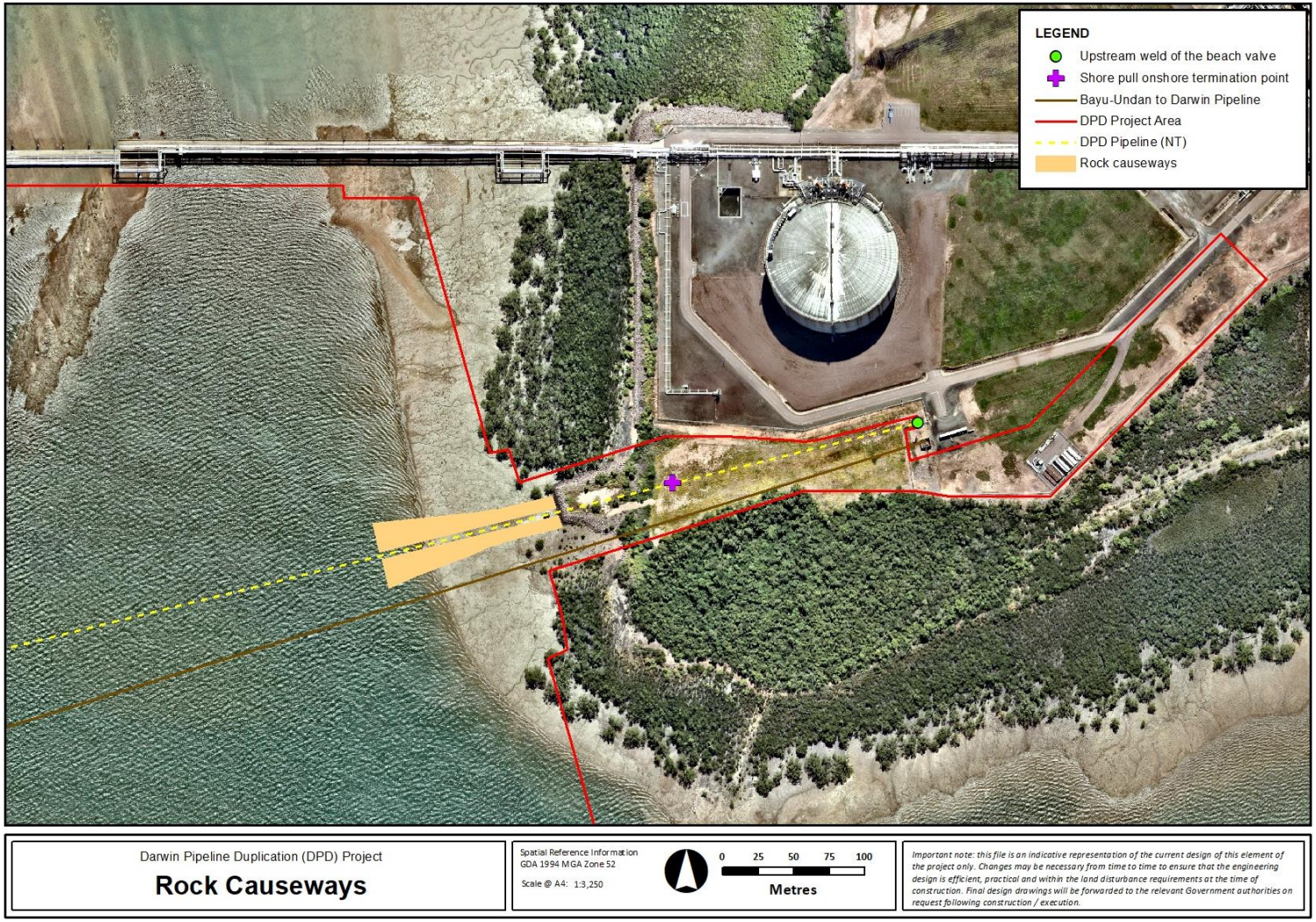


Figure 2-6: Location of causeway

2.3.1.4 Pre-lay span rectification and foundation installation

Pre-lay span rectification will be required in some areas to reduce pipeline spanning. The use of a TSHD to rectify sand waves by removal of sediment between kilometre point (KP) 92.2 and 94.4 is shown in **Figure 2-3**. Otherwise, pre-lay span rectification will occur preferentially through use of mass flow excavation (MFE).

An MFE tool works by accelerating a mass flow of water to blow away sediments within a localised area and can be used to accurately remove sediment high points and reduce pipeline spanning. MFE is an alternative to the installation of numerous concrete mattresses or grout bags. Where concrete mattresses or grout bags aim to support a spanning pipeline, the MFE will remove the span entirely limiting the exposure of the pipeline over its operational life and remove potential integrity concerns. The MFE would be deployed by a construction vessel using dynamic positioning and therefore no additional seabed disturbance is required other than within the localised area where the tool operates.

The use of MFE has been identified as a potential method to reduce sediment high points at 8 locations within two areas along the offshore pipeline route in NT waters. The first area is between KP 51 to 53 (four sites), approximately 40 km offshore from Darwin Harbour boundary and the second area is between KP 72 and 81 (four sites), approximately 12 km from the Darwin Harbour boundary. At each location it is expected that typically less than 100 m of excavation would be required along the pipeline route.

The use of MFE would occur during pre-lay activities and is expected to take an indicative 7-14 days to complete, with an estimated six hours of operation at each site.

The MFE tool will generate localised turbidity at the seabed during the excavation process. At the locations identified for MFE use, sediment characteristics, as identified by DPD Project sediment sampling (RPS, 2022), indicate a high proportion of sand/gravel (70-90 %), with a lesser contribution of fine sediments (silt/clay) (10-30 %). Given the localised method and area of operation and the type of sediments observed at the excavation sites, turbidity created by the MFE tool is predicted to be localised and temporary only. The lower fines content will also help mitigate large plume generation and limiting turbidity.

The installation of concrete mattresses or grout bags may be used additional to MFE in instances where MFE proves not suitable (e.g., if consolidated sediments are encountered that cannot be removed by MFE) or as an adjunct to MFE if there is residual spanning requiring further rectification. Each concrete mattress footprint is ~18m^2 and may be installed in groups and stacked on top of each other to reach the desired height.

In addition, for the in-line tee, a steel pre-lay foundation may be installed, complete with scour protection using mattresses or grout filled mats, with an approximate footprint of 375 m^2.

2.3.1.5 Cable crossings

Telecommunications and power cables in Darwin Harbour will be protected during pipelay operations using concrete mattresses if required. Supports either side of the individual cables will be provided, and it is likely that concrete mattresses will also be used to provide clearance between the DPD Project pipeline and cable.

If concrete mattresses are to be used, it is estimated that the footprint of the mattresses over the four existing cables will each be approximately 12 m × 12 m, or 600 m².

For future cables, installation over the DPD Project pipeline will be managed in consultation with the owner/operator of the future cable and Santos.

2.3.1.6 Pipeline crossings

Santos is yet to confirm the route alignment for the DPD pipeline, and the preferred option for the pipeline route has been developed to avoid crossing existing pipelines within Darwin Harbour. However, this would require encroachment into the shipping corridor and trenching. To avoid the interface with the shipping channel, the DPD pipeline may require crossing the Bayu-Undan to Darwin pipeline at two locations within the inner harbour; once to bring the pipeline alignment south away from the shipping channel and over the Bayu-Undan to Darwin pipeline, and then to cross back again to the northern side. These crossings would occur between KP110 and KP111 and between KP113 and KP114, respectively.

2.3.2 Pipeline installation and pre-commissioning

2.3.2.1 Pipelay activities

The pipeline will be 26/34-inch diameter carbon-steel with an external anti-corrosion coating and anodes to maintain the pipeline integrity and a concrete coating to provide stability and protection.

The DPD Project pipeline will be installed using a continuous assembly pipe-welding installation method, which involves the assembly of the single pipe joints (approximately 12 m in length) in a horizontal working plane on-board the pipelay vessel. The pipe joints are welded together, inspected and then the welded area is coated on-board the vessel before being lowered behind the pipelay vessel. The pipelay uses an 'S-lay' method (with the S notation referring to the shape of the pipeline catenary as it is lowered to the seabed). As the pipeline is lowered, it is supported on-board the pipelay vessel using a curved steel structure fitted with rollers known as a 'stinger'.

The pipelay vessel that will be used is dependent on a range of factors including the availability of vessels, final pipeline parameters and water depth. Both dynamically positioned (DP) and anchored pipelay vessels will be used to perform the installation, dependant on water depth. Examples of pipelay vessels are shown in **Figure 2-7** and **Figure 2-8**.

In the offshore NT waters, the pipeline will be installed at approximately 2 km/day using a deep-water DP pipelay vessel. For this ~65 km extent the installation footprint will be limited to a 50 m wide disturbance corridor due to the use of DP.

Figure 2-7: Example of pipelaying vessel (offshore)

Figure 2-8: Example of pipelaying vessel (nearshore)

In shallower waters, predominantly within the Darwin Harbour, anchoring will be required and the speed of pipelay will be reduced to ~300–400 m/day, depending on the coordination of other supporting activities (i.e., pipelay barge and shore pull). For this ~34 km extent, the footprint will be within a 50 m disturbance corridor, plus the footprints required for vessel anchoring. It is estimated that each of the 10 anchors has a footprint of ~10 m^2, including chain sweep. Between 10–20 anchor moves are expected each day, for a period conservatively estimated as 100 days.

When close to the shore crossing, pre-installed onshore anchors may be used. These will be within the proposed shore crossing (i.e., onshore) disturbance footprint. If onshore anchors are used, these anchors have a typical footprint of 5 m × 5 m with an additional 40 m^2 for anchor wire on the seabed.

The base case is for the DPD Project pipeline to be sequentially installed, beginning at the shore crossing, and progressing offshore through NT waters to the PLET in Commonwealth waters. For this to occur the last section of pipe laid by the shallow water pipelay barge will have a recovery head arrangement installed which will include a submersed pennant buoy, allowing this and the pipe to be recovered by the deep water pipelay vessel. Once retrieved the recovery head will be removed and recovered pipe welded to the new section of pipe to commence the deep-water pipelaying process. The base case handover point will be at KP 91.5 in approximately 20 m of water, in this case the shallow water pipelay barge will have laid approximately 34 km of pipe and the deep water pipelay vessel will lay approximately 65 km of pipe in NT waters.

An alternative, to pipelaying sequentially from onshore to offshore is to pipelay concurrently with the deep water pipelay vessel and a shallow water pipelay barge. In this scenario, the shallow water vessel would still commence at the shore crossing to facilitate the shore pull and the deepwater vessel would begin lay at KP0. An above water tie-in (AWTI) would be performed where the two sections of pipeline meet. The AWTI would occur using the shallow water pipelay barge and would involve recovery of pipeline end sections using davits and subsequent welding from a temporary work platform. This activity would involve the installation of buoyancy modules on the pipe tails to support the pipeline end sections and facilitate correct alignment for welding. Timing of AWTI operations would be conducted to coincide with neap tides where practicable.

2.3.2.2 Dead-man anchoring

A dead-man anchor will typically be used during a midline start up with a dynamically positioned pipelay vessel. The dead-man anchor will 'dig' into the benthic habitat to provide stability for the dynamically positioned pipelay vessel during pipelay.

A dead-man anchor will be employed adjacent to the DPD pipeline route, approximately 1500 m towards Darwin on the proposed pipeline route. There is no 'target box' or 'cut-to-length' requirements for the dead-man anchor cable start-up location, as the pipe will be recovered. The pipeline initiation point (for the deep water pipelay vessel) is approximately located at KP91.5, with the dead-man anchor situated adjacent to the pipeline route at approximately KP90.

The expected duration of the dead-man anchor operation from connection of the dead-man anchor wire until head touchdown is approximately seven hours. This includes an allowance for contingency time.

Before the actual pipeline initiation can commence, the anchor will be installed and tested according to the procedure outlined in the Gas Export Pipeline – Audacia 26-inch Pipelay Procedure (BAS-273 5005). This is summarised below:

+ Install the anchor, typically 22 tonne stevshark, fluke angle 32 degrees, at the midline start-up location adjacent to KP90;
+ Move dynamically positioned vessel to the required test location and pay out the 2.5-inch dead-man anchor cable from the dead-man anchor winch;
+ The dead-man anchor will be tested by applying a factored bottom tension, for a duration of 30 minutes. To achieve the required test tension, tension will be increased in a slow and controlled manner to allow the anchor to set firmly into the ground;
+ On successful completion:
+ The dead-man anchor cable will be slackened from the dead-man anchor winch; and
+ The dead-man anchor cable will be transferred outboard, re-routed over the stinger and secured in the firing line. The dead-man anchor start-up rigging will be prepared and Audacia will set up at the start-up position.

A remotely operated vehicle deployed from the dynamically positioned vessel or survey support vessel will perform the following tasks during installation and testing of the anchor:

+ Monitor the correct landing of the dead-man anchor;
+ Take a fix of the position of the dead-man anchor after landing;
+ Monitor the anchor during the tensioning and testing of the dead-man anchor wire; and
+ Take a fix of the dead-man anchor after completion of the test.

2.3.2.3 In-line tee

The in-line tee (ILT) will be installed at KP 62.8 during the pipelay activities by the deep-water DP pipelay vessel. If required, a foundation for the ILT will be pre-installed during pre-lay works. The ILT is welded into the DPD Project pipeline on-board the pipelay vessel and is installed as part of normal pipelay. A protection frame, approximately 5 m high, will be installed post-pipelay by crane (guided by ROV).

2.3.2.4 Pipeline shore pull

Shore pull to bring the DPD Project pipeline onshore, will use a conventional winch operation. The arrangement for the shore pull consists of a winch spread installed on a winch pad and attached to a hold back anchor located onshore.

The pipeline pull head on the shallow water pipelay vessel is connected to the winch using a pull wire and suitable rigging. The pipe will be pulled ashore from the pipelay vessel using the winch spread located onshore through the pre-constructed trench and winched up to ~2 m above HAT (i.e. the onshore termination point).

The pulling arrangement will allow for the shore pull to be completed as a continuous operation, which will take approximately two weeks.

2.3.2.5 Trench backfill

The primary method of maintaining pipeline stability on the seabed will be the concrete weighted pipeline coating. It will also be necessary to install localised secondary stabilisation/protection for sections within Darwin Harbour where the concrete weighted coating alone is not considered sufficient to provide stability and/or protection. Backfilling using rock will also be required to protect the pipeline in areas where 21.5 tonne anchors may be used.

Rock sourced from onshore will be used for pipeline stabilisation and protection. The rock will likely be installed via a fall pipe vessel (FPV) or side dump vessel (SDV). Self-propelled DP vessels will be used to install rock on to the seabed, possibly with support barges used to transport rock. The volume of rock required is expected to be 200,000 tonnes and no more than 500,000 tonnes.

2.3.2.6 Post-lay span rectification

To provide pipeline stability, post-lay span rectification may be required and if so, would be undertaken by the installation of grout bags using a remotely operated vehicle (ROV). The likely disturbance footprint for each occasion of post-lay span rectification is 25 m^2. There will be a requirement to undertake downline flushing of the slurry which will result in a nominal amount of ~1.2m^3 per fil cycle. It is estimated that there will be ~30 pre- or post-lay grout bags.

The actual locations would not be known until after the DPD Project pipeline is installed and surveyed.

2.3.2.7 Flood/ clean/ gauge/ testing (FCGT) and dewatering/ pre-commissioning

The following section outlines all aspects of the FCGT and dewatering/pre-commissioning processes, however there is no planned discharge of FCGT fluids in NT waters and discharges are limited to Commonwealth waters and will be in accordance with the relevant environmental approvals. Information provided on the FCGT process and discharges within Commonwealth waters has been provided for context as water extraction, filter flushing and pipelay contingencies outlined in **Sections 2.3.2.8** and **2.3.2.9** will occur within the Project Area.

Once installed, the DPD Project pipeline internal surfaces need to be cleaned, tested, and preserved in preparation to carry hydrocarbons. This is conducted through pigging, whereby a series of pipeline inspection gauges (pigs) will be pushed through the pipeline to clean the pipeline, gauge the pipeline, and ensure all air is removed during the flooding process. Pigs are typically bullet shaped instruments which are pushed through the pipeline. Pig launcher/receivers (PLRs) will be installed on the pipeline end termination point (PLET) in Commonwealth waters and at the shore crossing. The pigs will be pushed using chemically treated seawater with seawater sourced from Darwin Harbour. The chemically treated seawater is typically a mixture of biocides (to prevent biofouling and bacterial corrosion on the internal surfaces), an oxygen scavenger (to control corrosion of the pipeline) and a

dye (for leak detection during hydrotest). The proposed water treatment chemical is 'Hydrosure' or 'Hydro-3', however there may be a requirement to use other Santos approved chemical packages. The concentration of treated chemical will depend on the required preservation period, which is the period the pipeline will be left filled with the chemically treated seawater before being dewatered for tie-in and commissioning. However, the maximum concentration will be 550 ppm.

Following pigging operations the pipeline will be subjected to a hydrostatic pressure test (hydrotest). Hydrotesting will be completed in line with Santos' specification, Pressure Testing of Process and Utility Piping (1540-120-SPC-0018), and Downer standard, Hydrostatic Testing (SM-QA-ST014) (Downer 2022). The offshore pipeline installation contractor will source hydrotesting water by water winning from Darwin Harbour, which will be filtered to remove particulates and then chemically treated. A volume of chemically treated seawater will be pushed into the pipeline to raise its pressure. This hydrotest pressure will be held for a period of time as per the relevant standard to test the pipeline integrity. There will be small, localised discharges at the PLET as the pipeline is depressurised.

On completion of FCGT, the flooded pipeline will be dewatered with ~55,000 m^3 of treated seawater discharged at the PLET in Commonwealth waters. The pipeline will be dewatered using a train of dewatering pigs separated by monoethylene glycol (MEG) slugs, driven by nitrogen, which will condition the pipeline. Approximately 1000 m^3 of MEG will be discharged. Dewatering is expected to take one week and discharge will be at the seabed through a diffuser attached to PLET C.

On completion of dewatering, the pipeline will be left packed with nitrogen, ready for hook up.

While the current plan is to dewater the entire DPD Project pipeline in one event as described above, if there is a failure in the pipeline during installation that requires remedial construction work on the pipeline, or if a pipeline wet buckle occurs during pipelay (a wet buckle is when there is a failure in the pipeline during installation which results in the ingress of raw / untreated sea water into the pipeline), contingency plans will be implemented, with associated discharges. Refer to pipelay contingencies below for detail.

2.3.2.8 Water extraction and filter flushing

To provide water for FCGT activities, water will be extracted (water winning) from Darwin Harbour. Water winning will be via a pumping spread comprising four mesh-screened, submersible pumps supported on an anchored pontoon. It is anticipated that the pontoon and extraction hose will be positioned approximately 600 m from shore in approximately 15 m of water at LAT. The total volume of water required will be dependent upon the nature of the FCGT and any contingency requirements (e.g. pipeline filling associated with responding to a wet buckle event). Planned FCGT water winning requirements are expected to require approximately 55,000 m^3 of water. Pumping rates are expected to be approximately 9 – 16 m^3/minute and water winning for FCGT activities is expected to take place over approximately three days (not including any contingency activities).

Water extracted from Darwin Harbour will be filtered prior to chemical treatment. To ensure the effectiveness of filters, regular backflushing is required. While the number of backflushes and volume of water associated with backflushing may vary depending upon the effectiveness of filters and level of clogging by suspended solids, it is estimated that a total of approximately 300 m^3 of backflush water is expected to be discharged. Backflush water will have a higher suspended solids loading compared to water extracted (i.e., higher than ambient Darwin Harbour water suspended solid concentration). The concentration of total suspended solids (TSS) within backflush water will depend upon the ambient concentration within Darwin Harbour, which will vary with tidal state and season. Water during spring tides and over the wet season are expected to be more turbid (higher TSS concentration) than water during neap tides and over the dry season.

Backflush water will be discharged onto the existing disturbed shore crossing construction site, where it will then drain into the intertidal area and solids will disperse with tidal movements. Where possible, and dependent on the progress of shore crossing rock installation at the time of FCGT activities, backflush water will be discharged onto installed rock, to baffle the flow of the discharged backflush water.

2.3.2.9 Pipelay contingencies

While highly unlikely to occur, failures in the DPD Project pipeline and the occurrence of wet buckling can occur during pipelay activities and in these situations, pipelay contingency activities will be required.

A 'wet buckle' event may occur during installation should the pipeline become buckled and fracture during pipelay, resulting in flooding of the pipeline with raw, untreated seawater. If this occurs, the raw seawater will need to be displaced from the pipeline to prevent corrosion to the undamaged section of pipeline. To remove the raw seawater, a contingency pig is launched with treated seawater containing preservation chemicals (biocide, corrosion inhibitor and oxygen scavenger) to flush the pipeline, followed by a second contingency pig which is pushed with compressed dry air. The pipeline end is then recovered and pipelay can continue.

The wet buckle event may occur anywhere along the proposed pipeline between KP 0 and KP 122.2 and therefore contingency dewatering could occur within this range, treated seawater discharge modelling has been conducted at three locations (KP 84, KP 102 and KP 114) to inform impact assessment of contingency treated seawater of discharge in NT waters. These sites which were specifically selected due to their proximity of pipeline to areas of environmental importance (i.e., reefs, coral, etc) and to be representative of differing metocean conditions along the pipeline route in NT waters.

In the event of an extended period before pipelay can recommence, the pipeline will be flushed and then filled with inhibited seawater to safely preserve the pipeline in the intervening period before pipelay is recommenced. The inhibited seawater will be treated with chemicals to preserve the pipeline (i.e., the same treatment described in **Section 2.3.2.7**). If preservation is required, the entire content of the treated seawater within the pipeline will be discharged (dewatered) prior to pipelay recommencing.

Both overflow and dewatering discharges were modelled at these locations. The volume of treated seawater released as overflow (~600 m^3) was modelled at all three locations. However, during dewatering the volume was varied due to the length of the pipe at the given location, shown below.

- KP 84 – 19,958 m^3
- KP 102 – 10,623 m^3
- KP 114 – 4,400 m^3

2.3.2.10 Demobilisation of onshore support facilities

At the completion of the pipeline installation and pre-commissioning activities, the offshore pipeline installation contractor/ sub-contractors will be responsible for removal the onshore supporting facilities e.g. site pad, access roads (**Figure 2-2**) and demobilising any onshore equipment. Wastes will be disposed of, and site reinstatement undertaken as required.

The causeway/s will be removed upon completion of all activities at the shore crossing site. Excavators will start at the deep end and recover material into dump trucks for temporary storage, with material subsequently disposed offsite. A final survey will be completed to confirm all material brought to site for the causeway has been removed.

2.3.3 Summary of vessel and support activities

Vessel and support activities will include the operation of vessels, vehicles/mobile plant, helicopters and ROVs. Vessel and support activities associated with the DPD Project will be undertaken throughout all phases of the DPD Project.

2.3.3.1 Vessel activities

A number of vessel types will be required to complete the proposed activities, including:

- Marine survey vessels – to support pre-lay and post-lay surveys of the Project pipeline, including verifying trench depth and rock placement, support pipeline and structure placement and monitor spoil ground.
- Environmental monitoring vessel – to conduct environmental monitoring during construction activities;
- Pipelay vessels – A deep water pipelay vessel and shallow water pipelay barge, to install the pipeline and ILT;
- Construction vessels – to support installation of structures (i.e., spool, mattresses for scour protection, mechanical protection, stabilisation and pipeline support) and pre-commissioning activities;
- Rock installation vessels – including fall pipe vessel, side dump vessels and non-propelled barges;
- Trenching and spoil disposal vessels – including a cutter suction dredge (CSD), trailing suction hopper dredge (TSHD), backhoe dredge (BHD) and split hopper barges (SHB);
- Pipe supply vessels – to provide pipe to the pipelay vessel; and
- Supply vessels – to provide general support, crew transfers, material and supplies to all offshore activities.

For trenching and spoil disposal activities, an expected 11 vessels will be required, for deep water and shallow pipelay activities an expected six and seven vessels, respectively, are expected to be involved, for rock installation an expected six vessels will be involved and for pre-commissioning an expected four vessels will be involved.

Supply vessels are expected to operate from local regional ports (i.e. Darwin) to transport fuel, stores, waste and specialist supplies such as rock, pipe etc.

Bunkering (re-fuelling) of the vessels may take place either at sea (i.e. if required for the pipelay vessel) or in port (support and other vessels).

Vessels will vary in length and draft. They may anchor depending on water depth and activity type, with varying anchor requirement and disturbance footprints. Known sensitive areas will be avoided when anchoring.

2.3.3.2 Helicopter activities

Helicopters are the primary means of transporting passengers or urgent freight to and from the pipelay vessel and helideck equipped construction vessel during offshore installation and pre-commissioning activities. They are also the preferred means of evacuating personnel in the event of an emergency. Helicopter support will be principally supplied from Darwin Airport. Helicopter operations will be approximately three days per week, with typically two flights each day. Helicopters will operate during daylight hours unless in the event of an emergency. Helicopters may be required to refuel offshore.

2.3.3.3 Remotely operated vehicle activities

Throughout the DPD Project, offshore activities will be supported by ROVs. The ROV can be fitted with various tools and camera systems that can be used to capture permanent records of the underwater operations and immediate surrounding environment.

2.3.3.4 Onshore facilities and equipment

Constructing onshore facilities will be required to undertake activities up to the shore pull onshore termination point. The activities include:

+ Preparation the site pad and temporary stockpile – this will include a pre-excavation survey to establish a baseline for re-contouring of the site at completion of works. Soil investigations will also be conducted at the locations of the causeway, winch installation area and temporary stockpile area. Excavation will then commence with ~5000 m^3 of material moved to the temporary spoil stockpile or intertidal area (location of spoil dependent on ASS inspection)
+ Temporary road construction, installation of geotextile and site hard stand areas – Compaction of loose soils will be done with vibratory rollers and post compaction geo-fabric to be installed where hardstand material will be applied. The hardstand material shall be placed and compacted to a minimum thickness of 300mm. Lighting will be provided for safety purposes during night activities.
+ Site installation of the ablution facilities and office buildings. Ablutions will be connected to a septic tank with sludge periodically removed. Office containers will be lifted in via mobile crane and electrical wiring connected to a generator which will be in protective casing.
+ Installation of holdback anchor, linear winch, trench and shore pull wire. The winch will be installed using a crane with lifting capacity of 300/350 tons. Prior to the pipe pull operations an anchor pit will be excavated with ~1608m^3 of material removed, which will be stored onsite and used as backfill for the pit on completion of activities. The anchor pit is above HAT and as the water table is assumed to be equal with the sea level it is expected that the bottom of the pit will be dry (with the exclusion of rain events).

The types of equipment expected to be used include:

+ Light vehicles;
+ Mobile equipment such as excavators, graders, trucks, fuel trucks, etc.; and
+ Heavy equipment such as cranes

Facilities to be installed at the project site include:

+ Muster point
+ Generator
+ Contractors offices
+ Meeting room
+ Stores container
+ HV parking area
+ LV parking area
+ Light towers
+ Septic tank with water supply tank
+ Ablution facility discharging on septic tank
+ Gas detectors

All equipment and facilities are rated for cyclones as per the Cyclone rated design report.

2.3.4 Resource requirements and access

Other resources required for the DPD Project will include:

+ Personnel will be required during the construction period. Labour will be recruited from the domestic and local labour market where possible; this is subject to the contractors' resourcing

requirements at the time. Accommodation will be provided for the workforce within the Darwin area or onboard vessels.

- Power will likely be supplied by onsite generators to support construction amenities and operation of equipment.
- Water usage for onshore activities including for dust suppression, washdown facilities and ablutions supply will likely be sourced from mains water supply within the DLNG facility or provided as self-sufficient water through containerised water trucks.
- Access to the shore crossing location (i.e. onshore site) will be via the existing DLNG access at the end of Middle Arm Peninsula into Wickham Point.

2.3.5 Fuels and chemicals

Chemical and fuel storage will be stored onsite within the shore crossing location and will include bunded fuel storage/tanks. Fuel trucks will likely be used to supply fuel to construction equipment including excavators, graders, cranes, and generators. Hydrotest chemicals will also be stored onshore within a hydrotest spread (i.e. biocides, oxygen scavenger and dye).

2.3.6 Atmospheric Emissions

A greenhouse gas (GHG) emissions study was conducted to determine the scope 1, 2 and 3 emissions from the DPD Project and the broader Barossa development. The scope 1 emissions within NT jurisdiction are emissions that result directly from the construction DPD Project includes:

- Vessel-based construction activities
- Onshore construction activities from power generating equipment (i.e. engine and generators)

Scope 2 and Scope 3 emissions are associated with the broader Barossa project and comprise electricity use, transport and construction of materials and consumption of Barossa products by customers.

The total scope 1 emissions for DPD Project construction activities in the NT are approximately 50,000 tCO_2-e.

2.3.7 Discharges

The DPD construction activities will produce the following discharges:

- Vessel wastes including sewage, greywater, food waste, cooling water and RO brine, deck drainage and bilge
- Contingency pigging resulting discharge of FCGT fluids (in the event of an unplanned wet buckle only)
- Trench spoil (offshore, intertidal and onshore including PASS)
- Filter backflush discharges associated with FCGT activities (water extraction).

Approximate volumes of these discharges are presented in **Table 2-3**.

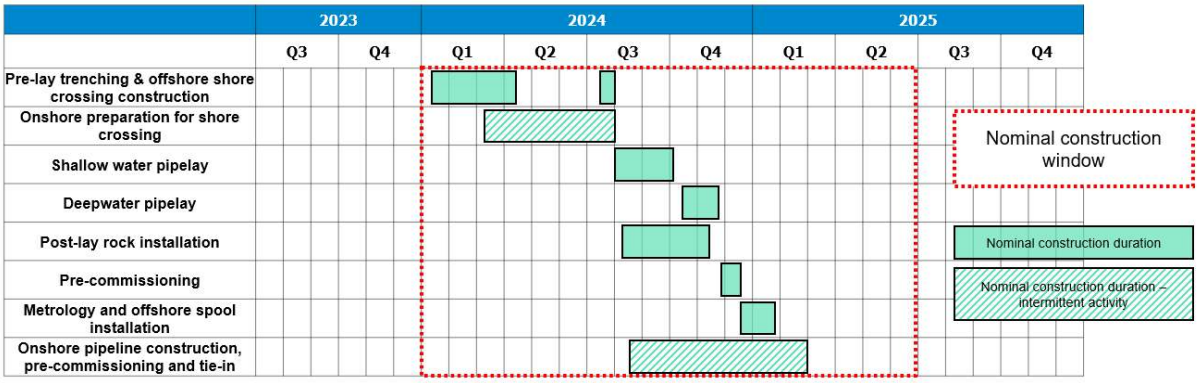
Table 2-3 Projected and contingency construction discharge volumes for the DPD Project in NT jurisdiction

Discharge source	Projected volume (m^3)	Contingency volume (m^3)
Vessel waste	n/a	n/a
Contingency treated seawater discharges	n/a	Dependent upon wet-buckle location. Example discharge volumes are provided below: ~19,958 m^3 (KP 84) ~10,623 m^3 (KP 102) ~4,400 m^3 (KP114)
Trench spoil	~310,000	750,000
Downline flushing of grout lines	~40	n/a
Filter backflushing	~300 m^3	

2.4 Indicative construction schedule

Santos is targeting to have all DPD regulatory approvals in place by Q1 2024 to ensure construction activities do not delay Barossa first gas in the first half of 2025. A nominal DPD construction sequence and schedule is shown in **Table 2-4** representing a start of construction activities at the beginning of nominal construction window. The construction activities will span a nominal cumulative period of 15-months in the field. The actual construction sequence and schedule will be subject to the timely receipt of all regulatory approvals and drivers such as vessel availability, operational issues, and weather. Santos' regulatory approvals and stakeholder consultation consider construction activities at any time between Q1 2024 to mid-2025.

Table 2-4: Preliminary pre-lay, construction, installation, and pre-commissioning schedule for DPD



3 Legal and other obligations

The following sections describe the legislative framework governing the environmental impacts from the construction of the DPD Pipeline (NT).

3.1 Commonwealth Environmental Approval

The DPD Project including the DPD Pipeline section in Commonwealth Waters was referred to the DCCEEW under the EPBC Act on 7 October 2022 (EPBC 2022-9372). On 6 December 2022 the DPD Project was determined to be a Controlled Action requiring further assessment based on Preliminary Documentation. Further information was requested under section 95A(2) of the EPBC Act on 23 December 2022.

It was determined that the Project may have a significant impact on the following controlling provisions under the EPBC Act:

+ Listed threatened species and communities (sections 18 & 18A)
+ Listed migratory species (sections 20 & 20A)
+ Commonwealth marine areas (sections 23 & 24A)

The Preliminary Documentation is currently being prepared for submission to DCCEEW.

This CEMP will be updated to reflect any relevant regulatory conditions associated with this approval.

3.2 Northern Territory Environmental Approvals

The DPD Project was referred to the NT EPA on 14 January 2022 under Section 55 of the EP Act. The NT EPA determined the DPD proposal required assessment by Supplementary Environmental Report (SER) (Tier 2) in accordance with the Environment Protection Regulations 2020 (EP Regulations). The SER is required to address public submissions and include information additional to the referral document in relation to specific aspects of potential significance.

This CEMP has been prepared for submission in draft form with the SER (BAS-210 0020) and other supporting documents to the NT EPA under the EP Act and will be updated to reflect any relevant regulatory conditions associated with the DPD Project approvals. It will also be submitted to DITT for approval under the *Energy Pipelines Act 1981* and the *Petroleum (Submerged Lands) Act 1981 and Energy Pipelines Act 1981*.

The following approvals are also required for construction of the DPD Project under NT legislation:

+ Department of Infrastructure, Planning and Logistics (DIPL) - Development Permit (*Planning Act 1999*) and Occupational Licence (*Crown Lands Act* (1992))
+ DITT – Energy Division Consent to construct and Consent to Test (*Energy Pipeline Act 1981* and *Petroleum (Submerged Lands) Act 1981*) Pipeline licences (*Petroleum (Submerged Lands) Act 1981 and Energy Pipeline Act 1981*)
+ Fisheries Permit (*Fisheries Act 1998*)
+ Underwater Heritage Clearance (*Heritage Act 2011*)

Conditions within these permits, where they are relevant to the environmental management of works will be incorporated into future revisions of the CEMP.

3.3 Aboriginal Areas Protection Authority certificates

Aboriginal Areas Protection Authority (AAPA) certificates aim to protect indigenous sacred sites preventing damage from nearby works and outlines conditions to be followed when carrying out works on land and sea near to sacred sites across NT. The AAPA administer these certificates under the *Northern Territory Aboriginal Sacred Sites Act 1989*.

Santos has received an AAPA Authority Certificate (C2022-098) from AAPA on 23 December 2022 and will ensure the requirements of the certificate (including avoidance of restricted work areas) and the *Northern Territory Aboriginal Sacred Sites Act 1989* are met.

3.4 Legislative framework

Environmental legislative requirements governing the DPD Project are described in the following sections. All activities will comply with legislative requirements established under relevant Commonwealth and NT legislation. Key legislation is described below in **Sections 3.5.1, 3.5.2, 3.5.3** and **3.6**. Other relevant legislation is described in **Table 3-1** and **Table 3-2**.

3.5 Key Legislation

3.5.1 *Environment Protection and Biodiversity Conservation Act 1999* (Cth)

The EPBC Act is administered by DCCEEW. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places, which are defined in the EPBC Act as matters of national environmental significance. There are nine matters of national environmental significance to which the EPBC Act applies, these are: world heritage properties, national heritage places, wetlands of international importance, nationally threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions, and water resources (in relation to coal seam gas development and large coal mining development) (DCCEEW, 2022a). When a person proposes to take an action that they consider may need approval under the EPBC Act, they must refer the proposal to the Commonwealth Minister for Environment.

Section 3A of the EPBC Act sets out the principles of ecologically sustainable development (ESD), which are:

+ 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 principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
+ The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making
+ Improved valuation, pricing and incentive mechanisms should be promoted.

The construction and operation of the DPD Project (including the Commonwealth waters section) has been referred to DCCEEW under the EPBC Act and assessed to be a Controlled Action (referral number EPBC 2022/9372) requiring further assessment based on Preliminary Documentation (in progress).

3.5.2 *Environmental Protection Act 2019* (NT)

The EP Act and associated EP Regulations are administered by DEPWS. The EP Act protects the environment and related purposes of the Northern Territory. The Act also:

- Promotes ecologically sustainable development
- Recognises the role of environmental impact assessment and environmental approval in promoting the protection and management of the environment of the Territory
- Provides for broad community involvement during the process of environmental impact assessment and environmental approval
- Recognises the role that Aboriginal people have as stewards of their country as conferred under their traditions and recognised in law, and the importance of participation by promotion of ecologically sustainable development.

This CEMP has been developed under the guidance of this act and the NT EPA Draft Guidelines for an Environmental Management Plan (NT EPA, 2015) and will be submitted as a draft to NT EPA with the DPD SER (BAS-210 0020) for assessment.

3.5.3 Energy Pipelines Act 1981

The *Energy Pipelines Act 1981* (NT) allows for the creation of provisions for the construction, operation, maintenance and cessation of use or abandonment of pipelines for the conveyance of energy-producing hydrocarbons, and for related purposes. The *Energy Pipelines Act applies* to the DPD pipeline inshore from the NT Territorial Sea Baseline to the upstream weld of the beach valve.

The NT *Energy Pipelines Act 1981* and subsidiary Energy Pipelines Regulations require the proponent to operate licensed pipelines in accordance with an accepted Pipeline Management Plan (PMP). The Energy Pipelines Regulations do not require the PMP to explicitly consider environmental impacts and risks, however it is DITT – Energy Division policy that an environmental management plan (EMP), detailing environmental management, is submitted to with the PMP for approval. This CEMP and supporting plans will constitute the EMP to be provided with the PMP for approval under the *Energy Pipelines Act 1981*.

3.5.4 *Petroleum (Submerged Lands) Act 1981* (NT).

The *Petroleum (Submerged Lands) Act 1981* allows for the creation of provisions with respect to the exploration for and the exploitation of the petroleum resources, and certain other resources, of certain submerged lands adjacent to the coasts of the Northern Territory and for other purposes. The *Petroleum (Submerged Lands) Act 1981* applies to the DPD pipeline in NT coastal waters, i.e., between the NT Territorial Sea Baseline and the NT/Commonwealth waters boundary.

3.5.4.1 Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (Cth)

The Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 allow for the creation of provisions with respect to the exploration and the production of the petroleum resources, and certain other resources, of certain submerged lands adjacent to the coasts of the Northern Territory and for related purposes. The regulations aim to ensure that proponents carry out all petroleum activity in a way that is consistent with the principles of ecologically sustainable development, in accordance with an environment plan that has appropriate environmental performance objectives and standards as well as measurement criteria for determining whether the objectives and standards are met. These Commonwealth regulations are enacted by the Petroleum (Submerged Lands) (Application of Commonwealth Laws) Regulations 2004 and apply between the

Commonwealth/NT waters boundary and the Territorial Sea Baseline. This CEMP has been developed in accordance with the content requirements for an Environment Plan under these regulations, including identifying clear and appropriate environmental performance objectives and standards as well as associated measurement criteria.

3.6 Other relevant legislation

3.6.1 Commonwealth legislation

Other Commonwealth legislative requirements relevant to the DPD offshore construction activities are outlined in **Table 3-1**.

Table 3-1: Other Commonwealth legislation relevant to DPD offshore construction activities

Title	Description
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	The purpose of this act is to preserve and protect places and objects in Australia and in Australian waters from injury or desecration; places or objects in question must be of particular significance to Aboriginal people with Aboriginal tradition.
Biosecurity Act 2015	The Act describes how to manage biosecurity threats to plant, animal and human health in Australia and its external territories, ensuring a very low level of risk.
Industrial Chemicals (Notification and Assessment) Regulations 1990 (Cth) National Industrial Chemicals Notification and Assessment Scheme (NICNAS)	Industrial chemicals are regulated by the Australian Government and administered by NICNAS. NICNAS provides a national notification and assessment scheme to protect the health of the public, workers and the environment from the harmful effect of industrial chemicals. NICNAS also assess all chemicals new to Australia and existing chemicals on a priority basis, in response to concerns about their safety on health and environmental grounds.
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about GHG emissions, GHG projects and energy use and production of corporations.
Native Title Act 1993	This Act provides for the recognition and protection of native title and provides or permits for the validation of past acts and intermediate period acts, invalidated because of the existence of native title. It additionally establishes ways in which future dealings affecting native title may proceed and sets standards for those dealings and establishes mechanisms for determining claims to native title.
Protection of the Sea (Harmful Anti-fouling Systems) Act 2006	This Act relates to the protection of the sea from the effect of harmful anti-fouling systems. It covers the application

Title	Description
	or use of harmful anti-fouling systems and the issue and endorsement of the required certificates and anti-fouling declarations.
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	This Act relates to the prevention of pollution (in any form) from ships and MARPOL requirements are implemented under this Act. MARPOL requirements are implemented under this Act.
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	This act, and associated regulations, implements the requirements of the Vienna Convention and Montreal Protocol to avoid using ozone depleting substances.
Underwater Cultural Heritage Act 2018 Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018	This Act provides for the protection of shipwrecks, sunken aircraft and their associated artefacts that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act. Some sites also have a protected zone around them.

Notes:

1. The *Environment Protection (Sea Dumping) Act 1981* (Cth) does not apply as spoil disposal will be within NT waters and therefore a sea dumping permit is not required.
2. There will be no trenching of the pipeline route or spoil disposal between the territorial baseline and NT coastal waters limit and therefore the activities included in this TSDMMP do not fall under the jurisdiction of the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999.*

3.6.2 Northern Territory legislation

Other Northern Territory legislative requirements relevant to the DPD Project offshore construction activities are outlined in **Table 3-2**.

Table 3-2: Other Northern Territory legislation relevant to DPD offshore construction

Title	Description
Aboriginal Land Rights (Northern Territory) Act 1976	The Act provides the basis upon which Aboriginal Australian people in the Northern Territory can claim rights to land based on traditional occupation
Aboriginal Land Act 1978	This Act provides for the access to Aboriginal land, certain roads bordered by Aboriginal land and the seas adjacent to Aboriginal land.
Bushfires Management Act 2016 Bushfires Management (General) Regulations 2017	The Act establishes the Bushfires Council and provides for the prevention and control of bushfires in the NT.
Dangerous Goods Act 1998 and Dangerous Goods Regulations 2017	This Act provides for the safe storage, handling, and transport of certain dangerous goods. These being explosives (including fireworks) and fuel gas (including Autogas) (NT WorkSafe, 2021)

Title	Description
Environmental Offences and Penalties Act 2011	This Act defines levels and penalties for environmental offences
Fire and Emergency Act 1996 Fire and Emergency Regulations 1996	This Act provides for the establishment and operation of the NT Fire and Rescue Service and their operational and emergency response activities. The Regulations outline general requirements under the Act, such as storing flammable or combustible material and using cutting, heating and welding equipment.
Fisheries Act 1988	This Act provides for the regulation, conservation and management of fisheries and fishery resources to maintain their sustainable utilisation, to regulate the sale and processing of fish and aquatic life, and for related purposes.
Heritage Act 2011	This Act provides a framework for the identification, assessment, recording, conservation, and protection of the Northern Territory's cultural and natural heritage.
Marine Act 1981	This Act is to regulate shipping within the Northern Territory and to provide for the application to the Northern Territory of the uniform shipping laws code and for related matters.
Marine Pollution Act 1999	This Act protects the marine and coastal environment by minimising intentional and negligent discharges of ship-sourced pollutants into coastal waters, and for related purposes.
Native Title Act 1993	This Act provides for the recognition and protection of native title and provides or permits for the validation of past acts and intermediate period acts, invalidated because of the existence of native title. It additionally establishes ways in which future dealings affecting native title may proceed and sets standards for those dealings and establishes mechanisms for determining claims to native title.
Northern Territory Aboriginal Sacred Sites Act 1989	This Act aims to provide a practical balance between the recognised need to preserve and enhance Aboriginal cultural tradition, in relation to certain land in the Northern Territory and the aspirations of the Aboriginal and all other peoples of the Northern Territory for their economic, cultural, and social advancement; by establishing a procedure for the protection and registration of sacred sites, providing for entry onto sacred sites and the conditions to which such entry is subject, establishing a procedure for the avoidance of sacred sites in the development and use of land and establishing an Authority for the purposes of the Act and a procedure for the review of decisions of the Authority by the Minister.
Northern Territory Environment Protection Authority Act 2012	This act aims to: a) promote ecology sustainable development; b) to protect the environment, having regard to the need to enable ecologically sustainable development; (c) to promote effective waste

Title	Description
	management and waste minimisation strategies; and (d) to enhance community and business confidence in the environmental protection regime of the Territory.
Planning Act 1999 Planning Regulation 2000	The Act provides framework of controls for the orderly use and development of land. The objective of the Act includes ensuring that strategic planning is applied to planning schemes and implemented in individual planning decisions, promotion of sustainable development of land and promotion of the responsible use of land and water resources to limit the adverse effects on development of ecological processes. Division 2 of the Act provides the planning basis for the submission, review, and authorisation of Exceptional Development Permits (EDPs), and related EDP variations. An EDP has been issued for the DLNG Plant. Approval for the DPD Project will be obtained under the Planning Act 1999 (NT), Santos is consulting with DIPL regarding the pathway for this approval.
Ports Management Act 2015	This Act provides for the safe, efficient, and effective control, management, and operation of Northern Territory ports.
Territory Parks and Wildlife Conservation Act 1976	This Act provides for the establishment of Territory Parks and other parks and reserves and for the study, protection, and conservation of wildlife in Northern Territory. This includes provisions on changes and revocation of parks, reserves and sanctuaries, the preparation and implementation of plans of management, the creation and management of sanctuaries and on the management of wildlife, flora, and fauna.
Waste Management and Pollution Control Act 1998 Waste Management and Pollution Control (Administration) Regulations 1998	This Act provides for the protection of the environment through encouragement of effective waste management and pollution prevention and control practices and for related purposes.
Weeds Management Act 2001	This Act allows for the classification of declared weeds or potential weeds, requirements for managing declared weeds or potential weeds and preparing management plans.

3.7 International conventions and agreements

Australia is signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats for flora and fauna. Those which are relevant to the activity re outlined in **Table 3-3**.

Table 3-3: International agreements and conventions relevant to the activity

International agreements and conventions	
Title	**Description**
China-Australia Migratory Bird Agreement (CAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in the EPBC Act.
Japan-Australia Migratory Bird Agreement (JAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in the EPBC Act.
International Convention for the Prevention of Pollution from Ships (MARPOL)	This convention is to eliminate international marine environment pollution through hydrocarbons and other toxic substances and to reduce the accidental discharge of such substances.
Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Korea. Implemented in the EPBC Act.
United Nations Convention on Biological Diversity – 1992	An international treaty to sustain life on earth.
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise GHG concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992, and it came into force on 21 December 1993.

3.8 Standards, codes and guidelines

There are several Australian Standards, Codes of Practice and Guidelines relevant to this CEMP, which have been identified below.

+ AS2885 Pipelines - Gas and Liquid Petroleum
+ AS/NZS 4801 Occupational Health and Safety (OHS) Management
+ AS/NZS ISO 9001:2008, Quality management systems – Requirements
+ AS/NZS ISO 14001:2004, Environmental management system – Requirements with guidance for use
+ AS/NZS ISO 31000:2009, Risk management – Principles and guidelines
+ HB 203:2006 Environmental Risk Management – Principles and Process
+ Australian Ballast Water Management Requirements. Version 8 (ABWM Requirements; Commonwealth of Australia, 2020a)
+ National Assessment Guidelines for Dredging (NAGD; Commonwealth of Australia, 2009a)
+ National Biofouling Management Guidance for Non-trading Vessels (NSPMMPI, Commonwealth of Australia, 2009b)
+ National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ, 2000)
+ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)

- Darwin Port Environmental Management Plan (Darwin Port, 2020)
- Declaration of Beneficial Uses and Objectives, Darwin Harbour Region, Northern Territory Government Gazette No. G27, 7 July 2010
- Darwin Harbour Water Quality Protection Plan (DLRM, 2014)
- Guidelines for Environmental Assessment of Marine Dredging in the Northern Territory (NT EPA, 2013)
- Draft Guidelines for the Preparation of an Environmental Management Plan (NT EPA, 2015)
- Guideline for Reporting on Environmental Monitoring (NT EPA, 2016)
- Water Quality Objectives for the Darwin Harbour Region – Background document (DNRETAS, 2010).

4 Environmental management framework

4.1 Santos Management System

Santos's Management System (known as the SMS) exists to support its moral, professional, and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The framework of policies, standards, processes, procedures, tools, and control measures that, when used together by a properly resourced and competent organisation, result in:

- A common HSE approach is followed across the organisation.
- HSE is proactively managed and maintained.
- The mandatory requirements of HSE management are implemented and are auditable.
- HSE management performance is measured, and corrective actions are taken.
- Opportunities for improvement are recognised and implemented.
- Workforce commitments are understood and demonstrated.

The Implementation Strategy (**Section 8**) and Stakeholder Consultation (**Section 9**) align with the Management System structure and are designed to require that:

- environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP
- controls are effective in reducing environmental impacts and risks to ALARP and acceptable levels
- environmental performance outcomes and standards set out in this CEMP are met
- consultation with relevant and interested persons is maintained throughout the activity as appropriate.

4.2 Santos' environment, health, and safety policy

Santos' Environment, Health and Safety Policy (**Attachment 1**) clearly sets out its strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This CEMP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos, each employee and contractor is made aware during the recruitment process that he or she is responsible for the application of this policy.

4.3 DPD Project environmental management plans

This Offshore CEMP is an overarching management plan covers DPD project construction activities (as defined in **Section 2**) from the 3 nm Commonwealth waters boundary to the onshore termination point. The Onshore CEMP (BAS-210 0025), covers the construction of the DPD Project pipeline from the onshore termination point to the upstream weld of the beach valve. Support facilities for activities under the Offshore CEMP may overlap the same areas used for activities covered under the Onshore CEMP. The TSDMMP, ASSDMP and MMNMP sit under these CEMPs and address specific activities and associated management measures requiring further detail and/or requested to be developed by the NT EPA for submission along with the SER. These activities are described in **Section 6** and **Figure 1-1**.

4.4 Supporting Management Processes and Procedures

4.4.1 Contractor Health, Safety and Environment requirements

The Santos HSE Contractor Management Operating Standard (SMS-HSS-OS08) supports the minimum requirements and expectations for HSE management of Contractors and subcontractors. In addition, the DPD Project has a developed an HSE Exhibit for its scopes of work. The HSE Exhibit forms a part of all contracts and has a detailed environmental requirements section including requirements for:

- Contractor to develop an environmental implementation plan to demonstrate how applicable environmental legislation and environmental approval requirements and requirements under this CEMP will be implemented
- Contractor to use an Environmental Management System for managing environmental impacts and risks throughout the activity, demonstrating leadership and accountability, organisational capability, and training/induction processes and performance reporting against environmental requirements
- Definition of key activities to support continuous environmental improvement
- Definition of the operational area of the work
- Chemical selection, approval, and chemical register requirements
- Prohibited of materials and chemicals
- Vessel environmental requirements, including trenching and spoil disposal requirements, marine discharge requirements, waste management requirements, unplanned discharge requirements, marine fauna interaction requirements, lighting requirements and invasive marine species requirements

The HSE requirements for contracts/contractor management during pre-contract planning, contracting, contract execution and contract completion and evaluation are outlined in the HSE Contractor Management Operating Standard (SMS-HSS-OS08) and the Contracting and Procurement Operating Standard (SMS-PRC-OS01). These include the following minimum requirements:

- Contractors to comply with all applicable HSE laws and regulations and any additional guidelines, operating standards and policies provided to the Contractor.
- A review of the Contractor HSE Management System is completed before being contracted.
- Provisions for Santos to conduct audits/inspections of the Contractor's operations, equipment and emergency procedures at any time.

4.4.2 Chemical selection and assessment procedure

All chemicals that are planned to be operationally discharged to the environment during the DPD construction activity will be evaluated using a defined framework and set of tools to ensure potential impacts are acceptable, ALARP and met Santos' expectation for environmental performance.

All chemicals that may be discharged to the environment will be detailed in a chemical register that is maintained and updated by the construction contractor. The contractor will submit the chemical application forms, with an SDS, to Santos for approval.

Chemicals that may be discharged to the environment will also require an environmental risk assessment which includes and assessment following principles of the UK Offshore Chemical Notification Scheme (OCNS) rating system.. The chemical hazard assessment and risk management (CHARM) model under the OCNS is the primary tool to rank offshore chemicals based on assessment of toxicity, biodegradation and bioaccumulation data provided by the chemical supplier. Santos will

approve chemicals planned to be discharge to the environment if they are Gold/Silver (OCNS CHARM) or OCNS group rating D/E (if not CHARM rated) or have an environmental risk assessment submitted by Contractor and approved by Santos.

4.4.3 Santos marine vessel vetting process

Santos manages marine vessel vetting and assurance using a hierarchy of procedures, outlined below. These requirements for vessel acceptance criteria include technical, personnel (e.g. crew competencies) and operational requirements for marine vessels engaged by Santos.

4.4.3.1 Marine assurance

The Marine Offshore Assurance Criteria (1530-045-STN-0001) is a standard that requires all vessels (including MODUs) used by Santos to be vetted. The vetting process is based on industry standards and best practices along with considerations of guidelines and recommendations from recognised industry organisations such as Oil Companies International Marine Forum (OCIMF) and International Maritime Contractors Association (IMCA), and international regulatory agencies like the IMO and vessel Classification Societies. The Marine Offshore Assurance Criteria requires a valid Offshore Vessel Inspection Database (OVID) report or Common Marine Inspection Document (CMID) report as required for vessel operation types. For vessels where the OVID and/or CMID are not valid or available, a Santos Approved Inspection Report is required.

4.4.3.2 Marine standards & compliance

The standards and guidelines that Santos expects the chartered vessels to operate to are:

+ Flag State Legislation
+ Coastal State Legislation for Marine Operations including Biosecurity Compliance
+ MCA Code of Safe Working Practices for Merchant Seamen (2015)
+ IMCA – M117
+ IMCA – M182
+ OCIMF – OVID and OVMSA
+ A.714 (17) Code of Safe Practice for Stowage and Securing (CSS Code) 2011 (IMO)
+ Guide for Offshore Marine Operations (GOMO) (Previously NWES Guidelines)
+ International Convention for the Safety of Life at Sea (SOLAS) 1974, as amended (IMO).
+ International Maritime Dangerous Goods (IMDG) Code (IMO)
+ Guidelines for the Preparation of cargo Securing Manual (MSC.1/Circ.1353 – IMO)
+ IACS - International Association of Classification Societies Rules
+ Safer Together Offshore Vessel Deck Water Management Specification
+ OCIMF Deck-Cargo-Management-Onboard-Offshore-Vessels

Santos performs a risk assessment or HSE Qualification Evaluation process for each vessel to identify any HSE issues or specific management requirements prior to commencing activities.

4.4.4 Santos waste management process

The Santos Environment Hazard Controls Procedure (SMS-EXA-OS01-PD02) requires that for all waste generated by contractors under its influence, the hierarchy of waste management applies whereby wastes are (in order of preference) avoided, reduced, re-used, recycled, treated and/or correctly

disposed. A waste inventory must be documented and onshore waste disposal records standardised (Waste Monitoring and Reporting Procedure – SMS-EXA-OS01-PD02-PD01) to allow accurate and consistent waste tracking. Contractors under this CEMP will demonstrate waste management processes will be aligned with regulatory and Santos requirements through the provision of Waste Management Plan for Santos acceptance.

4.4.4.1 Summary of requirements

The Australian ballast water requirements set out the obligation on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian seas. All internationally operating vessels entering Australia will require:

+ An approved Ballast Water Management Plan
+ Maintenance of a complete and accurate record of all ballast water movements including those conducted in Australian waters
+ An international Ballast Water Management Certificate.

Ballast water exchange should be conducted in areas at least 12 nm from the nearest land and in water at least 50 metres deep. Volumetric exchange must be at least 95% of the relevant tank. Records on ballast water exchange shall include the start and finish times and geographic coordinates of the operation.

All ballast water management equipment such as pumps will be maintained as per the vessel preventive maintenance system and regularly tested to ascertain accurate calculations for ballast water exchange operations.

4.4.4.2 Australian pre-arrival report

All international vessels must submit a Ballast Water Report and a Pre-Arrival Report (PAR), 96 to 12 hours prior to arriving in an Australian port through the MNES (MARS), for the Australian Department of Agriculture to review and process.

MARS is the online portal for commercial Vessel Masters and Shipping Agents to submit reports required of all international vessels seeking Australian biosecurity clearance; and request services such as coastal strip, waste removal, ship sanitation certification and crew change.

Department of Agriculture will request evidence from vessels with a ballast water management system of:

+ Valid ballast water management plan specific to the vessel (consistent with the Convention)
+ Valid ballast water management certificate, or certificate of compliance, that is approved by a port state administration, or a recognised survey authority (consistent with the Convention)
+ Ballast water management records that clearly demonstrate the BWMS has been operated consistent with the ballast water management plan.

A Department of Agriculture biosecurity officer will board the vessel to verify the Pre-Arrival Report and Vessel Master must ensure the vessel and personnel are available and able to demonstrate proficiency in the operation and maintenance of the ballast water management system.

4.4.5 Biofouling management

IMS may be present as biofouling on the vessel hull, or within piping, sea chests, etc. The biofouling which may be found on and in a vessel reflects the vessel's design, construction, maintenance, and

operations. Each of these aspects introduces biofouling vulnerabilities but also offers opportunities to limit the extent and development of biofouling, with commensurate reduction in biosecurity risks.

4.4.5.1 Vessel risk assessment

Vessels mobilised to the operational area from international or domestic waters will comply with the Australian National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009c). This includes:

+ Completion of a biofouling risk assessment
+ Implementation of mitigation measures commensurate with the level of risk.

Figure 4-1 presents the risk assessment process. Factors that will inform risk are:

+ Timing of marine pest risk assessment relative to vessels selection and movement to the title area to ensure there is sufficient time to implement control measures in cases where management is warranted
+ History of the vessels including time spent in ports of call since last dry dock and clean to inform whether the facility or vessel may have been exposed to high risk ports/locations
+ Level of biofouling and the presence of species of concern (in particular the presence of marine pests) within biofouling communities on the vessels associated with the activity (often informed by biofouling record books and/or maintenance/cleaning or inspection programs)
+ Operational profile relevant to biosecurity risk such as operating speed, time alongside a facility and the need for ballast exchanges within the title area
+ Receiving environment including the presence of shallow water sensitivities within proximity to the activity and the presence and area of non-biocidal surfaces on facilities that could harbour marine pests
+ Presence and effectiveness of external and internal marine growth prevention systems including effectiveness and integrity of antifouling coatings and functionality of internal treatment systems
+ Qualifications and competency of personnel conducting and reviewing the risk assessment and making management decisions.

4.4.5.2 Vessel risk status

There are three outcomes from the risk assessment which categorise the vessels risk status as outlined below. Vessels are required to have a ‘low’ risk status to demonstrate to the government that Santos has taken all reasonable measures to minimise the risk of IMS.

+ Low – low risk of introducing IMS; no additional management measures required
+ Uncertain – risk of introducing IMS is not apparent; precautionary approach adopted, additional management measures required to achieve low status
+ High – high risk of introducing IMS; additional management measures will be required.

4.4.5.3 Potential management measures to achieve low risk status

The outcome of the risk assessment will determine management measures required. If the vessel is deemed as ‘low’ risk status, no other measures are required (providing the vessel does not exceed the seven-day threshold at stationary or slow speed, in waters outside Australia (similar region).

For vessels that present an 'uncertain' or 'high' risk, Contractors will engage a qualified IMS inspector to conduct inspections and/or provide advice on obtaining low status. **Table 4-1** lists mitigation measures that can be applied to achieve 'low' risk status.

Table 4-1: Biofouling mitigation measures

No.	Mitigation Measure	Overview
1	IMS inspection	Visual inspection of submerged surfaces and niche areas by a qualified biosecurity inspector to better understand the actual biosecurity risk. IMS Inspectors will have the qualifications and align inspections and reports with DPIRD guidance in: + Criteria for Suitably Qualified Invasive Marine Pests Experts (DPIRD, 2017a) + Best Practice Guidelines for Invasive Marine Species Inspections (DPIRD, 2017b) + Invasive Marine Species Report Requirements (DPIRD, 2017c)
2	In-water cleaning	The appropriateness of in-water cleaning operations must be a decision made closely with IMS inspector on a case-by-case basis. Many factors will be considered, including: + Degree and type of biofouling; + Location of biofouling on the vessel. Prior to undertaking in-water cleaning within Australia, approval from the relevant state/territory authority must be granted and conditions may be imposed. Application for administering authority (Harbour Master, local government or state environmental protection agency) at least five working days prior to the proposed commencement of the work.
3	Dry docking cleaning	Dry docking and the removal/cleaning of biofouling will include hull surfaces, niche areas such as sea chests, all retractable equipment such as thrusters, intakes and outlets, anodes and voids.
4	Temporal or spatial controls	Temporal or spatial controls to limit vessel exposure to sources of risk.
5	Application of anti-fouling coating	Depending on the age the vessel may require application of new anti-fouling coating. The anti-fouling coating type will be based on technical advice and carried out by professional operators. All vessels greater than 400 gross tonnes will retain Antifouling System Certificate.
6	Treatment of internal seawater systems	In the absence of a marine growth prevention system, cleaning of internal seawater systems may be required, which may include: + Dehydration + Heat + Physical removal + Chemical treatment.

No.	Mitigation Measure	Overview
		Treatment of Internal Seawater systems will ideally be undertaken prior to mobilisation to Australia. Where chemical treatments are to be undertaken within Australian waters, advice will be sought from the Australian Pesticides and Veterinary Medical Authority (www.apvma.gov.au) in relation to permit and reporting requirements as it is prohibited to clean internal systems without a permit.

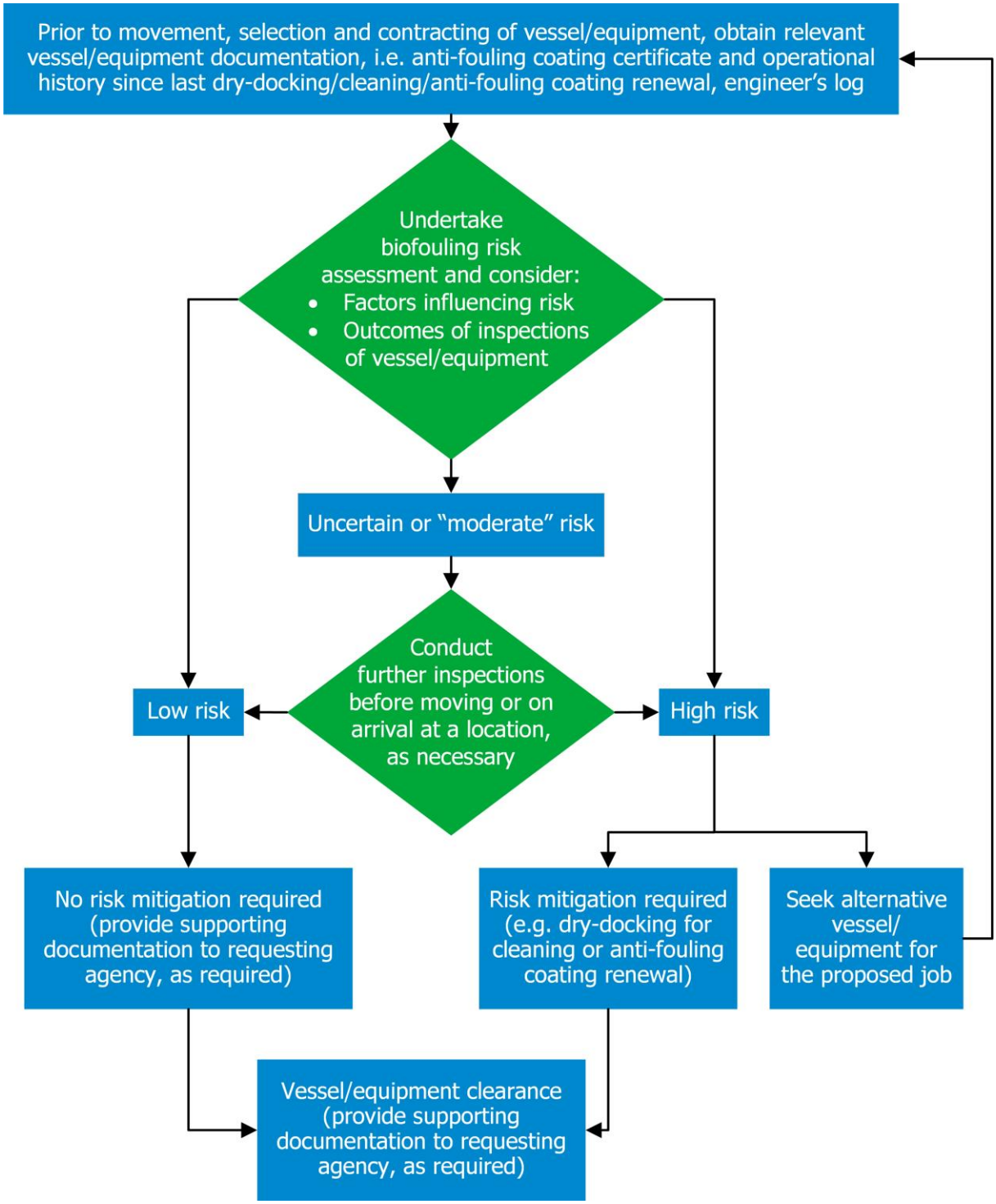


Figure 4-1: Generic biofouling risk assessment process (from Department of Agriculture, Fisheries and Forestry, 2009)

5 Existing environment

This section describes the key physical, biological, socio-economic, and cultural characteristics of the Project Area including the DPD spoil disposal ground. These characteristics have been summarised and grouped into the relevant NT EPA Environmental factors (NT EPA, 2022). Information provided in this section is drawn from the following documents:

- Darwin Pipeline Duplication (DPD) Project – NT EPA Referral (BAS-201 0003; Santos, 2022)
- Darwin Pipeline Duplication (DPD) Project – EPBC Referral Supporting Information (BAA-201 0004; Santos, 2022)
- Santos Barossa DPD – Pipeline Benthic Survey report (BAS-210 0014; RPS, 2022)
- Ichthys Gas Field Development Project – Draft Environmental Impact Statement (EIS) (INPEX, 2010)
- INPEX Ichthys GEP Dredging and Spoil Disposal Management Plan (INPEX, 2014)
- INPEX Ichthys Maintenance Dredging and Spoil Disposal Management Plan (INPEX, 2018)
- INPEX Draft Maintenance Dredging and Spoil Disposal Management Plan (2023 – 2027) (INPEX, 2022)
- Darwin Harbour – A Summary of the Ichthys LNG Project Nearshore Environmental Monitoring Program (NEMP) (Cardno, 2014).

5.1 Coastal processes

5.1.1 Physical environment

5.1.1.1 Meteorological conditions

5.1.1.1.1 Climate

The Project Area resides within the monsoonal (wet-dry) tropics of Northern Australia, which is subject to two distinct seasons a hot wet season from November to March and a warm dry season from May to September, with both April and October acting as transitional months between wet and dry seasons, respectively.

Temperatures are hot all year round with mean maximum temperature >30 °C, November is the hottest month of the year ranging from 25 °C mean minimum temperature to 33 °C mean maximum temperature. While June and July are the coolest months in the year ranging from 19 °C mean minimum temperature to 30 °C mean maximum temperature (BOM, 2022).

5.1.1.1.2 Rainfall

The annual mean rainfall for Darwin is 1723.8 mm with the majority of this (87%) rainfall coming in wet season months between November and March. Mean monthly evaporation ranges from 160 mm in February to 245 mm in October, with annual daily evaporation of 6.7 mm. Mean 9 am and 3 pm relative humidity is also higher in the wet season following similar trends to rainfall (BOM, 2022). Monthly and annual mean, max and min rainfall averages from 1941 to 2022 for Darwin International Airport are provided in **Table 5-1**.

Table 5-1: Average monthly and annual mean, max and min rainfall (mm) from 1941 to 2022 for Darwin International Airport (BOM, 2022)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	431	369	311	102	21	2	1	5	17	70	142	252	1724
Max	940	1110	1014	396	296	51	27	84	130	339	371	665	2777
Min	136	103	88	0.6	0	0	0	0	0	0	17	19	1025

5.1.1.1.3 Wind direction and speed

During the wet season winds are predominately light westerly and west–north–west winds, whilst in the dry season winds are varying from the south–east through to the north. Mean wind speeds are generally stronger in the afternoon than in the morning throughout the year. Mean morning wind speeds are typically stronger in the dry season, whilst mean afternoon wind speeds increase during the late dry season and build into the wet season where stronger winds are associated with afternoon storm cells.

5.1.1.1.4 Cyclone activity

The monsoonal tropics are also subject to intermittent cyclone activity usually resulting in the strongest winds and heaviest amount of rainfall. The cyclone season runs from 1 November to 30 April. Cyclones in the Anson-Beagle region are known to occur with low to moderate frequency. Storm surges often result in flooding, raised tidal levels, and increased wave heights resulting in damage, most of the damage caused by cyclones occurs near to the coast within 50 km from the coastline, causing concern for vessels and coastal developments in the area. Storm surges are hard to predict and dependent on the characteristics of the associated cyclone such as speed, intensity and the angle it crosses the coast. Bathymetry also contributes to the risk level of storm surges (BOM, 2022).

5.1.2 Coastal morphology

5.1.2.1 Offshore NT waters

The bathymetry of the Project Area in offshore NT waters has been thoroughly investigated and is well understood. Recent surveys have shown that the seabed along the DPD Project pipeline route in offshore NT waters and within the spoil disposal area is generally flat and featureless and typically less than 30 m in depth.

Within 5 km (north) of the Project Area resides the Carbonate bank and terrace system of the Van Diemen Rise key ecological feature (KEF) of regional significance. The feature consists of banks, terraces, channels, and valleys and the variability in water depth and substrate composition may contribute to the presence of unique ecosystems in the channels. The feature has enhanced biodiversity and productivity relative to surrounding areas and supports relatively high species diversity. This area will not be directly impacted by the DPD Project.

5.1.2.2 Darwin Harbour

Darwin Harbour is a large, drowned river system approximately 500 km^2 in extent. It is comprised of three arms (East Arm, West Arm, and Middle Arm), which along with the smaller Woods Inlet converge into a single unit before opening to the ocean and into Beagle Gulf in the north.

Freshwater inflow from the Elizabeth River into the East Arm and the Blackmore and Darwin rivers into the Middle Arm generally occurs between January and April creating more estuarine conditions.

Port Darwin's main channel is approximately 1525 m wide and 15 – 25 m deep, with a maximum recorded depth of 36 m. The channel is generally deeper on the eastern side of the Harbour, while the western side is broader and shallower areas with intertidal flats and shoal being more extensive.

The channel extends into the East Arm with depths of more than 10 m below LAT, the bathymetry of this area has been modified by dredging associated with the development of East Arm Wharf. A slightly deeper channel can be found in the Middle Arm extending up to the western side of Channel Island.

5.1.3 Oceanography

5.1.3.1 Offshore NT waters

The North Marine Region has no major ocean currents. However, there are tidal currents that play a role in the movement of water, biota, and benthic sediments. There are three recognised large-scale ecological systems in the North Marine Region which are the:

+ Gulf of Carpentaria
+ Arafura
+ Joseph Bonaparte Gulf.

The offshore NT waters Project Area traverses two meso-scale bioregions, the Bonaparte Gulf and Anson-Beagle Bioregions. The Bonaparte Gulf bioregion is predominately within offshore Commonwealth waters, but overlaps with NT coastal waters, south of Bathurst Island.

Oceanic currents within the Bonaparte Gulf are influenced by the Indonesian Through Flow (ITF) and South Equatorial Current. During the dry season (May to September) nearshore currents are generally westerly, whilst in the wet season (November to March) nearshore currents are easterly. Tides are semi-diurnal (two highs and two lows each day) and vary throughout the bioregion from offshore microtidal range (2 to 3 m variation) to inshore mesotidal range (3 to 4 m variation).

The Project Area within the Anson-Beagle Bioregion traverses Beagle Gulf. Due to the extent of the continental shelf ocean currents only have a minor influence on the Beagle Gulf region. Beagle Gulf has limited oceanic interaction and is strongly influenced by strong internal circulation. During the dry season (May to September) there is a south westerly drift due to south-easterly winds, the ITF, and the South Equatorial Current. Whilst during the wet season (November to March) there is a north-easterly drift due to the north westerly monsoonal winds. Tides in the gulf range from 6 to 8 m (IMCRA Technical Group, 1998).

Wave action in Beagle Gulf is seasonal; monsoonal north-westerly winds during the wet season (November to March) increase wave energy within Beagle Gulf and at the entrance to Darwin Harbour, due to the uninterrupted fetch over the Timor Sea. Whilst in the dry season (May to September) south-easterly trade winds generate low wave energy due to limited fetch.

5.1.3.2 Darwin Harbour

Darwin Harbour has a macrotidal (more than four metres) regime with tide range reaching 8 m which is considerable by world standards. Tides are generally semi-diurnal (two highs and two lows each day) with some inequality between successive tides in a single day. Neap tides result in a two-day period where tidal conditions are nearly diurnal (one high and one low each day). There is a great degree of variation in daily tidal range with the presence of spring-neap tide cycle approximately every 15 days. The spring phase of the cycle has an average tidal range of 6 m, while the neap phase average tidal range is 3 m . Large tidal movements and to a lesser extent wind, drives rapid and regular exchange of large volumes of water between Darwin Harbour and Beagle Gulf.

Darwin Harbour is considered sheltered with tsunamis and swell waves unlikely to occur due to the harbour's orientation, shallow bathymetry and protection afforded by the Tiwi Islands. Most waves are generated within Darwin Harbour or Beagle Gulf and are well below 1 m with periods of 2 – 5 seconds, under non-cyclone conditions. Tropical cyclones can cause extreme wave conditions producing significant wave height of 4.5 m and approximate periods of 7.5 seconds at the entrance to Darwin Harbour. Inside the harbour waves heights are reduced by the bathymetry to approximately 0.7 m (GHDM, 1997).

5.2 Marine environmental quality

5.2.1 Water quality

5.2.1.1 Offshore Northern Territory waters

Ichthys NEMP monitoring found that waters in Beagle Gulf were highly turbid in the wet season compared to the dry season likely due to stronger winds, larger waves, greater rainfall, and increased freshwater input (Cardno, 2014).

Environmental surveys to support the Barossa GEP Installation EP investigated water quality within the Barossa field (seasonal through 2015) and along the Barossa Gas Export Pipeline (GEP) (July to August 2017). This included areas close to the Project Area in Offshore NT waters, in which results showed metal concentrations below Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) dissolved metal trigger values (Santos, 2021).

In 2021, water sampling and analysis along the DPD pipeline route and at the spoil disposal ground in the offshore NT waters of the Project Area was completed (RPS, 2022 BAS-210-0014). Concentrations of three metals in water samples were detected above ANZG (2018) default guideline values (DGVs) (for slightly to moderately disturbed marine offshore ecosystems, at the 95% species protection level) Copper concentrations ins samples from three sites at western end of the offshore pipeline route were above the DGV; one of these exceedances was much higher than the DVG with the other two only slightly greater than the DVG, therefore it is likely an outlier and indicative of a potential contaminant. Lead concentrations were found to be much higher in the offshore Darwin Harbour samples than in samples taken at the spoil ground, with one sample above the DGV. Zinc concentrations were found at or above the DGV in 5 samples collected from the western end of the offshore pipeline route and across the proposed spoil disposal ground, with no clear trend in exceedances between surface and bottom waters. Arsenic was recorded below the ANZG (2018) DGV (RPS, 2022).

All nutrient concentrations were below the associated ANZG (2018) DGV (RPS, 2022). Dissolved hydrocarbons were below limits of reporting (LoR) for all samples. Naturally Occurring Radioactive Material (NORMs) were detected in near-seabed samples at two sited along the offshore pipeline route in low concentrations.

Total Suspended Solids (TSS) concentration were all above the limits of reporting LoR and ranged from 1.7 to 8.6 mg/L at offshore sites and 1.4 to 6.2 mg/L at spoil disposal grounds. There was no correlation between depth and TSS at either location.

Water column profiles at sites along the offshore pipeline and at the spoil ground showed no indications of stratification of the water column.

5.2.1.2 Darwin Harbour

Typically, water quality is high in the harbour, although naturally turbid as well. Water quality is highly variable within Darwin Harbour due to tide, sampling location, and season (**Table 5-2**). Darwin Harbour

water quality is affected by high levels of surface runoff in the wet season (November to March), which can extend until April or May depending on rainfall received. Tides also influence water quality in the harbour with neap tides promoting water clarity while spring tides carry sediment for fringing mangrove and resuspend fine sediment from the harbour floor (DHAC, 2008).

Water temperatures within Darwin Harbour are predominately high with some seasonal variation, averaging 30.6°C in the wet season and 24.5°C in the dry season. The lowest water temperatures occur in June and July (23°C) while the highest occur in October and November (33°C) (Padovan, 1997).

Salinity within Darwin Harbour is also subject to some seasonal variation, with mean salinity levels in the Harbour being lower during the wet season, due to freshwater influence being greater (**Table 5-3**). Sea water salinity has a global average of 35 ppt (parts per thousand), however salinities throughout the harbour are approximately 37 ppt during the dry season. Salinity is higher in the dry season due to increased evaporation and less freshwater inflow. Areas in the middle of the harbour such as Weed Reef can experience salinity as low as 27 ppt due to monsoonal inflow during February and March (Parry & Munksgaard, 1995). Salinities in the arms are heavily influenced by freshwater inflow in the wet season and can drop to 17 ppt. The water column during this time is heavily stratified with Parry and Munksgaard (1995) reported salinities on the bottom of the harbour to be up to 12 ppt higher than the surface.

Darwin Harbour waters remain well oxygenated throughout the year. Padovan (1997) finding no seasonal effects. Dissolved oxygen levels range from 74% to 96%, averaging approximately 84%. Dissolved oxygen levels are slightly higher at the harbours mouth compared to further into the estuary. Additionally, during spring tide cycles oxygen levels increased by 7% at high tide compared low tide (Padovan, 1997).

Darwin Harbour waters have a narrow pH range of 8.3 – 8.6. Padovan (1997) found no seasonal, spatial, or tidal effect on the pH of the harbour.

Turbidity in the Darwin Harbour is higher in the wet season compared to the dry season, mainly due to influx of terrigenous sediment and somewhat due to surface water sheet flow. Light levels at the bottom of the harbour can be as low as 1% of surface light levels during the wet season (Padovan, 1997). However, the most important factors affecting turbidity are tidal cycle and location (Padovan, 1997). Spring tides are associated with higher current velocities, and therefore higher capacity of water to move sediment, which results is greater turbidity (DHAC, 2005).

5.2.2 Sediment quality

Sediments sampled in the Santos Barossa DPD Pipeline Benthic Survey were found to be represented by slightly gravelly muddy sands to gravelly sands (RPS, 2022) The silt/clay and gravel components indicated a transition in benthic sediments from KP0 to the shore crossing at KP122.5. Sampled areas including the offshore pipeline, the spoil ground, the sand wave dredge area in the northern part of Darwin Harbour and the pipeline route in southern Darwin Harbour (near the shore crossing) were all significantly different in terms of particle size distribution, with clay/silt and gravel per cent contributions highest in Darwin Harbour. Similar transitional patterns were observed for infauna biological assemblage composition along the offshore pipeline route and at the spoil ground. It is likely that other unmeasured factors, e.g. current speeds/site energy, riverine input into Darwin Harbour (e.g. freshwater, silt), salinity profiles up the river and sediment chemistry, also contribute, and that there is likely to be seasonal variability in the distribution and composition of benthic faunal assemblages

Overall, no contaminants of concern were found in the sediments along the pipeline route or at the potential spoil disposal ground, with elevated levels of arsenic considered to be naturally occurring.

Therefore, the sediments along the pipeline route are suitable for unconfined ocean disposal, as per the National Assessment Guidelines for Dredging (NAGD) and NT EPA (2013) guidelines for dredging.

5.2.2.1 Acid sulfate soils

ASS are formed naturally and often occur in low lying coastal areas (BAA-201 0003; Santos, 2021). Coastal estuarine and mangrove environments develop ASS due to its typical waterlogged nature, saltwater influences and anaerobic soils.

ASS mapping over the Darwin region indicates that the Project Area shore crossing has a high potential for ASS to occur (BAA-201 0003; Santos, 2021). However, considering the historical earthworks undertaken as part of the development of the DLNG facility, the natural material has been removed across the onshore zone and replaced by imported (non-ASS) fill material (generally sand) up to a depth of approximately 6 m below ground level. Therefore, ASS associated with the naturally occurring soil material is no longer expected to be present within the onshore zone and the risk has been diminished, however the presence of ASS cannot be completely discounted and may require management. (BAS-210-0049; Santos, 2023).

5.2.3 Underwater noise

Underwater noise, excluding naturally occurring noise, within Darwin Harbour is influenced by the existing shipping traffic, biological sources, and weather. Vessel traffic in Darwin Harbour is a year-round source of noise with the Port of Darwin recording 1,510 trading vessel visits in 2021 – 2022 financial year (Darwin Port Operations, 2022). Further information regarding ambient noise levels in Darwin Harbour including measures is detailed in the MMNMP (BAS-210 0022).

5.3 Marine ecosystems

5.3.1 Benthic habitats

The Darwin region supports several benthic habitats including mangroves, coral, seagrass, macroalgae and soft-bottom benthos described below. Further details of benthic habitats can be found in DPD Project NT EPA Referral and Santos Barossa DPD – Pipeline Benthic Survey Report (Santos, 2021; RPS, 2022 BAS-210-0014).

5.3.1.1 Offshore Northern Territory waters

RPS conducted baseline investigations in October 2021 and June 2022 using drop/towed video at 30 sites and ROV video transects at 42 sites respectively (RPS, 2022). These surveys were used to describe the seabed of the offshore DPD Project pipeline route and to ground truth the results of the Australian Institute for Marine Science (AIMS) 2021 Revised Predicted Benthic Habitat Map for Darwin Harbour. The results are included in full in the NT EPA Referral (Santos, 2021), Santos Barossa DPD – Pipeline Survey Report (RPS, 2022) and are summarised below.

The benthic habitats along the offshore DPD Project pipeline route verified the expectations from the AIMS (2021) Revised Predicted Benthic Habitat Map and were found to be silty shelly sand habitat, with, burrows and polychaete worm tubes. Biota commonly associated with this habitat type were very sparse to sparse, and included hydroids, soft corals (gorgonians, *Junceella* and Alcyoniidae), sea stars and sponges. This soft sediment habitat was also present at the offshore end of the DPD Project pipeline route. Within three of these silty, shelly sand sites, there were sections of sand waves, roughly one metre high, with silty sand in the troughs and coarse shelly sand at the peaks. This substrate was associated with very sparse epibiota. The proposed sand waves dredge area (sand waves) was found to contain rippled coarse sand with very little epibiota (<1% abundance), consisting of some sparse soft corals and crinoids.

The spoil disposal ground sites all consisted of the same soft substrate habitat. This habitat is defined by silty/clay sediment with medium density biota. Biota commonly seen at this habitat were soft corals (gorgonians, *Junceella* and Alcyoniidae), branching and encrusting sponges, Bryozoa (lace coral), invertebrate burrows, polychaete tubes, brown algae and occasional motile crinoids.

5.3.1.2 Darwin Harbour

Benthic habitat surveys were completed in Darwin Harbour in October 2021 and in June 2022 (RPS, 2022). The October 2021 survey was completed systematically to describe habitats along the proposed pipeline route. The June 2022 survey targeted sites which were predicted by the AIMS (2021) Revised Predicted Benthic Habitat Map to have unique habitat or showed features from geophysical surveys, that were considered to potentially represent maritime heritage features. The comparison between the AIMS and survey datasets revealed differences between predicted and observed habitat types, particularly with the level of information provided (approximate densities of biota, substrate types are not available in AIMS data).

Sections 5.3.1.2.1 and **5.3.1.2.2** summarise the findings of the October 2021 and June 2022 surveys respectively.

5.3.1.2.1 October 2021 survey

Darwin Harbour benthic habitats comprised soft sediment habitats with two hard substrate habitats recorded during the surveys. Hard substrates were recorded along the section of the pipeline route offshore from Fannie Bay and low profile reef was recorded offshore of Woods Inlet with medium to high density epibiota. The soft substrate habitat adjacent to hard substrate habitats in Darwin Harbour were generally silty, shelly sand with very sparse soft corals to no conspicuous epibiota. As this habitat was recorded both adjacent to and between hard substrate habitats, this soft substrate habitat is potentially a veneer overlying submerged geology. Other recorded soft sediment benthic habitats in Darwin Harbour included:

+ Sand waves <1 m with coarse shelly sand and very sparse epibiota
+ Silt/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids) (at the southern end of the pipeline, near the shore crossing)
+ Silty, shelly sand with sparse epibiota (soft corals) and scattered bombora (at the southern end of the pipeline, near the shore crossing).

5.3.1.2.2 June 2022 Survey

Key objectives of the June 2022 survey were to collect additional samples and benthic habitat imagery during other surveys to augment the benthic dataset and to ground truth the AIMS (2021) Revised Predicted Benthic Habitat Map at selected sites within Darwin Harbour and to increase the number of benthic survey sites along the pipeline route. Ground-truthing within Darwin Harbour focused on sites predicted to be suitable for rarer high-value biota types (e.g., macroalgae, hard corals and seagrass) that were closest to the proposed pipeline route (and therefore had the greatest potential to be influenced by DPD Project construction activities, including trenching). This included an area west of the pipeline route where the route comes closest to the shoreline of Cox Peninsula (including sites HAB 1-4), an area west of the pipeline route where the route comes closest to Weed Reef (including sites HAB 6-8) and sites close to the shore crossing (HAB 9 and 10) (refer to **Figure 5-1**). Results from these surveys showed that the selected sites which were predicted as suitable for macroalgae, seagrass and/or hard coral by the AIMS (2021) Revised Predicted Benthic Habitat Map typically did not show presence of these biota types (BAS 210 0014; RPS 2022, **Figure 5-1** – **Figure 5-3**). Additional to these benthic habitat ground-truthing sites, a number of benthic habitat monitoring sites used by INPEX

during the Ichthys project were ground-truthed including hard coral sites (INPHCMAN, INPHCWED, INPHCCHI, INPHCSSI and INPHCNEW) and seagrass sites (INPSGWOD and INPSGCPW) (refer **Figure 5-1** – **Figure 5-3**). Surveys from these sites generally confirmed the presence of seagrass or hard coral as expected, although seagrass was observed at very low densities. The additional sites surveyed along the pipeline route within Darwin Harbour in June 2022 provided results consistent with surveys in October 2021 in that sites comprise a mix of hard substrate and sediments supporting varying densities of filter-feeding biota such as soft corals, hydroids, crinoids and sponges but with an absence of photosynthetic biota such as hard corals, seagrass and algae (BAS 210 0014; RPS, 2022; **Figure 5-1** – **Figure 5-3**).

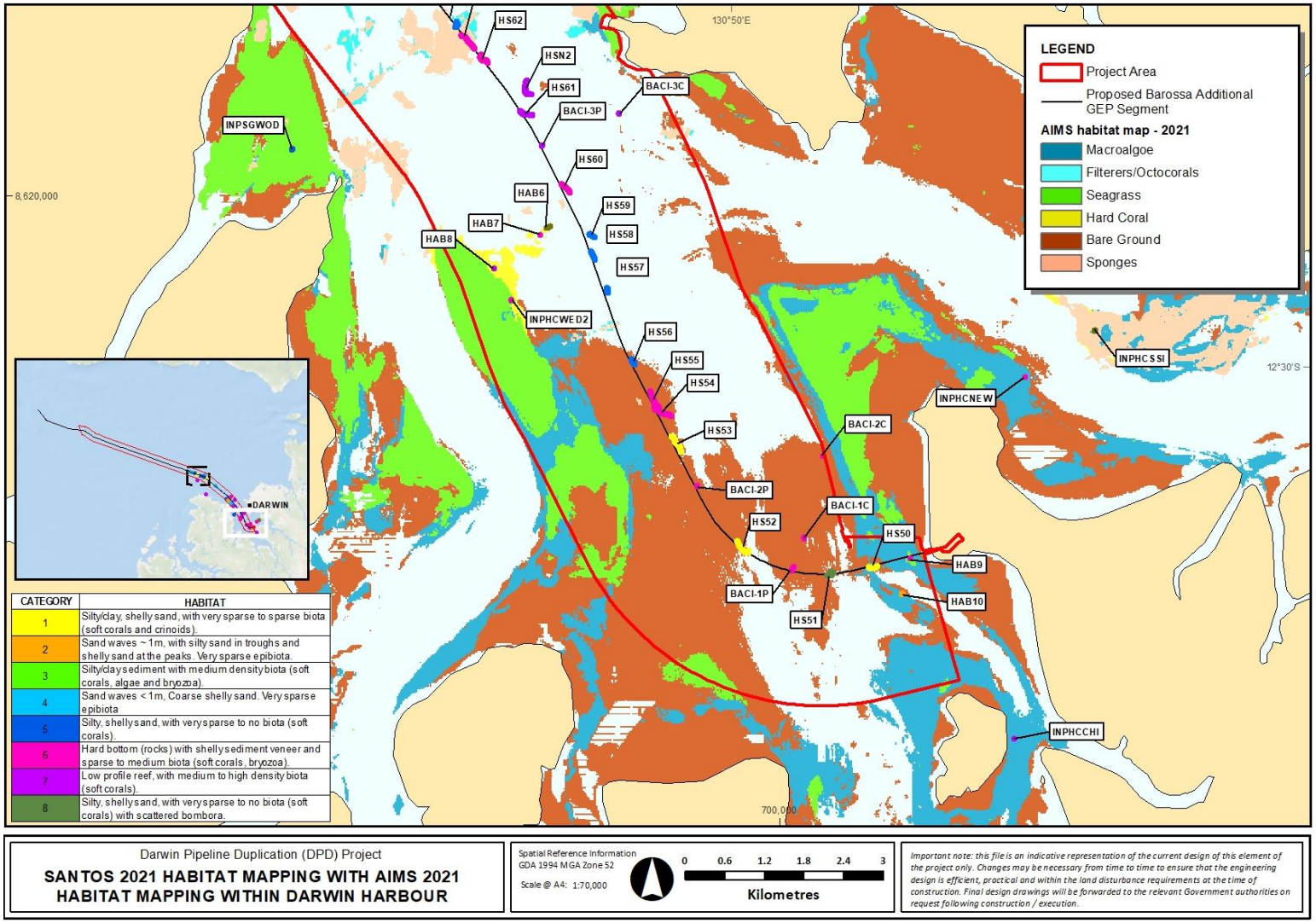


Figure 5-1: RPS surveys habitat mapping against AIMS 2021 habitat mapping within Darwin Harbour (AIMS, 2021)

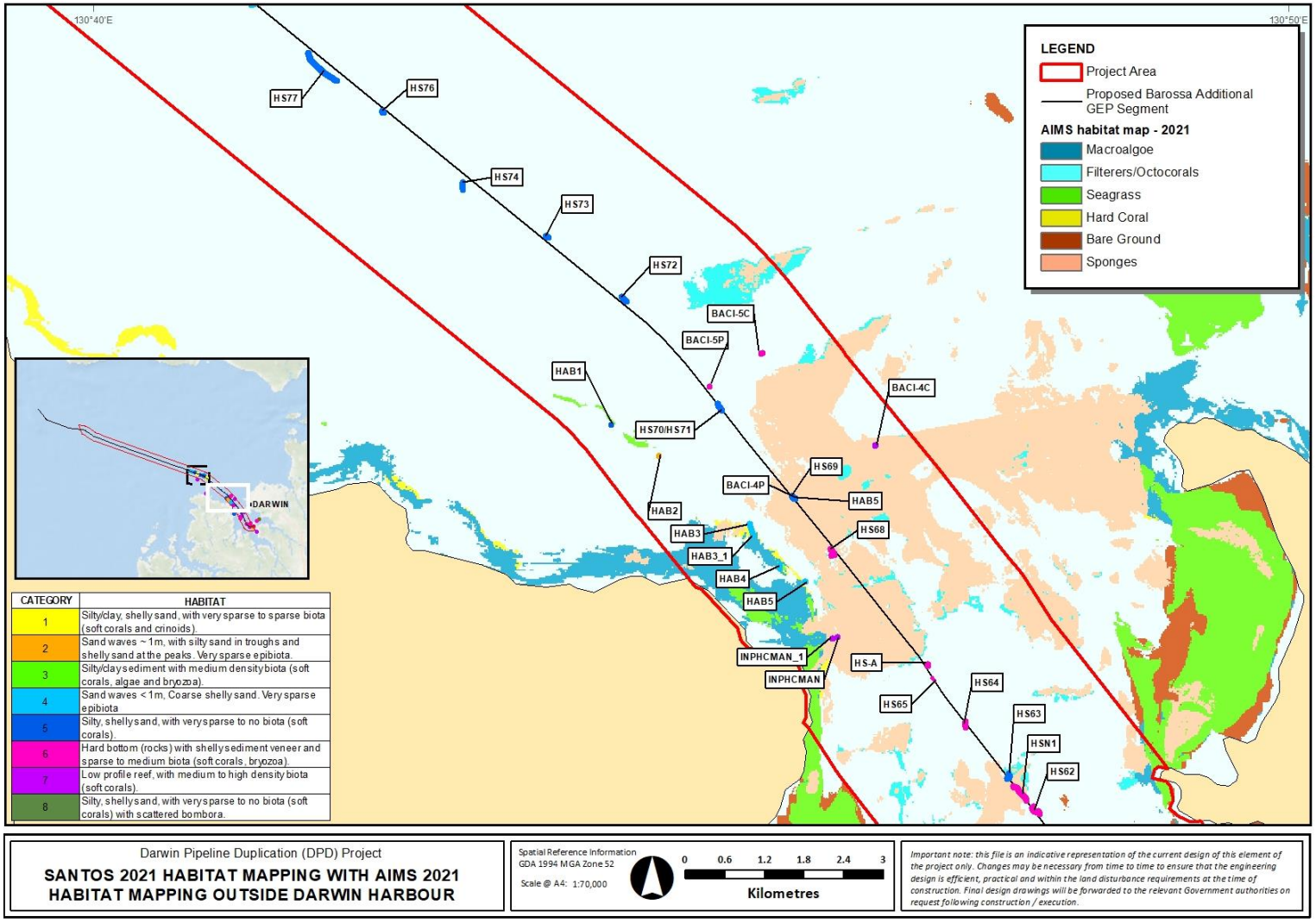


Figure 5-2: RPS survey habitat mapping against mapping against AIMS 2021 habitat mapping outside Darwin Harbour (AIMS, 2021)

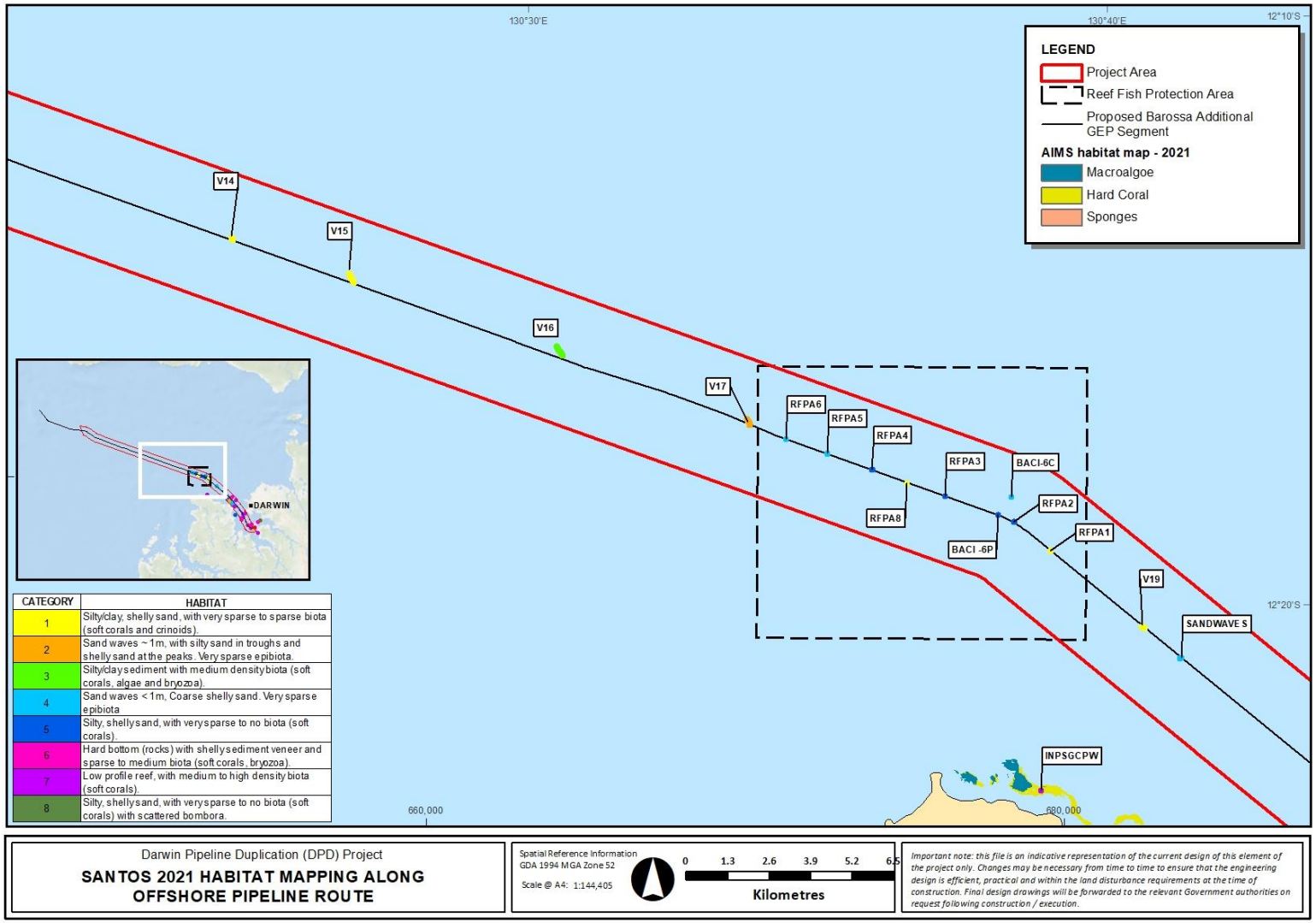


Figure 5-3: RPS surveys habitat mapping along offshore pipeline route

5.3.1.3 Protected/significant areas

Protected/significant areas identified near or overlapping the Project Area are detailed in **Table 5-2**. NT Reef Fish Protection Areas (RFPA) are described in **Section 5.3.1.3.1**.

Table 5-2: Protected areas near or overlapping the Project Area

Value/ sensitivity	Name	Overlaps Project Area	Protection classification/ zone
Nationally Important Wetlands	Port Darwin	✓	-
Northern Territory Reserves	Casuarina	✗	Coastal Reserve
	Charles Darwin	✗	National Park
NT Reef Fish Protection Areas	Charles Point Wide	✓	Reef Fish Protection Area
	Lorna Shoal	✗	Reef Fish Protection Area

5.3.1.3.1 NT reef fish protection areas

The DPD Project pipeline route intersects the Charles Point Wide RFPA and is approximately 9 km west of the Lorna Shoal RFPA (refer **Figure 5-4**). No fishing activities are permitted within RFPAs. Protection of these areas prevents over-fishing of golden snapper, black jewfish and other vulnerable reef species. The Project Area is also in close proximity to East Point Aquatic Life Reserve and Doctors Gully Aquatic Life Reserve (refer **Figure 5-4**).

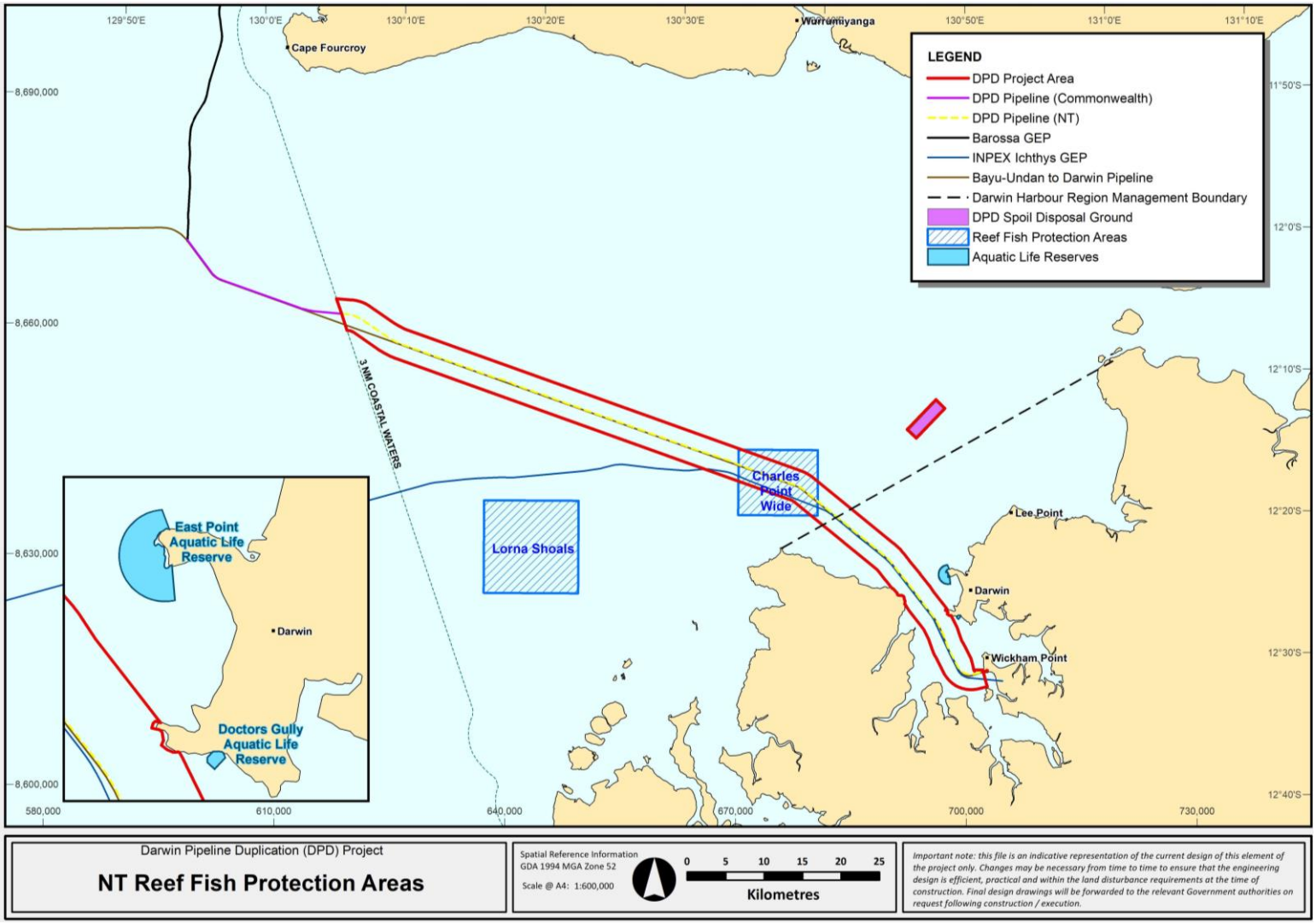


Figure 5-4: Northern Territory Aquatic Reserves and Reef Fish Protection Areas

5.4 Terrestrial ecosystems

5.4.1 Flora

A search of the DEPWS Natural Resource (NR) Maps database for threatened flora and significant flora within 5 km of the onshore Project Area identified one significant flora species, Byblis (*Byblis aquatica*) (DEPWS, 2022). This species is listed as near threatened under the *Territory Parks and Wildlife Conservation Act 1976* (TPWC Act) and was recorded approximately 5 km to the south-east of the onshore Project Area. It grows in semi-aquatic conditions and is insectivorous to acquire nutrients in nutrient-poor environments (Atlas of Living Australia, 2022). This species is commonly found in areas specifically between Darwin and Berry Springs.

Previous flora surveys of the DLNG Facility disturbance envelope did not identify the presence of any threatened or conservation significant flora species (BAA-201 0003; Santos, 2021). The Byblis is unlikely to occur within the onshore Project Area as it has been previously disturbed and there are no permanent freshwater habitats present (BAA-201 0003; Santos, 2021).

5.4.2 Mangroves

Monitoring of the mangrove communities surrounding the DLNG Facility has being ongoing since 2006 (ConocoPhillips, 2018). They are comprised of predominately *Rhizophora* and *Sonneratia* species and to a lesser extent *Aegialitis*, *Avicennia*, *Osbornia* and *Aegiceras* species. The data collected indicates that the mangrove communities are in good health, with no significant deterioration or stress resulting from DLNG Facility operations.

CDM Smith's (2021) vegetation assessment of the DPD shore crossing location identified less than five individuals of one mangrove species, *Sonneratia alba*, within 20 m either side of the DPD pipeline alignment. This species of mangrove is a common taxon that is well represented and characterised in the DLNG Facility's mangrove monitoring program. CDM Smith (2021c) concluded that the vegetation in proximity to the DPD pipeline is of low ecological value and well represented in the area.

These mangroves are located outside of the pipeline alignment for the approximately 200 m section of onshore pipeline, therefore are unlikely to be impacted by the onshore works relevant to this CEMP.

5.5 Fauna

5.5.1.1 Threatened and migratory fauna

The Protected Matters Search Tool (PMST) is used to search for matters (including species) protected under the EPBC Act and generates a list of protected matters that may occur in or near a selected area. PMST searches were undertaken on 24 August 2021 within five kilometres either side of the Project Area. Copies of the PMST search reports are available in **Attachment 2**.

A summary of the Listed Threatened Species (LTS) and Listed Migratory Species (LMS) identified by the PMST for the Project Area and surrounds is shown in **Table 5-3**.

Table 5-3: Summary of EPBC Act Listed Threatened (LTS) and Listed Migratory Species (LMS) identified by the Protected Matters Search Tool

Threatened and migratory fauna type	Number of species
LTS	42 (birds – 13, mammals – 14, reptiles – 7, sharks – 8): + Critically Endangered – 4

Threatened and migratory fauna type	Number of species
	+ Endangered – 12 + Vulnerable – 25 + Conservation Dependent – 1
LMS	74 (migratory marine birds – 6, migratory marine species – 28, migratory terrestrial species – 6, migratory wetland species – 34) many of which are also listed as 'Threatened': + Critically Endangered – 3 + Endangered – 6 + Vulnerable – 12
Total	95

Those fauna listed as threatened or migratory species under the EPBC Act and which have been identified as being likely to occur or potentially present within the Project Area, are listed in **Table 5-4**.

Table 5-4: EPBC Act listed threatened and migratory marine fauna within the Project Area

Common name	Scientific name	EPBC Act status	Presence	Particular values or sensitivities
Marine reptiles				
Flatback turtle	*Natator depressus*	Vulnerable, Migratory	Likely	Species is known to occur in Darwin Harbour and surrounding waters. Refer **Figure 5-5**.
Olive ridley turtle	*Lepidochelys olivacea*	Endangered, Migratory	Likely	Species unlikely to occur in Darwin Harbour but is likely to occur in shallow soft-bottomed habitats of protected waters represented within the Project Area seaward of Darwin Harbour. Refer **Figure 5-6.**
Green turtle	*Chelonia mydas*	Vulnerable, Migratory	Likely	Species is known to occur in Darwin Harbour and surrounding waters.
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable, Migratory	Likely	Species is known to occur in Darwin Harbour and surrounding waters.
Leatherback turtle	*Dermochelys coriacea*	Endangered, Migratory	Potential	Species unlikely to occur within Darwin Harbour, but potentially occurs in surrounding waters.
Loggerhead turtle	*Caretta caretta*	Endangered, Migratory	Potential	Species unlikely to occur within Darwin Harbour, but potentially occurs in surrounding waters.
Salt-water crocodile	*Crocodylus porosus*	Migratory	Likely	Species is known to occur within Darwin Harbour; individuals sighted on boat ramps near Project Area. There is no important habitat for the species in the Project Area.
Marine mammals				
Australian snubfin dolphin	*Orcaella brevirostris*	Migratory	Likely	Suitable habitat for the species is present. Individuals of the species have previously been recorded in Darwin Harbour and near Catalina Island, located to the east of the Project Area. Refer **Figure 5-7**.
Dugong	*Dugong dugon*	Migratory	Likely	Individuals of the species are known to occur within Darwin Harbour.
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory	Likely	Suitable habitat for the species is present. The species is widely known from Darwin Harbour. Refer **Figure 5-8**.
Spotted bottlenose dolphin	*Tursiops aduncus*	Migratory	Likely	Suitable habitat for the species is present. The species is widely known to occur within Darwin Harbour. Refer **Figure 5-9**.
Birds				
Asian dowitcher[1]	*Limnodromus semipalmatus*	Migratory	Potential	Some species recorded in proximity to the Project Area. Potential habitat in Darwin Harbour.
Common sandpiper [1]	*Actitis hypoleucos*	Migratory	Potential	The Project Area does not contain suitable habitat for nesting/roosting, however there is suitable habitat for foraging on either side of the Project Area which may result in this species traversing the Project Area.
Grey plover [1]	*Pluvialis squatarola*	Migratory	Potential	The Project Area does not contain suitable habitat for nesting/roosting however there is suitable habitat for foraging on either side of the Project Area which may result in this species traversing the Project Area.
Oriental plover[1]	*Charadrius veredus*	Migratory	Potential	Some species recorded in proximity to the Project Area. Potential habitat in the Darwin Harbour and offshore of Wagait Beach.
Osprey	*Pandion haliaetus*	Migratory	Potential	The Project Area and surrounds contain suitable foraging habitat for the species. It is noted that there is an osprey nest on the DLNG site (atop an artificial pole).

Notes:

1. It is important to note that although there is a number of migratory species as having the potential to or likely to occur within or nearby to the Project Area, several of these were migratory birds, most of which would likely be transiting to areas either side of the Project area where suitable habitat is known to occur (i.e. shoreline crossing is within a disturbed area). Other than the osprey, which is known to nest on tall artificial structures, migratory birds have not been considered further. In addition, given the shore crossing is located within the existing DLNG disturbance envelope and there is no suitable habitat for other migratory terrestrial species within the Project area, migratory terrestrial species have not been considered further.

Table 5-5: Biological Important Areas (BIAs) identified within 5 km of the Project Area

Species	BIA	Project Area overlap
Marine reptiles		
Flatback turtle	Nesting/Internesting	Overlaps
Marine mammals		
Australian snubfin dolphin	Breeding	Overlaps
Indo-Pacific humpback dolphin	Breeding	Overlaps
Spotted bottlenose dolphin	Breeding	Overlaps

Relevant recovery plans, conservation advice, and wildlife conservation plans for marine fauna identified in the PMST are outlined in **Table 5-6**. Recovery plans set out the research and management actions necessary to stop the decline of and support the recovery of LTS. **Table 5-6** summarises the threats relevant to each LTS and the DPD Project with references to the CEMP sections where these are addressed.

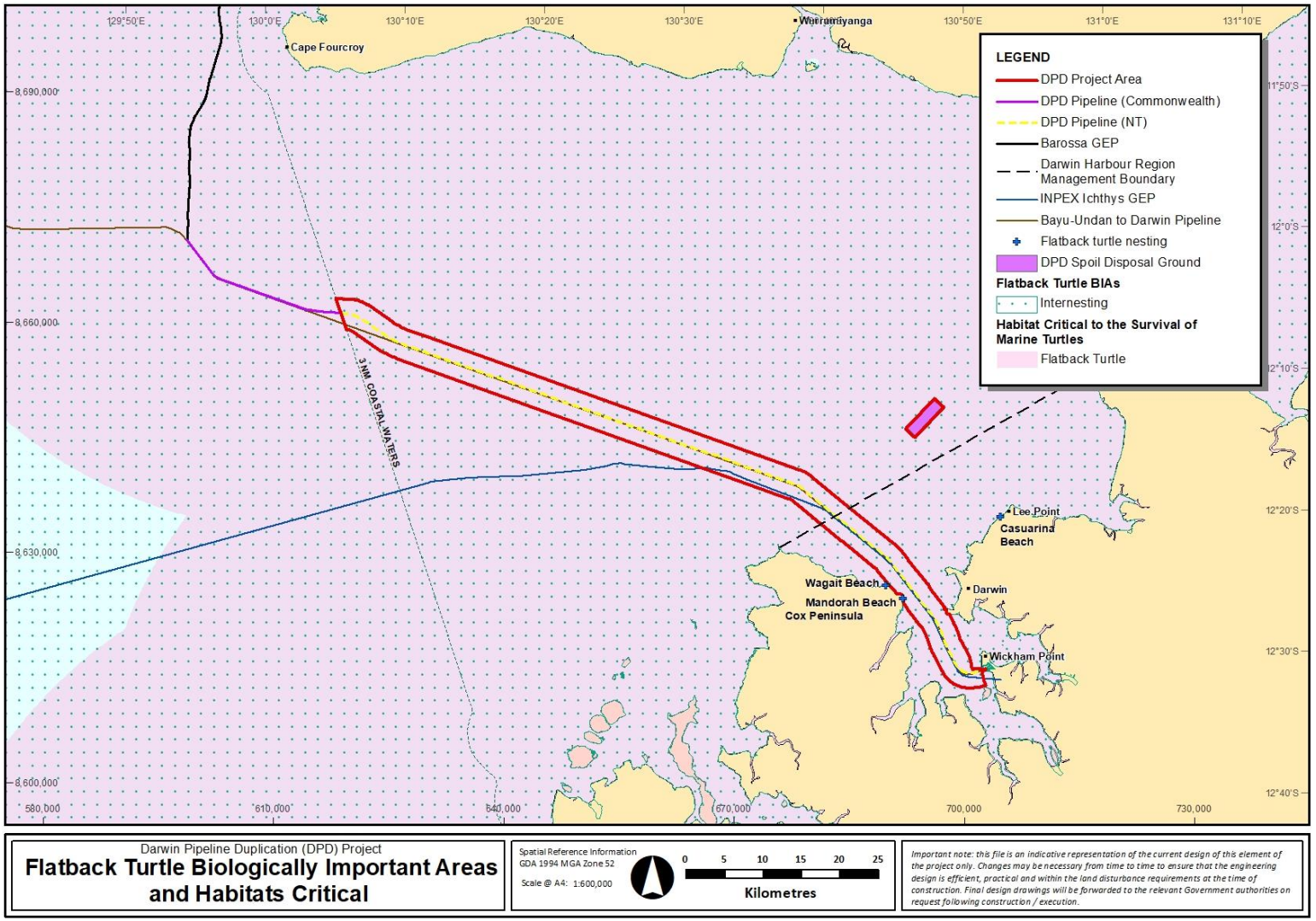


Figure 5-5: Flatback turtle BIA and Habitats Critical to survival

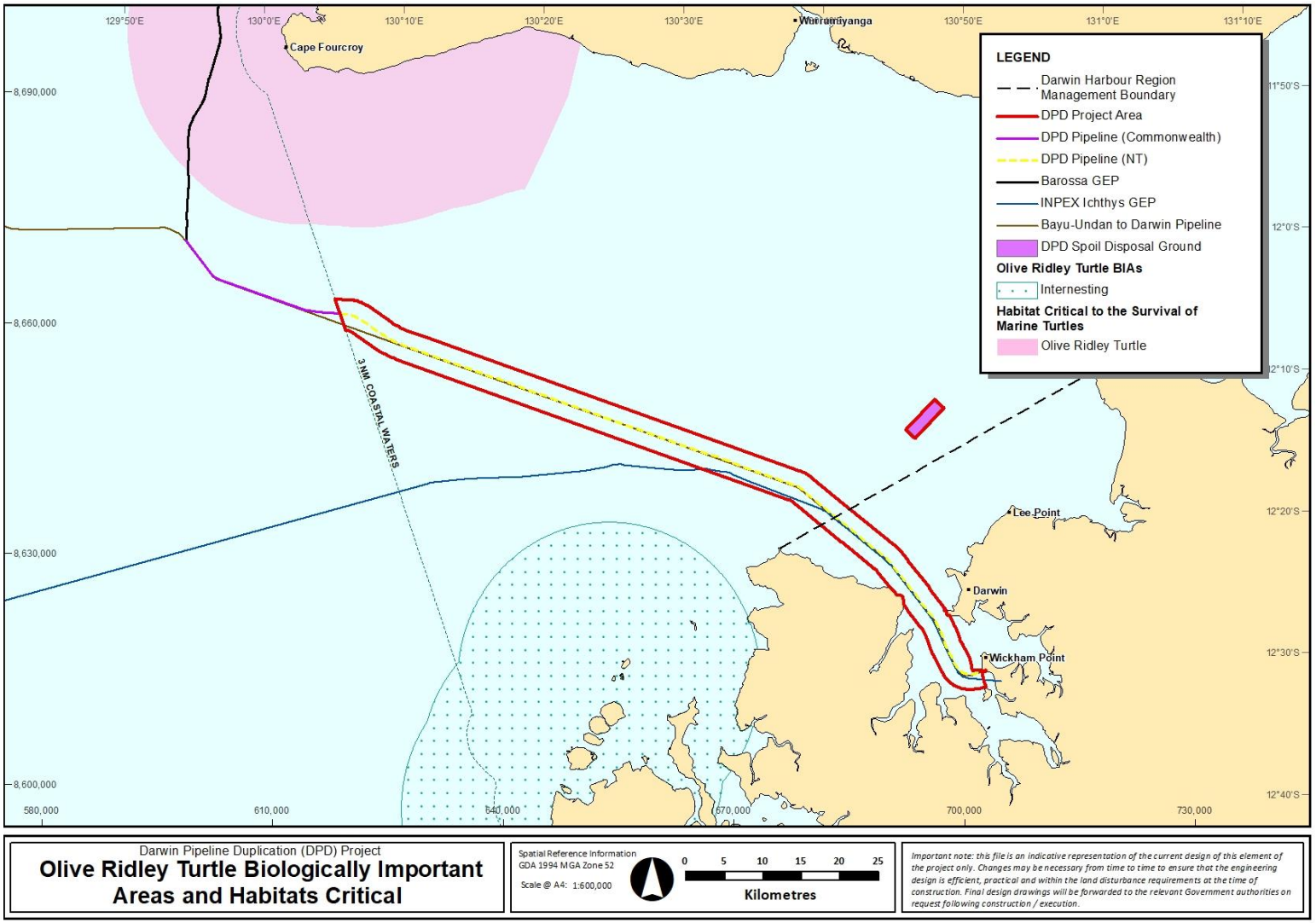


Figure 5-6: Olive ridley turtle BIA and Habitats Critical to survival

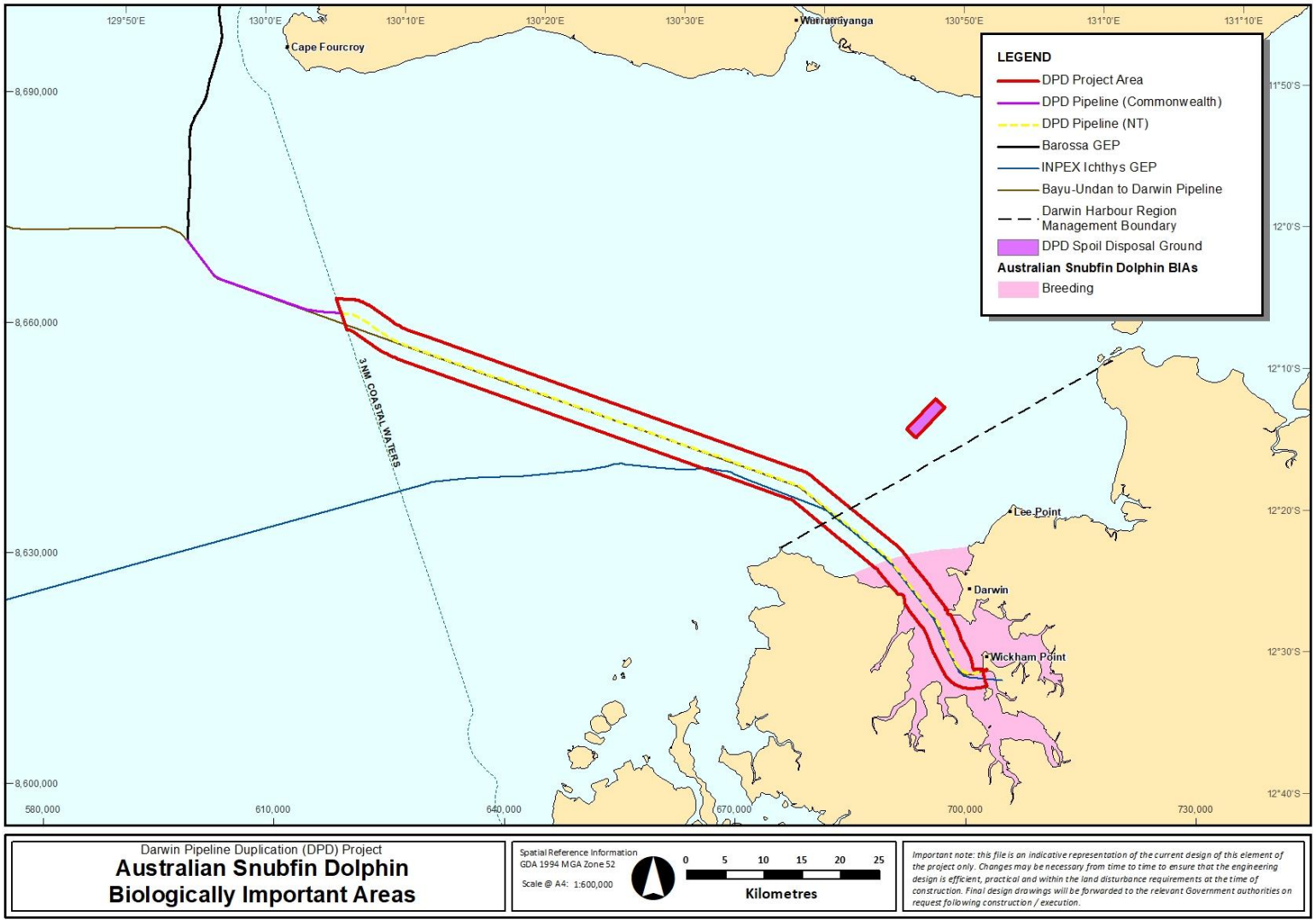


Figure 5-7: Australian snubfin dolphin BIA

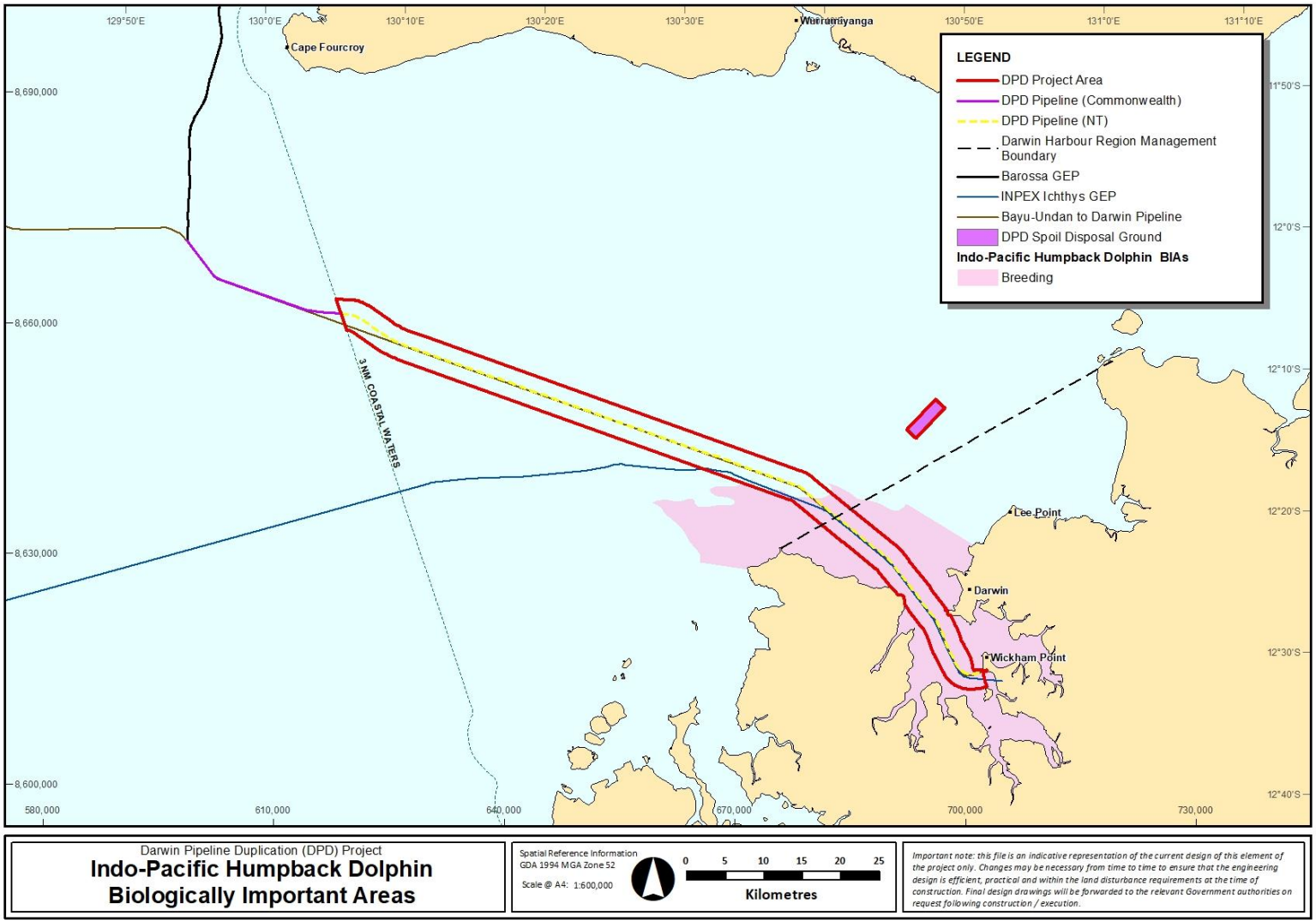


Figure 5-8: Indo-Pacific humpback dolphin BIA

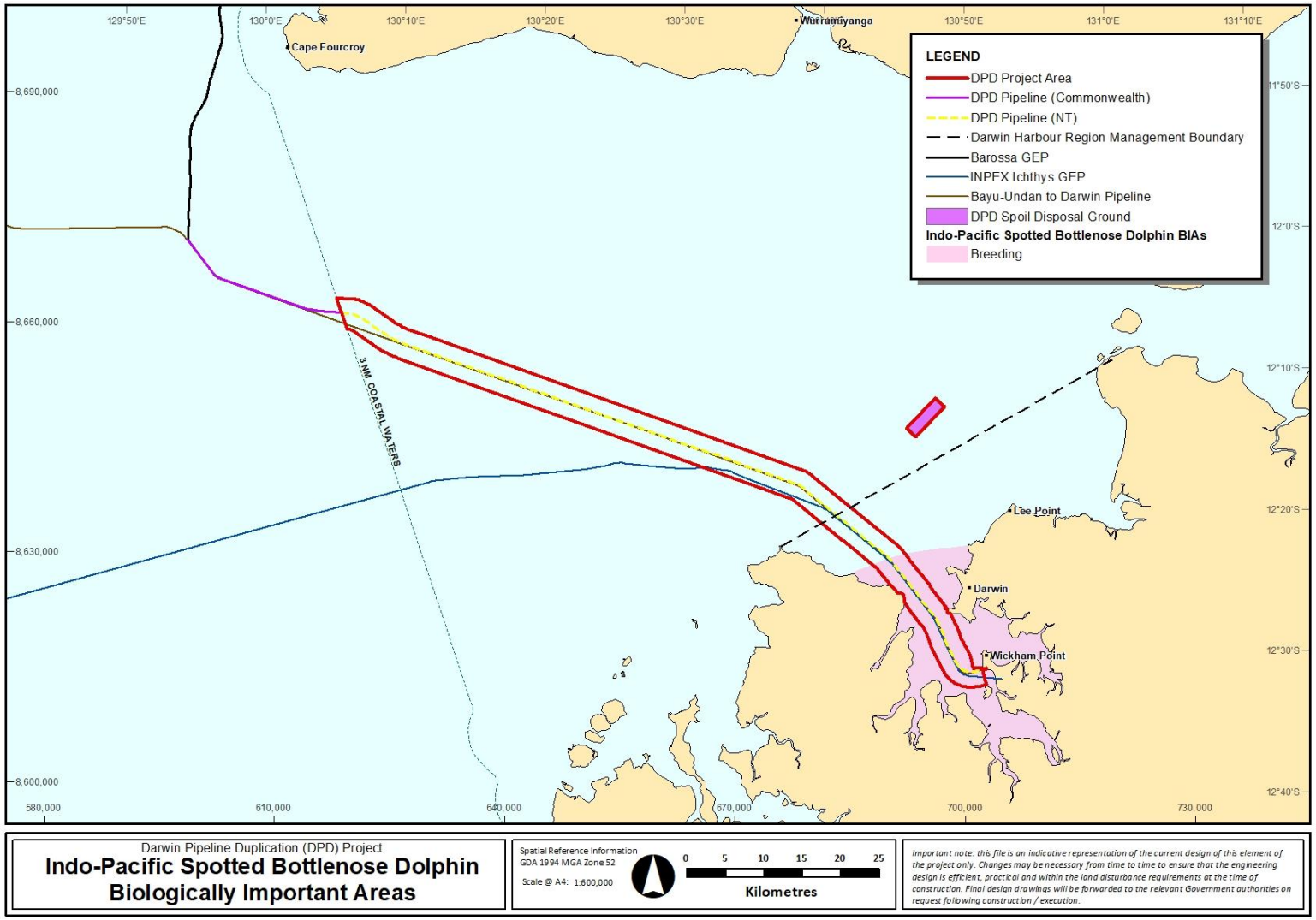


Figure 5-9: Spotted bottlenose dolphin BIA

Table 5-6: Threats from recovery plans, conservation advice and wildlife conservation plans relevant to the activity

Name	Recovery Plan/Conservation Advice/ Management Plan	Threats identified as relevant to the activity	Addressed (where relevant)
All vertebrate fauna	Threat Abatement Plan for impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (Commonwealth of Australia, 2018)	Marine debris	**Section 7.6.8** **Section 7.7.1**
Marine reptiles			
All marine turtles	National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds (Commonwealth of Australia, 2020b)	Light pollution	**Section 7.6.5**
	Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a)	Deteriorating water quality	**Section 7.6.2** **Section 7.6.5** **Section 7.6.7** **Section 7.6.9** **Section 7.7.2** **Section 7.7.3** **Section 7.7.4**
		Marine debris	**Section 7.6.8** **Section 7.7.1**
		Loss of habitat	**Section 7.6.2** **Section 7.6.9** **Section 7.7.3**
		Light pollution	**Sections 7.6.5**
		Vessel disturbance	**Section 7.6.3** **Section 7.6.6** **Section 7.7.1**
Leatherback turtle	Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008)	Boat strike	**Section 7.6.3** **Section 7.7.3** **Section 7.7.1**
Seabird and shorebirds			
All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds (Commonwealth of Australia, 2020b) Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2020c)	Light pollution	**Sections 7.6.5**
		Habitat loss and degradation	**Section 7.6.2** **Section 7.6.5** **Section 7.6.7** **Section 7.6.9**

Name	Recovery Plan/Conservation Advice/ Management Plan	Threats identified as relevant to the activity	Addressed (where relevant)
	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015)		**Section 7.7.2** **Section 7.7.3** **Section 7.7.4**
Common sandpiper	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015)	Pollution and contaminants	**Section 7.6.2** **Section 7.6.5** **Section 7.6.7** **Section 7.6.9** **Section 7.7.2** **Section 7.7.4**
		Habitat loss and degradation	**Section 7.6.2** **Section 7.6.5** **Section 7.6.7** **Section 7.6.9** **Section 7.7.2** **Section 7.7.3** **Section 7.7.4**

5.5.1.2 Marine reptiles

There are six species of marine turtle known to occur in NT waters, of these only green, hawksbill and flatback turtles are known to occur in Darwin Harbour regularly. Olive ridley and loggerhead turtles are known to occasionally occur in Darwin Harbour, and leatherback turtles are unlikely to occur in the Harbour as they are an oceanic species (Whiting, 2001; Whiting, 2003). The closest nesting sites to the Project Area are Casuarina Beach and Cox Peninsula beaches, although these are not considered significant nesting areas and Casuarina Beach is additionally a popular recreational area (Pendoley Environmental, 2022). Other more significant turtle nesting sites in the region include Bare Sand Island and Quail Island, located approximately 50 km from Darwin and over 25 km from the Project Area near the mouth of Bynoe Harbour.

5.5.1.3 Marine mammals

Dolphin species are the most recorded marine mammal in Darwin Harbour, with the Australian snubfin (*Orcaella heinsohni*), Indo-Pacific humpback (*Sousa chinensis*) and Indo-Pacific spotted bottlenose (*Tursiops aduncus*) having known populations in Darwin Harbour. There are approximately 150 individuals across all species thought to inhabit the Darwin region (Brooks & Pollock, 2015).

Dugongs (*Dugong dugon*) are also known to occur in the Darwin region. Ichthys NEMP dugong monitoring estimates approximately 180 to 300 individuals inhabit the Darwin Region (Cardno, 2014).

5.5.1.4 Other fauna

5.5.1.4.1 Bony fishes and sharks

Darwin Harbour supports an abundance of fish species across an array of habitats. There is a diverse range of species within the harbour, from small site-specific species such as gobies, cardinals, and

pipefish to larger species of recreational and commercially importance such as mackerel, trevallies, and barramundi. Barramundi is the most targeted recreational species in the Northern Territory accounting for 26% of total recreational catch; however, barramundi only accounts for 5% of total catch in Darwin Harbour. Jewfish are the most targeted species in Darwin Harbour followed by golden snapper.

Juvenile recreationally and commercially important fish species utilise mangroves within Darwin Harbour for habitat.

Three protected sawfish species listed on the PMST search results have been recorded within the Darwin Harbour region—the dwarf sawfish (*Pristis clavata*), freshwater sawfish *(Pristis pristis* or *Prisitis microdon*) and green sawfish (*Pristis zijsron*). However, they are unlikely to be encountered in the Project Area.

Whale sharks are known to migrate to Australian waters seasonally, aggregating at Ningaloo Reef and in the Coral Sea following surges in food productivity. The migratory paths of whale sharks are not known to include Darwin Harbour and records from NT coastline are anecdotal (Woinarski *et al*., 2007).

5.5.1.4.2 Seabirds and shorebirds

Of the 37 species of migratory shorebirds that regularly visit Australia (Commonwealth of Australia, 2017b; Lilleyman *et al*., 2018), 25 of them occur along the coastlines of Darwin Harbour, which has a variety of coastal habitats that migratory shorebirds use during the non-breeding season (Lilleyman *et al*., 2018). This includes natural sites such as beaches, rocky reefs, intertidal sand and mud flats, but also an artificial site – the dredge spoil disposal ponds at Darwin Port's East Arm Wharf.

Lilleyman *et al*. (2018) undertook aerial surveys of Darwin Harbour and recorded 724 individuals of 19 species of bird during the low tidal phase of the survey and at high tide recorded 789 individual shorebirds belonging to 13 species. The study was focused on the Far Eastern curlew (*Numenius madagascarensis*), two flocks of which were identified in numbers that meet the threshold for protection of threatened shorebirds under the EPBC Act. One flock was recorded at East Arm Wharf, where large congregations assemble frequently. The other flock was at a saltpan, south-east of East Arm Wharf, adjacent to the Darwin LNG Plant (although it was noted that this roosting site may not be available at the highest tides) (Lilleyman *et al*., 2018).

5.5.1.4.3 Phytoplankton

Inner Darwin Harbour is known to have low concentrations of bio-available nutrients, low light levels and high turbidity which limits the growth of phytoplankton. The large tidal range also ensures that the Harbour is well flushed. Ichthys NEMP monitoring found low biomass of phytoplankton indicated by low chlorophyll-a fluorescence, although there was a slight increase in phytoplankton biomass during the wet season compared to the dry season. This could be due to the additional nutrient input from increase rainfall and subsequent runoff. Variations in phytoplankton biomass within Darwin Harbour follows complex patterns indicating that multiple factors may influence the productivity of phytoplankton in the Harbour.

5.6 Community and economy

5.6.1 Socio-economic environment

Socio-economic activities that may occur within the Project Area and surrounds including recreational, traditional and commercial fishing, shipping, oil and gas production, defence activities and tourism, as summarised in **Table 5-7**.

More detailed descriptions of socio-economic considerations are provided in the DPD NT EPA Referral (BAA-201 0003; Santos, 2021).

Table 5-7: Summary of socio-economic activities that occur within the Project Area.

Value/ sensitivity	Description
Commercial fisheries – Commonwealth	The Northern Prawn Fishery is the only active Commonwealth managed fishery overlapping the Project Area. There are three other inactive or low operating (less than five vessels active in the fishery each year since 2005) Commonwealth managed fisheries overlapping the Project Area: Southern Bluefin Tuna Fishery, Western Tuna and Billfish Fishery and the Western Skipjack Tuna Fishery (Commonwealth of Australia, 2020d; DAFF, 2022).
Commercial fisheries – NT	There are five NT managed fisheries that intersect the Project Area: Coastal Line, Demersal, Offshore Net and Line, Spanish Mackerel, and Aquarium Fishery.
Recreational fishing	Recreational fishing does occur within the Project Area. The Darwin Harbour/Surrounds fishing zone supporting 63% of total fishing effort within the Greater Darwin Area (Matthews *et al*. 2019).
Traditional fishing	Traditional Australian Indigenous fishing in NT waters predominately occurs within inshore tidal waters. Approximately 55% of NT's coastline is owned by Traditional Aboriginal Owner groups in the Northern Land Council region (NLC, 2022).
Shipping	The closest major commercial port to the Project Area is Darwin. The Darwin Port Corporation serves multiple shipping and cargo markets, including cruise and naval vessels, livestock exports, dry bulk ore, offshore oil and gas rig services, and container and general cargo. The Australian Maritime Safety Authority (AMSA) shipping routes close to the Project Area are shown in **Figure 5-12**.
Tourism	Within Darwin Harbour common tourism/recreational activities include fishing, boating, scuba-diving, sailing, water-skiing, and beach use.
Defence	The Project Area intersects a Central Defence Practice Area of the Darwin Air Weapons Range (AWR), a maritime military zone administered by the Department of Defence. The Project Area is also nearby to the Australian Exercise Area (NAXA) Defence Training Area approximately 3km to the South
Petroleum industry	Several offshore petroleum projects are in operation and there is considerable exploration activity within the NMR; however, only the existing INPEX Ichthys and Santos Bayu-Undan to Darwin gas export pipelines overlap with the Project Area.
Aboriginal heritage	There are four registered/recorded sacred sites within Darwin Harbour within or adjacent to the Project Area: three rocky areas and shoals on the western side of the Harbour and an underwater sand and rock bar outside the mouth of the Harbour, north of Cox Peninsula. Santos has received an Authority Certificate from the AAPA for the DPD Project (Authority Certificate C2022/098) and will abide by conditions of the certificate.
Maritime heritage	Five historic shipwrecks listed under the *Underwater Cultural Heritage Act 2018* (Commonwealth) are overlapped by the Project Area: I-124 Japanese Submarine (1942) 800 m radial protection zone, Yu Han 22 unlisted protection zone, Song Saigon (1982) unlisted protection zone, Mauna Loa USAT (1942) 100 m radial protection zone and Meigs USAT (1942) unlisted protection zone (DCCEEW, 2022b). Santos has undertaken maritime heritage surveys within the Project Area to determine the presence of additional maritime heritage objects and will apply measures to ensure these are not impacted.

5.6.1.1 Commercial fishing and aquaculture

5.6.1.1.1 Commonwealth fisheries

The Northern Prawn Fishery is the only active Commonwealth managed fishery that overlaps the Project Area (Santos, 2021). The Commonwealth managed Southern Bluefin Tuna Fishery, the Western Tuna and Billfish Fishery and the Western Skipjack Tuna Fishery overlap with the Project Area but have been excluded from assessment as these fisheries are either inactive or operate at extremely low levels (<5 vessels active each year since 2005) within or nearby the Project Area (DAFF, 2022; Santos, 2021).

5.6.1.1.2 Northern Territory fisheries

Northern Territory managed fisheries include the Aquarium Fishery, the Offshore Net and Line Fishery, the Spanish Mackerel Fishery, the Coastal Line Fishery, and the Demersal Fishery (Santos, 2021). The Aquarium Fishery includes freshwater, estuarine, and marine habitats to the outer boundary of the Australian Fishing Zone (AFZ), which is 200 nm offshore (Santos, 2021). The Offshore Net and Line Fishery and the Spanish Mackerel Fishery extend from the high water mark of NT waters to the outer boundaries of the AFZ (Santos, 2021). The Demersal Fishery extends 15 nm from the NT low water mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery (Santos, 2021). The Coastal Line Fishery extends seaward from the high water mark to 15 nm from the low water mark, covering the entire NT coastline (Santos, 2021).

The Aquarium Fishery is a small-scale, multi-species fishery that is active within the Project Area (Santos, 2021). Licencees employ several types of nets, hand pumps, freshwater pots, and hand-held instruments to collect specimens. The fishery supplies local, interstate, and international pet retailers and wholesalers, including aquarium fishes (mostly rainbowfish, catfish, scats), invertebrates (hermit crabs, snails, whelks, and hard and soft corals) and plants.

The Offshore Net and Line Fishery permits the use of pelagic gillnets and longline gear (Santos, 2021). Pelagic gill nets are the primary gear utilised and are generally set within 15 nm of the coast (Santos, 2021). Most fishing effort is within 12 nm of the coast and immediately offshore in the Gulf of Carpentaria (Northern Territory Government, 2022b). The fishery targets Australian blacktip sharks (*Carcharhinus tilstoni*), common blacktip sharks (*C. limbatus*) and grey mackerel (*Scomberomorus semifasciatus*), other shark species (i.e. hammerhead, bull, tiger, pigeye, lemon, winghead and dusky whalers) and finfish (i.e. Spanish mackerel, longtail tina, black pomfret) are also caught by the fishery (Northern Territory Government, 2021). There is potential for fishing to overlap with the Project Area; however, stakeholder consultation conducted by Santos (2021) only identified one licence holder that may fish off the south-west end of the Tiwi Islands.

The Spanish Mackerel Fishery permits the use of troll lines, floating handlines, and rods, solely targeting Spanish mackerel (*Scomberomorus commerson*) (Santos, 2021). Most of the fishing effort occurs around reefs, headlands, and shoals off the western and eastern mainland coast and near islands including Bathurst Island, Groote Eylandt, and the Wessel Islands (Northern Territory Government, 2021). In 2012, there were 16 fishery licences with 12 actively operating (Santos, 2021). There is potential for fishing to occur close to or within the Project Area. Stakeholders have advised during stakeholder consultation by Santos (2021), that there is potential for fishing to occur within the southern extent of the original Barossa GEP (Santos, 2021).

The Coastal Line Fishery permits the use of a variety of gear types including rod and line, hand lines, cast nets (for bait only), scoop nets and gaffs (Northern Territory Government, 2016a). Drop lines and five fish traps are permitted beyond 2 nm from the coast; however, fish traps are only permitted in the Eastern zone of the fishery (Northern Territory Government, 2016b). Black jewfish and golden snapper are the main targeted species of the fishery, although emperor, cod and other snapper species are

caught as bycatch. Fishing effort is concentrated within nearshore waters, therefore there is potential for fishing to occur within or close to the nearshore Project Area.

The Demersal Fishery permits the use of fish traps, hand lines, droplines, and semi-demersal trawl nets (Northern Territory Government, 2022). It is important to note that semi-demersal trawl nets are only permitted in two defined multi-gear areas (Northern Territory Government, 2022). Trap catch is mainly goldband snapper and red snapper with red emperor and cod caught as bycatch (Northern Territory Government, 2022). Trawl catch is mainly saddletail snapper and crimson snapper with painted sweetlip, redspot emperor and goldband snapper caught as bycatch. There are 18 licences currently issued for the fishery (Santos, 2021). Most fishing effort occurs within deep offshore waters along the Timor Reef Fishery eastern boundary in water depths 80 – 100 m, therefore there is low potential for fishing to overlap with the Project Area.

Most fisheries are not permitted to operate within Darwin Harbour, except for the Coastal Line Fishery and Aquarium Fishery (DPIR, 2015). Therefore there is little to no commercial fishing taking place within Darwin Harbour.

The Darwin Aquaculture Centre is located on Channel Island in the Middle Arm Peninsula. It is a research facility undertaking a range of research and development projects on several species including pearl oysters, sea cucumbers, giant clams, prawns, barramundi, mud crabs, reef fish, as well as undertaking several disease investigations (Northern Territory Government, 2018).

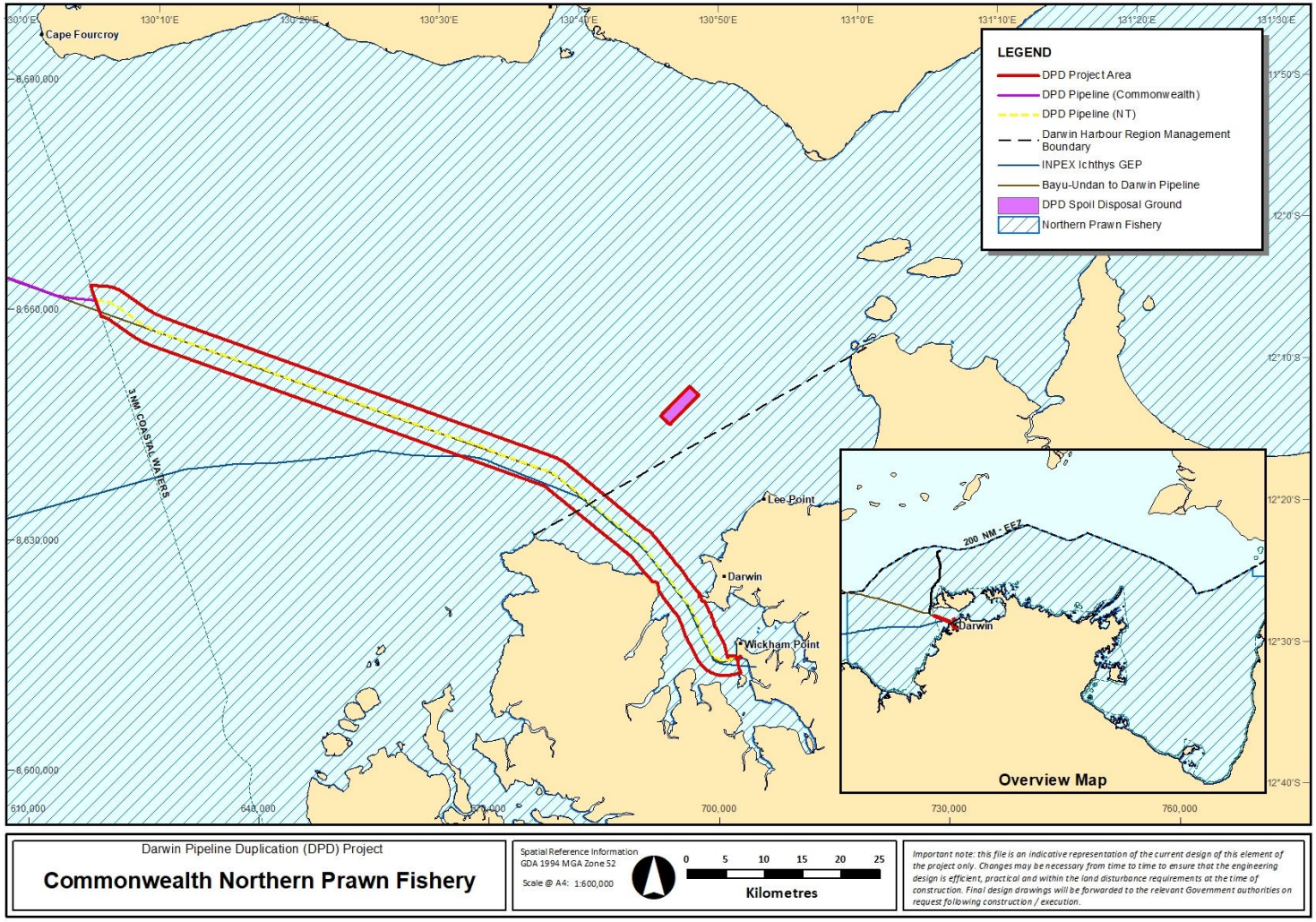


Figure 5-10: Commonwealth managed Northern Prawn Fishery

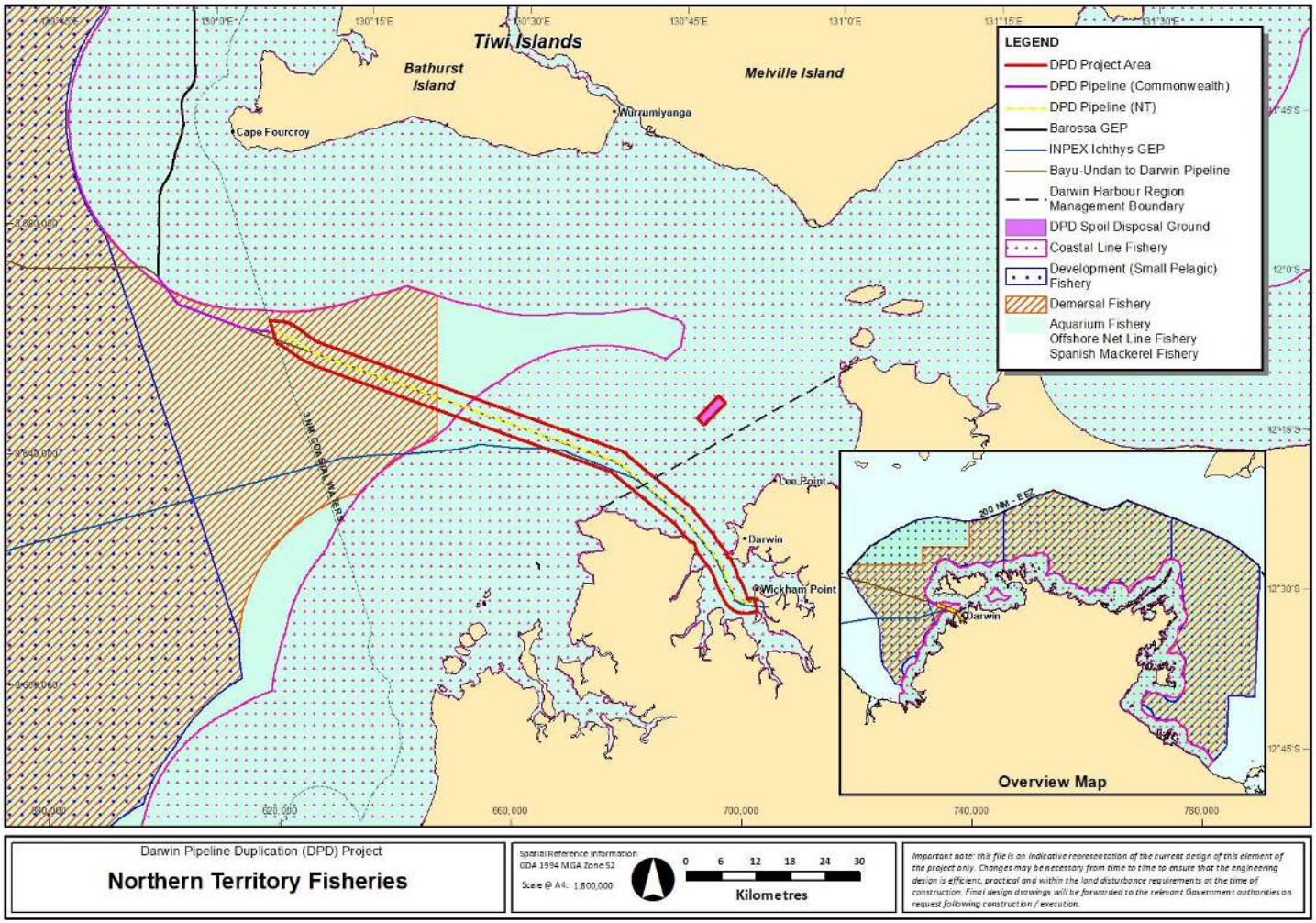


Figure 5-11: Northern Territory managed commercial fisheries

5.6.1.2 Shipping

Vessel traffic data from the AMSA Marine Traffic Database (AMSA, 2021) for the Project Area during March 2021 is shown in **Figure 5-12**, which shows the Project Area intersects areas of high shipping traffic.

Shipping traffic in the offshore NT waters of the Project Area is relatively light; however, at the approach to Darwin Harbour, and within the harbour itself, several notable shipping traffic lanes converge to create a high-density shipping traffic area that overlaps with the Project Area.

The Port of Darwin recorded 1,510 trading vessel visits in 2021-2022 (Darwin Port Authority, 2022) with traffic in the Port typically influenced by number of the well-established industrial and commercial facilities that receive a wide of maritime traffic (i.e. cargo, livestock vessels, LNG tankers and cruise ships).

Whilst 61 cruise ships visited Darwin Port in 2020-21, with the majority travelling between South East Asia and the eastern coast of Australia, this number dropped significantly with the onset of the Covid-19 pandemic with 36 cruise ships recorded in 2021-22. Regional commercial shipping activities are also associated with support and supply vessels servicing oil and gas offshore facilities. For example, in 2021-22, there were 283 rig tender vessel calls to Darwin Port facilities. The Port forms the main base for oil and gas contracted supply vessels that support northwest Australia offshore activities (Darwin Port Authority, 2021).

Although Darwin Port remains the primary active port in the region, there is small-scale port activity at the Tiwi Islands. Port Melville is located on Melville Island (122 km north of Darwin) and the wharf infrastructure at Port Melville was constructed in 2013. Shipping traffic associated with the route between Darwin Port and the Tiwi Islands, including Port Melville, is shown in **Figure 5-12**.

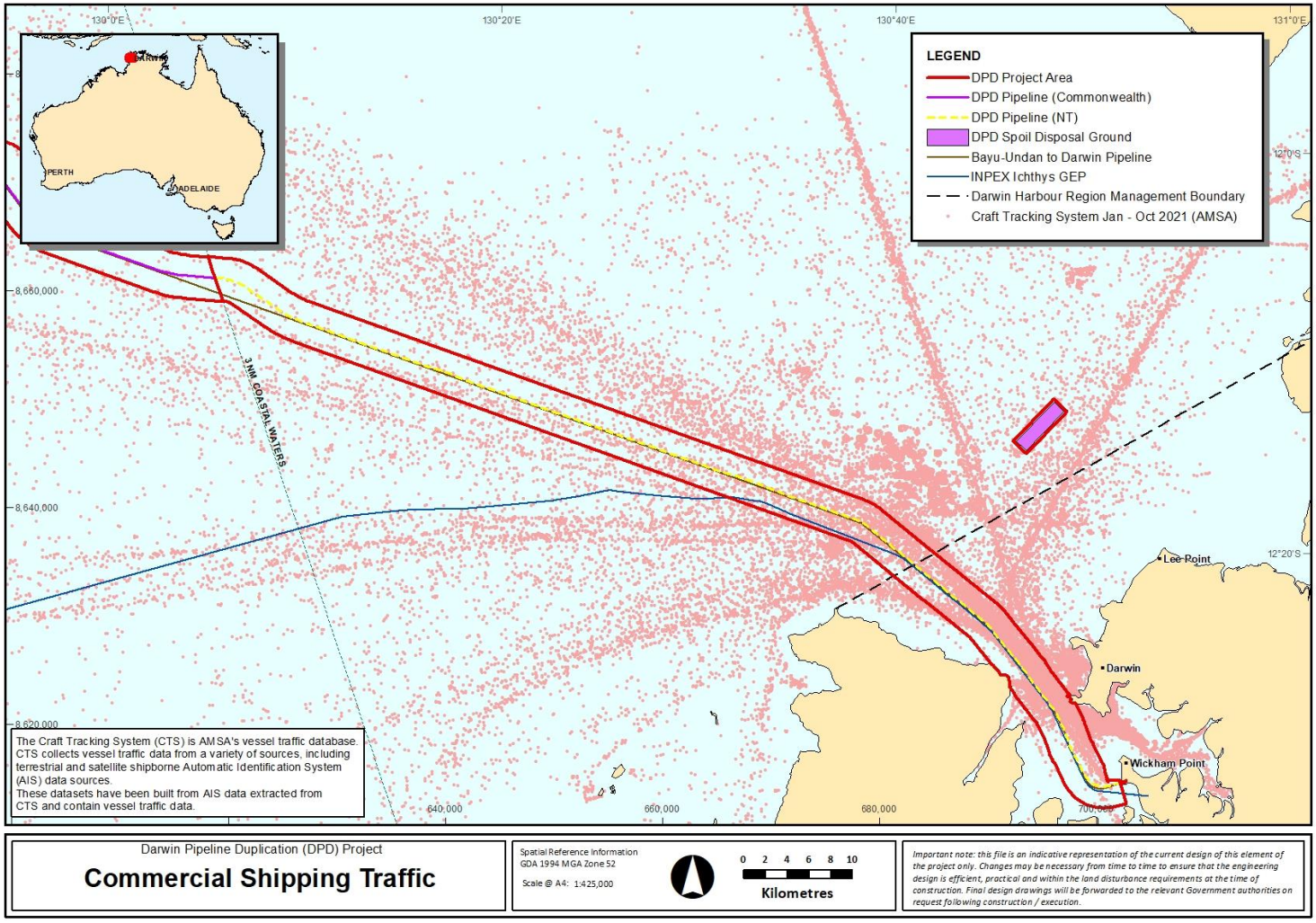


Figure 5-12: Commercial shipping traffic

5.6.1.3 Recreational activities and tourism

During 2021 there were 1,283,000 visitors to the Northern Territory, which contributed an estimated $1.84 billion to the local community (Tourism NT, 2022). This was substantially lower than 2019, with 2,001,000 visitors contributing an estimated $2.6 billion, likely due to the reduction in international visitation resulting from border closures (Tourism NT, 2022).

The Darwin Harbour supports a range of commercial and recreational uses, including fisheries, tourism and recreational shipping and boating activities. Fishing tours often frequent Fenton Patches located approximately 30 km north-west of Darwin Harbour. Recreational fishers also visit Casuarina Bay and Lee Point.

The water surrounding Middle Arm Peninsula is used for recreational fishing, sailing, and boating. However, tour boats tend to avoid this section of the Harbour due to navigational hazards associated with the shallow nearshore waters (URS, 2002).

5.6.1.4 Traditional fishing

Approximately 55% of NT's coastline is owned by Traditional Aboriginal Owner groups in the Northern Land Council region (NLC, 2022). Several areas within this coastal region have been declared Aboriginal sacred sites, which are restricted from other recreational and commercial fishing. Within Darwin Harbour, fishing and foraging for food and other resources occurs within the intertidal regions, mainly around Nightcliff, Coconut Grove, Kululuk, Sadgroves Creek, and Lee Point. As such, Indigenous fishing is likely to occur within the coastal areas of the Project Area but is likely to be restricted mainly to NT coastal waters.

5.6.1.5 Defence

A search on National Map (DCA, 2021) was undertaken and identified that the Project Area intersects the Darwin Air Weapons Range (AWR) Central Defence Practice Area and is nearby to the Australian Exercise Area (NAXA) Defence Training Area (approximately 3 km to the south), as shown in **Figure 5-13**.

5.6.1.6 Petroleum industry

Several offshore petroleum projects are in operation and there is considerable exploration activity within the NMR.

The Project Area contains two existing gas export pipelines (GEPs), the Bayu-Undan to Darwin GEP (approx. 50-100 m to the west of the proposed DPD Project pipeline route) and the INPEX Ichthys GEP which is further to the west of the Bayu-Undan to Darwin GEP (**Section 2.2**).

The two primary LNG facilities on Middle Arm Peninsula are the DLNG Facility operated by Santos, and the Ichthys LNG Project operated by INPEX. The Project pipeline will connect into the existing DLNG Facility and the Project Area overlaps the DLNG Facility.

The DLNG Facility is a gas processing facility which includes units for:

+ Gas receiving facilities (including the beach valve, pig receiver and meter station for the Bayu-Undan to Darwin pipeline)
+ Acid gas removal
+ Dehydration and mercury removal
+ Propane and ethylene refrigeration
+ Liquefaction, methane compression and nitrogen rejection.

There are several exploration and production permits and leases throughout the NT and Commonwealth waters adjacent to the Project Area, which include current exploration and production activities including platforms, FPSO (floating, production, storage and offloading) vessels, pipelines, and drilling.

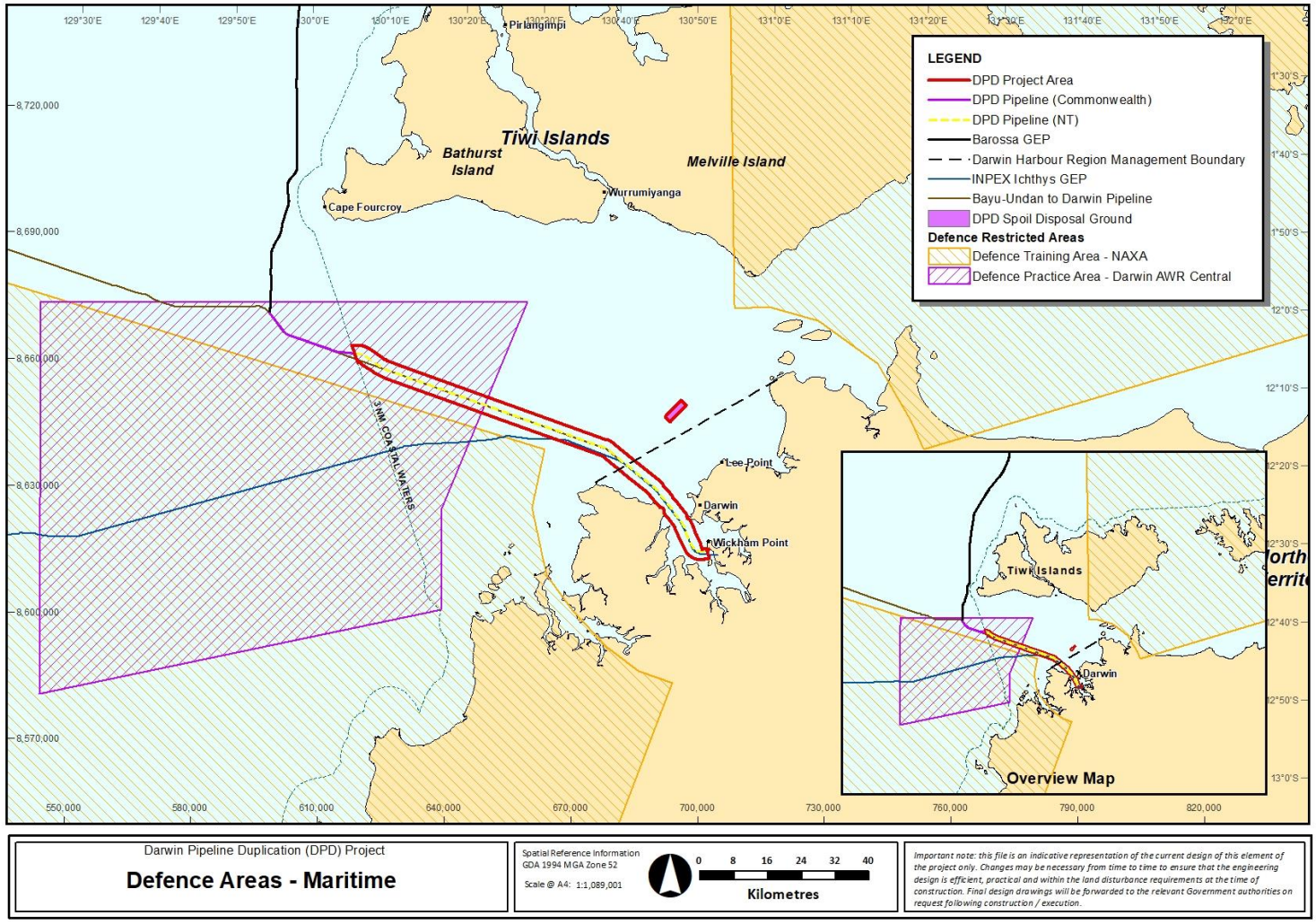


Figure 5-13: Defence areas – maritime

5.6.2 Culture and heritage

5.6.2.1 Cultural environment

Darwin Harbour is host to a wide range of historical, spiritual and heritage values that are significant to the people of the Northern Territory and Australia. These values have been broadly categorised as either Aboriginal and non-Aboriginal values and are described in more detail in the following **Sections 5.6.2.1.1** and **5.6.2.1.2**. Further detail of the cultural environment can be found in Santos' NT EPA referral (Santos, 2021).

5.6.2.1.1 Aboriginal sacred sites

Sacred sites are places within the landscape that have a special meaning or significance under Aboriginal tradition, this can include hills, rocks, waterholes, trees, plains, lakes, billabongs (AAPA, 2022). There are many sacred sites within Darwin Harbour and the surrounding waters, all sacred sites within the Northern Territory are protected under the *Northern Territory Aboriginal Sacred Sites Act 1989*. In coastal and sea areas, sacred sites may include features which lie both above and below the water (AAPA, 2022). Sacred sites are surrounded by "restricted works" areas in which no land or maritime development works of any kind is allowed, under the *Northern Territory Aboriginal Sacred Sites Act 1989*.

There are sacred sites within Darwin Harbour that are adjacent to or overlap the Project Area (INPEX, 2010). These sites as identified in INPEX (2010), include rocky areas or shoals on the western side of the Darwin Harbour, and an underwater sand and rock bar at the mouth of the harbour, north of the Cox Peninsula (**Figure 5-14**).

Santos has received an Authority Certificate from AAPA for the DPD Project (Authority Certificate C2022/098) and will ensure conditions of the certificate and the requirements of the *Northern Territory Aboriginal Sacred Sites Act 1989* are met. Refer to (**Figure 5-15**) for subject lands and restricted works areas.

5.6.2.1.2 Non-Aboriginal heritage sites

Darwin Harbour is host to several shipwrecks and sunken aircraft, some of which are protected under the *Heritage Act 2011* (NT) and/or the *Underwater Cultural Heritage Act 2018* (Commonwealth) (**Figure 5-16**). Most wrecks are associated with either, the bombing of Darwin in 1942 or Cyclone Tracy in 1974. The Project Area is within ~2 km east of the oldest known wreck in Darwin Harbour the *SS Ellengowan*, a nineteenth-century Norwegian-built iron steamer, which is of high significance to maritime archaeology (Northern Territory Government, 1999; **Figure 5-16**).

The *Underwater Cultural Heritage Act 2018* may declare a protected zone around wrecks which require a permit to enter, there are currently three protected zones having closed water orders in NT. These are the Japanese submarine I-124 (1942), Florence D (1942) and Sanyo Maru (1937) (**Figure 5-16**). The regional harbourmaster has also ordered the Booya and Catalina 6 wrecks to have closed water controls over them and permission from the Heritage Branch is needed to enter the zones.

The Australian National Shipwrecks Database has identified five historic wrecks that overlap the Project Area, all of which are listed under the Underwater Cultural Heritage Act (DCCEEW, 2022b). These wrecks are the Japanese submarine I-124 (1942) 800 m radial protection zone, Yu Han 22 unlisted protection zone, Song Saigon (1982) unlisted protection zone, Mauna Loa USAT (1942) 100 m radial protection zone and Meigs USAT (1942) unlisted protection zone (DCCEEW, 2022b). The pipeline route has been deliberately altered to avoid the I-124 and Mauna Loa USAT wrecks.

No European heritage is currently listed at Wickham Point, with the remnants of artefacts documented and removed prior to the construction of the DLNG facility. There are no World, National or Commonwealth Heritage places within or near the Project Area.

Santos has engaged the services of a maritime archaeologist (Cosmos Archaeology) to undertake an underwater heritage assessment of the pipeline route and surrounding buffer and will work with the Heritage Branch of the NT Department of Territory Families, Housing and Communities to ensure disruption to underwater heritage objects are avoided or minimised as far as practicable and that requirements of the *Heritage Act 2011* are met.

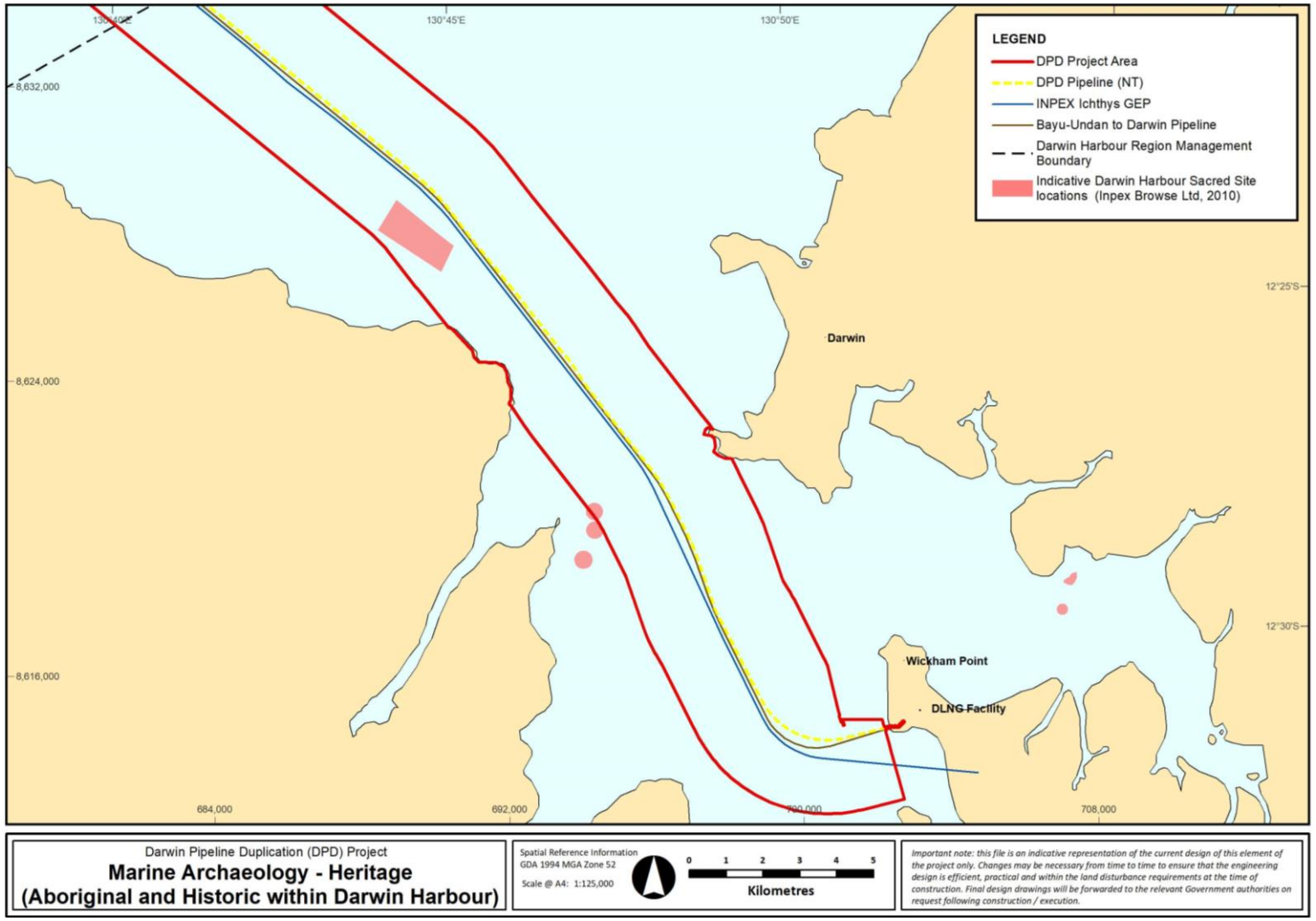


Figure 5-14: Aboriginal sacred sites located within Darwin Harbour (INPEX, 2010)

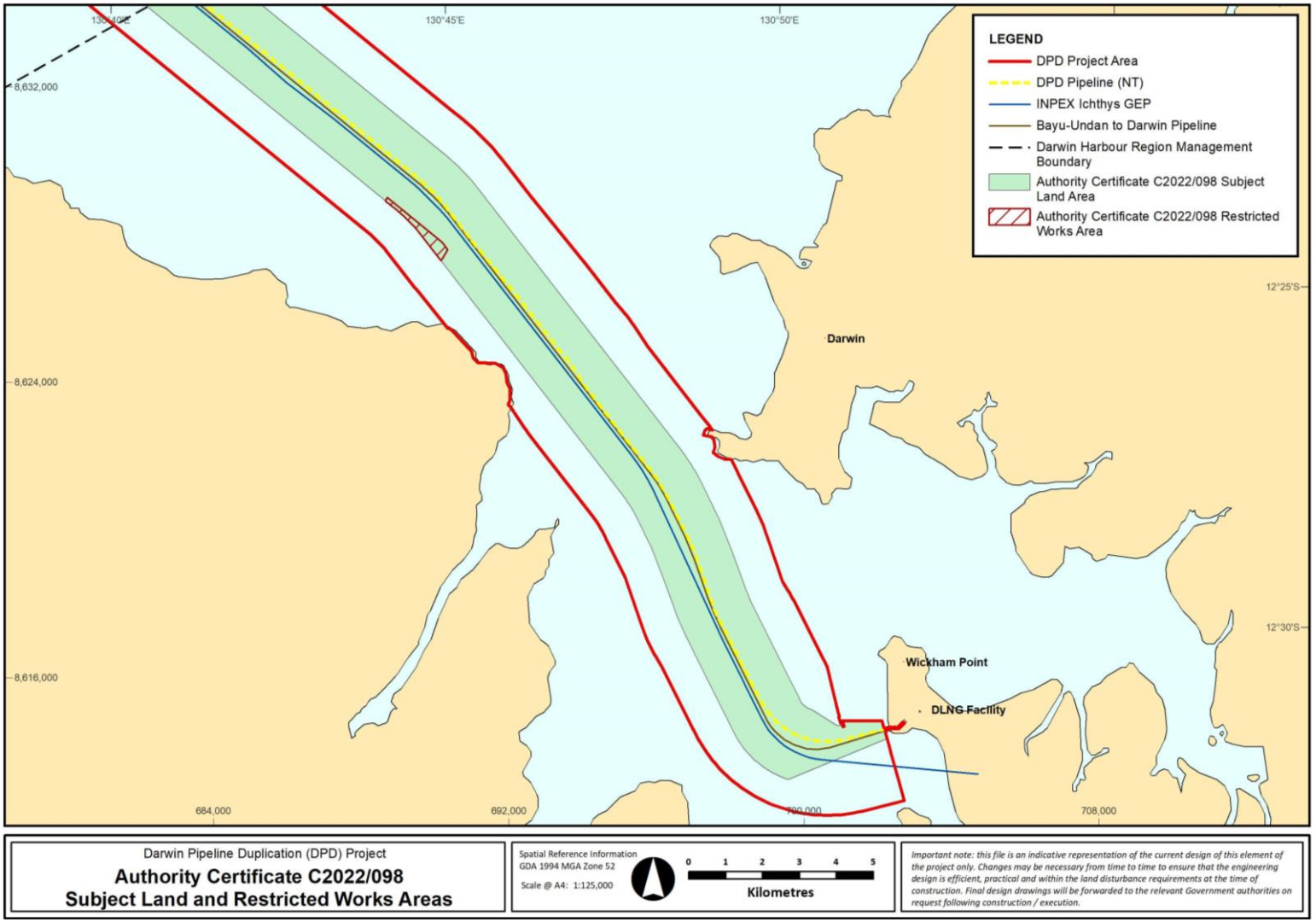


Figure 5-15: Authority Certificate C2022/098 subject land and restricted work areas

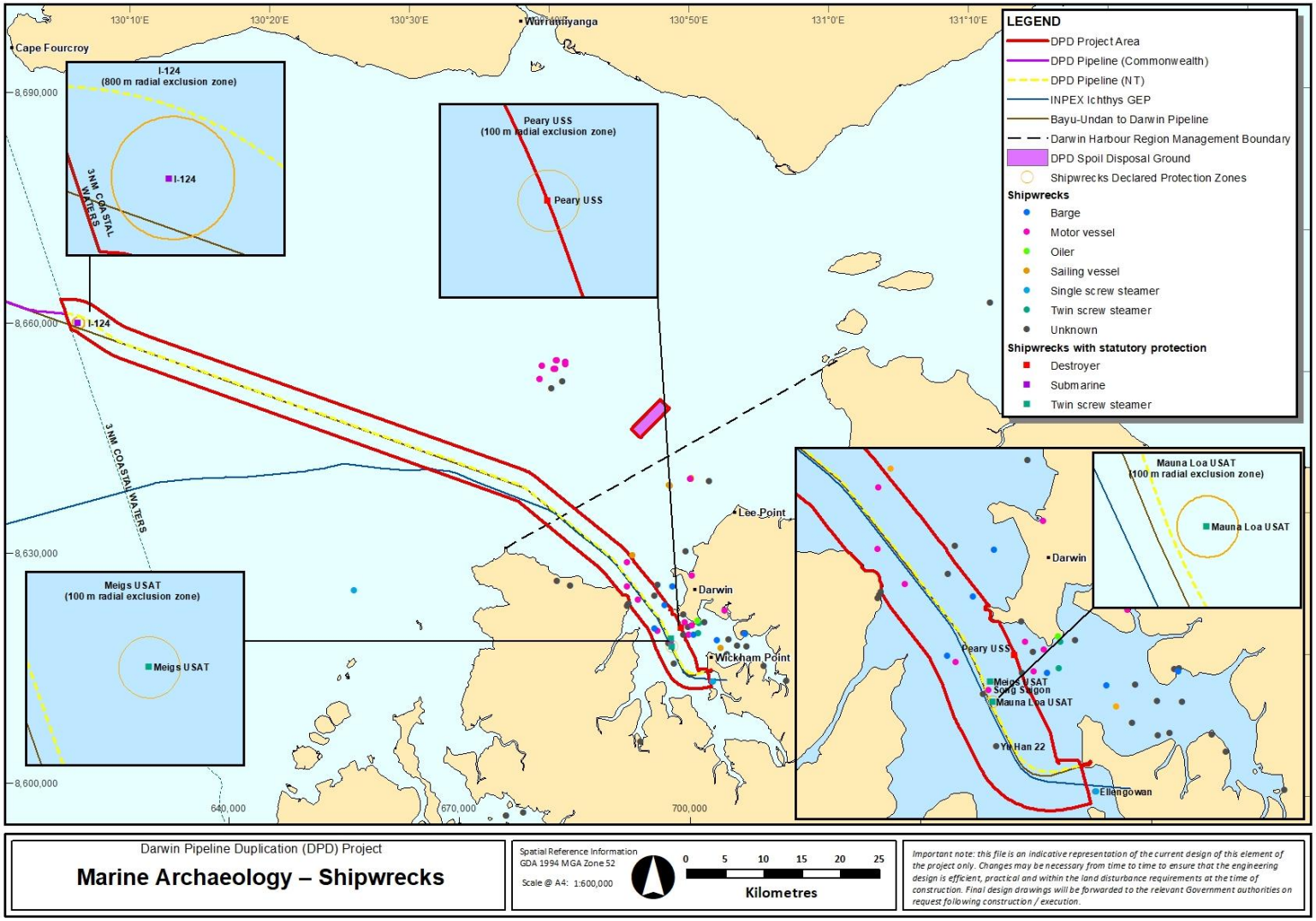


Figure 5-16: Shipwreck locations within and adjacent to Darwin Harbour

5.7 Windows of sensitivity

Timing of peak activity for threatened species and other sensitive receptors is outlined in **Table 5-8**.

Table 5-8: Windows of sensitivity in the vicinity of the Project Area

Key	
	Peak activity, presence reliable and predictable
	Lower level of abundance/activity/ presence
	Very low activity/presence
	Activity can occur throughout year
Footnotes	
[1] The 'run-off' is towards the end of the wet season and is the peak Barramundi fishing season for recreational fishers (https://northernterritory.com/things-to-do/outdoor-activities/fishing/fishing-seasons/the-run-off)	
[2] Chatto & Baker (2008)	
Socio-economic	
Receptors (critical lifecycle stages)	
Northern Prawn Fishery	
Oil and gas	
Seagrass	
Shipping	
Coral (spawning periods)	
Tourism/recreational	
Larger Macroalgae	
Turf Algae	Build-up season
Mangroves (increased productivity)	
Other benthic and terrestrial habitats	
Fish/sharks and fisheries species	
Barramundi	'The Run-Off'[1]
Goldband snapper	Spawning / Spawning
Black jewfish	Spawning
Grey mackerel	Spawning
Narrow-barred Spanish mackerel	Spawning
Marine mammals	
Dugong (breeding)	Breeding / Breeding
Australian snubfin Dolphin	Breeding
Indo-Pacific Humpback Dolphin	Breeding
Spotted Bottlenose Dolphin	Breeding
Marine reptiles	
Hawksbill turtle (resident adult and juveniles[2])	Widespread throughout North Australian waters, highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines, etc.)
Flatback turtle (resident adult and juveniles[2])	Widespread throughout North Australian, increased density over soft bottom habitat 10 to 60 m deep, post-hatchling age classes and juveniles spread across shelf waters
Flatback turtle (nesting[2])	
Green turtle (resident adult and juveniles[2])	Widespread throughout North Australian, highest density associated with seagrass beds and macro algae communities, high-density juveniles in shallow waters off beaches, among mangroves and in creeks
Loggerhead turtle (resident adult and juveniles[2])	Widespread throughout the North Australian, increased density associated with soft bottom habitat supporting their bivalve food source, juveniles associated with nearshore reef habitat

6 Impact and risk assessment

This CEMP has employed a systematic impact and risk assessment process for the environmental management of the DPD Project construction activities. The impact and risk assessment process has been developed in line with Santos' Environmental Impact Identification (ENVID) process and is consistent with the requirements of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 for NT waters and the NT EPA Draft Guideline for the Preparation of an Environmental Management Plan (NT EPA, 2015).

6.1 Conceptual site model

A conceptual site model, as required by the NT EPA, is a written or illustrated representation of the nature, fate and transport of discharges, wastes or contaminants that allows assessment of potential and/or actual exposure of the environment to contaminants (NT EPA, 2015). The Conceptual Site Model for this CEMP is embedded within the risk assessment which details receptors and pathways, refer **Table 6-7**.

6.2 Impact and risk assessment methods

The CEMP environmental impact and risk assessment was performed consistent with the Santos' Risk Matrix Procedure (SMS-LRG-OS01-TP02) and identification of management actions was consistent with Santos' Environment Hazard Controls Procedure (SMS-EXA-OS01-PD02). An environmental aspect, for the purpose of this environmental management plan, is defined as characteristics of the construction activities that could potentially affect the environment.

6.2.1 Identification of environmental hazard

Environmental hazards for this CEMP were identified using Santos' DPD Project NT EPA Referral (BAA-201 0002; Santos, 2021), DPD Project Basis of Approval (BAS-210 0005; Santos, 2022) and discussion by the DPD Project team and environmental specialists. Key DPD Project construction activities and associated hazards and results from key technical studies were presented during ENVID workshops to inform the impact and risk assessment process.

6.2.2 Standard controls

The standard controls identified in **Table 6-7** were drawn from:

+ Santos' DPD Project NT EPA Referral (BAA-201 0002; Santos, 2021)
+ Santos' environmental plans and procedures for similar activities
+ Regulator approved management plans developed by other proponents.

Additional controls were provided by ENVID workshop attendees based on their relevant experience.

6.2.3 Impact and risk assessment

All hazards identified were assigned a consequence level following the six levels and criteria outlined in Santos' Risk Matrix Procedure (SMS-LRG-OS01-TP02). More detailed criteria were developed to assist in addressing NT EPA Key Environmental Factors. These are the NT EPA consequence descriptors shown in **Table 6-1**.

The consequence is defined as the resulting impact from an event occurring. Consequence level for this assessment was based on the credible worst-case scenario and assumed no management actions were in place. Categories of environmental consequence and detailed definitions of each severity level are outlined in **Table 6-2**.

The likelihood can be described as the probability that the described consequence will occur. When determining the likelihood of consequences, proposed prevention and mitigation controls identified to mitigate potential impacts were considered. A detailed description of likelihood levels is outlined in **Table 6-3**.

A likelihood level was only assigned to unplanned events as per the Santos Risk Matrix Procedures (SMS-LRG-OS01-TP02), shown in **Table 6-4.** The consequence and likelihood for each impact was then assessed to determine the residual risk that remained after proposed standard controls were considered.

Table 6-1: NT EPA Consequence Descriptors

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Consequence Level Description		**Negligible** No impact of negligible impact	**Minor** Detectable but insignificant change to local population, industry or ecosystem factors Localised effect	**Moderate** Significant impact to local population industry or ecosystem factors	**Major** Major long-term effect on local population industry or ecosystem factors	**Severe** Complete loss of local population industry or ecosystem factors AND/OR extensive regional impacts with slow recovery	**Critical** Irreversible impacts to regional population industry or ecosystem factors
Environmental Receptors	**Marine Ecosystems** Fauna, habitat, conservation significant areas and ecological function, processes and integrity	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle/ vales of a protected area. No introduction of disease and no reduction in habitat area/function.	Detectable but insignificant decrease in local population size and threat to local population viability. Insignificant disruption to the breeding cycle of local population / area of occupancy of species / loss of habitat critical to survival of a species/ values of a protected area. Detectable but insignificant loss of area/function of habitat with rapid recovery within 2 years.	Moderate. Significant decrease in local population size but no threat to overall population viability. Significant behavioural disruption or disruption to the breeding cycle of local population / Significant reduction in area of occupancy of species / loss of habitat critical to survival of a species. Modify, destroy, remove or decrease availability of quality habitat to the extent that a long-term decline in local population or function of habitat is likely with recovery over medium term (2-10 years) Introduction of disease likely to cause significant population decline	Long term decrease in local population size and threat to local population viability. Major disruption to the breeding cycle of local population / area of occupancy of species / loss of habitat critical to survival of a species/ values of a protected area Fragmentation of existing population / Loss or change of habitat to the extent that a long-term decline in local population and function of habitat is likely with slow recovery over decades Introduction of disease likely to cause long term population decline	Complete loss of local population, habitat critical to survival of local population or protected area/conservation significant area Widespread (regional) decline in population size or habitat critical to regional population Extensive destruction of local habitat with no recovery or long term (decades) or widespread loss of area or function of primary producers on a regional scale	Complete loss of regional population Complete loss of habitat critical to survival of regional population
	Marine Environmental Quality Water quality, sediment quality, ecosystem health and parameters that support fishing, aquaculture, recreation, aesthetics and cultural/spiritual values	Negligible. No or negligible reduction in physical environment nor decrease in ecosystem function/health. No or negligible loss of value to socio-economic activities	Detectable but localised, short term and insignificant impact to physical environment or ecosystem function/health or value to socio-economic activities. Rapid recovery evident within ~ 2 years.	Significant wide-scale medium term impact to physical environment, decrease in ecosystem function/health or value to socio-economic activities. Recovery over medium term (2-10 years).	Wide-scale, long term impact to physical environment, long term decrease in ecosystem function/health or value to socio-economic activities. Slow recovery over decades.	Extensive impact to/destruction of physical environment with no recovery or shutdown of socio-economic activities Long term (decades) and widespread loss of ecosystem function/health on a regional scale that damages value to socio-economic activities.	Complete destruction of regional physical environment / habitat with no recovery Complete loss of area or function of primary producers on a regional scale

Consequence Level		I	II	III	IV	V	VI
	Coastal Processes Geophysical processes, primary productivity/ nutrient cycling, conservation significant areas/coastal landforms and cultural, aesthetic or recreation values	Short term changes to local geophysical/hydrological processes, widespread loss of area or function of primary producers/nutrient cycling or conservation significant areas on a regional scale	Detectable but insignificant loss or change to local geophysical/hydrological processes, area or function of primary producers/nutrient cycling or conservation significant areas with rapid recovery within 2 years.	Moderate. Significant modification, destruction, removal or change of local geophysical/hydrological processes, wide-scale loss of area or function of primary producers/nutrient cycling or conservation significant areas on a regional scale with recovery over medium term (2-10 years).	Long term loss or change of local geophysical/hydrological processes, widespread loss of area or function of primary producers/nutrient cycling or conservation significant areas on a regional scale with slow recovery over decades	Extensive destruction of local geophysical/hydrological processes, widespread loss of area or function of primary producers/nutrient cycling or conservation significant areas on a regional scale with no recovery or long term (decades)	Complete loss or change of geophysical/hydrological processes. Complete loss of area or function of primary producers/nutrient cycling or conservation significant areas on a regional scale.
	Community and Economy Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping	No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry. Significant medium-term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry. Permanent loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry Permanent loss of key natural features or populations supporting the local or regional industry
	Culture and heritage Includes: Indigenous heritage and maritime heritage (i.e. shipwrecks)	No or negligible impact on the area's cultural or heritage values. No or negligible alteration, modification, obscuring or diminishing of the area's cultural or heritage values.	Detectable but insignificant impact on one or more of the area's cultural or heritage values. Detectable but insignificant alteration, modification, obscuring or diminishing of the area's cultural or heritage values.	Significant impact on one or more of the area's cultural or heritage values. Significant alteration, modification, obscuring or diminishing of the area's cultural or heritage values.	Major long-term effect on one or more of the area's cultural or heritage values. Major alteration, modification, obscuring or diminishing of the area's cultural or heritage values.	Complete loss of one or more of the area's cultural or heritage values.	Permanent loss of one or more of the area's cultural or heritage values with no recovery.

Table 6-2: Summary environmental consequence level descriptions

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

Table 6-3: Likelihood descriptions

No.	Matrix	Description
F	Almost Certain	Occurs in almost all circumstances OR could occur within days to weeks
E	Likely	Occurs in most circumstances OR could occur within weeks to months
D	Occasional	Has occurred before in Santos OR could occur within months to years
C	Possible	Has occurred before in the industry OR could occur within the next few years
B	Unlikely	Has occurred elsewhere OR could occur within decades
A	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 6-4: Risk assessment matrix

		Consequence					
		I	II	II	IV	V	VI
Likelihood	F	Low	Medium	High	Very High	Very High	Very High
	E	Low	Medium	High	High	Very High	Very High
	D	Low	Low	Medium	High	High	Very High
	C	Very Low	Low	Low	Medium	High	Very High
	B	Very Low	Very Low	Low	Low	Medium	High

		Consequence					
		I	II	II	IV	V	VI
	A	Very Low	Very Low	Very Low	Low	Medium	Medium

6.3 Residual consequences and risks

6.3.1 Planned events

The residual consequence levels from the planned impacts following implementation of standard and additional (as low as reasonably practicable; ALARP) management actions detailed in **Section 7** are summarised in **Table 6-5**. Given the likelihood of a planned event occurring is 100% (in other words, it will occur), the risk ranking is not assessed. A comprehensive impact assessment for each of the planned events, and subsequent management actions proposed by Santos to reduce the impacts to ALARP and/or acceptable levels are detailed in the following sections. Within the ENVID developed by Santos some environmental aspects had multiple residual consequence ratings since multiple environmental factors were assessed. In these cases the residual consequence of greatest severity was chosen for this summary.

Table 6-5: Summary of the residual consequence levels associated with planned impacts

CEMP section	Planned event impact	Residual consequence
7.6.1	Interactions with other marine users	II - Minor
7.6.2	Seabed and benthic habitat disturbance	II - Minor
7.6.3	Onshore ground disturbance	II – Minor
7.6.4	Noise emissions	II - Minor
7.6.5	Light emissions	II - Minor
7.6.6	Routine vessel discharges	I - Negligible
	Pre-commissioning water extraction and discharges	II - Minor
7.6.8	Atmospheric emissions	I - Negligible
7.6.9	Contingency Pipeline Discharges	II - Minor

6.3.2 Unplanned events

The residual risk levels from unplanned events following implementation of standard and additional (ALARP) management actions (detailed in **Section 7**) are summarised in **Table 6-6**. Comprehensive risk assessments for each of the unplanned events, and subsequent management actions proposed to reduce the risk to ALARP and acceptable levels are detailed in the following sections. Within the ENVID some unplanned events had multiple residual risk ratings since multiple environmental factors were assessed. In these cases the residual risk of greatest severity was chosen for this summary.

Table 6-6: Summary of the residual risk level associated with unplanned risks

CEMP section	Unplanned event risk	Residual risk level
7.7.1	Dropped objects	Low

CEMP section	Unplanned event risk	Residual risk level
7.7.2	Introduction of invasive marine species	Low
7.7.3	Unplanned marine fauna interaction	Low
7.7.4	Release of liquid hazardous material	Low
7.7.5	Release of hydrocarbon (offshore bunkering or vessel tank rupture)	Low
7.7.6	Release of dry natural gas	Very Low

6.4 Impact/risk assessment summary

The outcomes of the impact / risk assessment are presented in **Table 6-7**, including reference to the relevant management strategy within this CEMP proposed to manage individual environmental aspects.

Table 6-7: Summary of impact and risk assessment outcomes

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
Planned impacts							
Interaction with other marine users	Vessel activities including: + Surveys/ROV operations + Pre-lay works + Pipeline installation and pre-commissioning Marine DPD Project infrastructure including: + Pipeline and supporting/stabilising structures (including rock installation) + Pipeline crossings + Cable crossings Coastal DPD Project infrastructure and equipment required to construct it, including: + Temporary causeway/s	Impact to other marine users may occur as a result of the presence of vessels and associated exclusion zones, where applicable, in the Project Area, causing potential inconvenience. For trenching and spoil disposal activities, an expected 11 vessels will be involved, for deep water and shallow pipelay activities an expected 6 and 7 vessels, respectively, will be involved, for rock installation an expected 6 vessels will be involved and for pre-commissioning an expected 4 vessels will be involved. On an ongoing basis, subsea infrastructure may present a hazard to marine users due to the potential for snagging. The temporary physical presence of the causeway structures (approximately 200 m in length) and associated activities at the shore-crossing location may exclude other users from this intertidal/ shoreline area, although given this is within the existing disturbance footprint for the DLNG Facility, interactions are considered unlikely and impact negligible.	**Spatial** Localised around the Project vessels (and vessel exclusion zones, advised through a notice to mariners [NTM], as applicable), pipeline route and shore crossing activities including temporary causeway structures. Vessel exclusion zones are typically 500 m and will apply to Project vessels, including pipelay vessel, construction vessels and dredging vessels. **Temporal** Temporary and intermittent presence of project vessels within the Project Area within a nominal 15-month cumulative period. Ongoing presence of the pipeline within the Project Area once construction has been completed. Temporary presence of causeway structures.	Interactions with other marine users including potential displacement from commercial, recreation and tourism areas or alteration of routes to avoid exclusion areas. Construction and the presence of a causeway/s at the shore-crossing area may exclude other users from the area during construction.	Community and economy (commercial fishers, traditional fishing, tourism and recreational activities, shipping traffic and other oil and gas activities)	II-Minor	**Section 7.6.1**
Seabed and benthic habitat disturbance	Pre-lay trenching with: + Cutter suction dredge (CSD) + Trailer suction hopper dredge (TSHD)	Temporary and permanent infrastructure Temporary and permanent infrastructure placement, resulting in direct disturbance to seabed, benthic habitat and cultural sites. Temporary	**Spatial** Localised within the Project Area to the pipeline, supporting structure footprints, trenching zones, causeway/s, spoil ground, anchoring footprints and the zones of moderate impact and zones of influence	Temporary and permanent infrastructure Disturbance of benthic habitat Disturbance of the seabed from vessel anchoring or placing of infrastructure and rock could:	Marine environmental quality (water quality, physical parameters that support fishing, aquaculture, recreation	II-Minor	**Section 7.6.2**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
	+ Backhoe dredge (BHD) + Land-based excavators Spoil Disposal at: + Spoil ground + In situ Vessel activities: + Vessel anchoring during pipelay installation (pipelay, water winning, cutter dredge) + Positioning on spuds for back hoe and cutter + Installation of underwater positioning structures Installation of marine DPD Project infrastructure including: + Pipeline installation + ILT installation (including foundations) + Pre-lay span and supporting/stabilising structures including cable crossings and post-lay span rectifications + Rock placement	disturbance will occur from anchoring and the presence of temporary causeway/s. Permanent disturbance will occur from placement of permanent infrastructure (pipeline, rock protect etc.). Potential change to current flows Alteration of currents within Darwin Harbour will also occur due to temporary causeway/s blocking the flow of water. Trenching and spoil disposal Spoil from trenching areas will be transported to and disposed of in the DPD spoil disposal area in offshore NT waters, which will result in permanent disturbance from smothering due to sedimentation. Spoil from trenching activities at the shore crossing in the intertidal area will be side cast to the lower intertidal area to provide a mitigation to potential acid sulfate soil risk (i.e. to keep wet under most tidal conditions). Dependent upon access by BHD this build-up of spoil will be subsequently removed (if not already dispersed) for disposal to the DPD spoil disposal area in offshore NT waters using a BHD and SHB. Onshore Clearing of regrown native grasses and weeds in a previously disturbed area will be required prior to excavating a trench for onshore	derived from sediment dispersion modelling. **Temporal** Construction activities will typically occur for days to months at a site. Temporary causeway/s is in place for the duration of construction activity. Ongoing presence of the pipeline within the Project Area Permanent presence of DPD spoil ground in offshore NT waters Sporadically during high rainfall events due to increased levels of runoff.	Disturb the seabed and result in loss of habitat Impact infauna/ epifauna and primary producers Increase water turbidity and sedimentation Anchoring has the potential to result in disturbance to maritime heritage and sacred sites protected under the *Northern Territory Aboriginal Sacred Sites Act 1989* (NT) and the *Heritage Act 2011* (NT) The pipeline will create an artificial reef that could attract and support marine biota including fish which may benefit recreational fishing resources Rock placement may result in creation of artificial reef that could attract and support marine biota including fish which may benefit recreational fishing resources Creation of barrier to coastal processes Potential disturbance up to 20 m x 200 m in inter-tidal area Potential change to current flows Potential alteration of currents due to temporary project infrastructure with potential for seabed scouring/coastal erosion. Trenching and spoil disposal Increase in sedimentation and reduction in water quality from: Trenching activities	and aesthetics, sediment quality) Marine ecosystem (potential loss of the following habitats: macroalgae, sandy sediment with filter feeders and sponges, infauna, epifauna and biota quality, benthic habitats, and primary producer habitat, including mangroves) Coastal processes (bathymetry and seabed features) Community and economy (impacts to demersal fish habitats) Culture and heritage (heritage areas, shipwrecks, maritime archaeology and sacred sites)		

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
	Installation of coastal DPD Project infrastructure and equipment including: + Causeway/s (132 m x 44 m) Construction above HAT and onshore support facilities: + site clearing for onshore activities including pull winches and site buildings + placement of geotextile and hardstand + onshore laydown area + access road	pipeline section, which increases the risk of run off during rainfall event.		Additional run off created by onshore land and vegetation clearing and onshore site pad. Trenching nearshore in mangrove muds may result in ASS leaching and reduction in health of intertidal marine animals Direct and indirect impact to benthic habitats, including removal and smothering of benthic habitats Reduction in available food for marine species utilising the area Potential to impact fish health and other fauna Potential risk of coastal erosion If heavy rainfall is received, water may need to be pumped from the trench to adjacent land area. If stormwater runoff enters Darwin Harbour, coastal water quality may be impacted If trenching reaches groundwater, there is potential for acid release and metal leaching into the groundwater from oxidised ASS.			
Onshore ground disturbance	Onshore construction (above HAT) including: + trench/excavation + temporary storage of fill to be stockpiled in the disturbance footprint for use as backfill + disposal of excess fill	Clearing of regrown native grasses and weeds in a previously disturbed area will be required prior to excavating a trench for onshore pipeline section. Excavated soil will be temporarily stockpiled within the onshore Project Area to be used as fill or disposed of if in excess. Preparation of the DPD site pad, including vegetation clearing.	**Spatial** Localised within the Project Area **Temporal** Temporary duration when the section of trench will be open. The trench will be backfilled at the conclusion of pre-commissioning works. The clearing of any vegetation currently present onsite will be permanent.	Excavating the trench may result in: + minimal clearing of the ground/vegetation + digging soil and placing it adjacent for later re-use + additional fill of specific parameters to be brought to site if engineered backfill required. This may require disposal of excess 'original' soil – may need to be	+ Marine environmental quality (coastal water quality) + Marine ecosystem (marine fauna) + Terrestrial impacts (sediment quality, vegetation and terrestrial fauna) + Air quality	II – Minor	**Section 7.6.3**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
	+ site clearing for onshore activities including pull winches and site buildings + Placement of geotextile and hardstand + Access road			tested/treated prior to disposal + potential risk from erosion + spread of weeds + If heavy rainfall is received, water may need to be pumped from the trench to adjacent land area. If stormwater runoff enters Darwin Harbour, coastal water quality may be impacted. + If trenching reaches groundwater, there is potential for acid release and metal leaching into the groundwater from oxidised ASS.			
Noise emissions	Pre-lay works including: + Cutter suction dredge (CSD) + Trailer suction hopper dredge (TSHD) + Backhoe dredge (BHD) for excavating with potential used of hydraulic tools (Xcentric Ripper, hydraulic hammer) for fracturing rock + + Mass flow excavation (MFE) + Construction of two temporary causeways either	+ Vessel noise is considered non-impulsive (continuous) and broadband and includes vessel thrusters, engines and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull. The main source of vessel noise will be from propellers or dynamic positioning (DP) thrusters (deeper water pipelay only). Project vessels (excluding trenching vessels) may emit noise up to ~180 dB re 1 µPa at 1 m. + Trenching will be completed using different trenching vessels, including a BHD, a	**Spatial** For TSHD, CSD and BHD trenching and Xcentric Ripper tool use, permanent threshold shift (PTS) SEL24 hour ranges for dolphins, dugongs and turtles modelled at <50 m. Equivalent threshold range for hydraulic hammer modelled at 100- 160 m. For TSHD, CSD and BHD trenching and Xcentric Ripper tool use, temporary threshold shift (TTS) SEL24 hour ranges for dolphins, dugongs and turtles modelled at 40-350 m. Equivalent threshold range for hydraulic hammer modelled at 950- 2,500 m. The PTS and TTS ranges were shown to decrease with reduced hammering time (per 24 hours) for the hydraulic hammer. For behavioural response thresholds, ranges for marine mammals (dolphins and	+ Project activities including trenching, pipelay, additional vessel operations and will add to the existing underwater noise profile inside and outside Darwin Harbour during construction. + The use of sound in the underwater environment is important for marine animals, particularly cetaceans, to navigate, communicate and forage effectively, along with reptiles, sharks/rays and other fish, for a range of functions such as social interaction, foraging and	+ Marine ecosystem (marine mammals particularly cetaceans, marine reptiles, sharks, rays, pelagic and demersal fish, seabirds, shorebirds and invertebrates) + Marine environmental quality (impact to parameters that support fishing, aquaculture, recreation, aesthetics and	II-Minor	**Section 7.6.4**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
	side of the trench at the shore crossing Pipelay by nearshore pipelay barge in shallower waters including Darwin Harbour. Pipelay by dynamic positioning (DP) vessel in deeper waters outside of Darwin Harbour. Operation of onshore plant and equipment within Project Area at DLNG facility Support operations including: + General vessel operations during all DPD Project activities + Vessel and subsea positioning equipment e.g. MBES, SSS, LBL) / USBL) + Helicopter operations	TSHD and a CSD. Noise includes operation of vessel engines for propulsion (as applicable), onboard equipment, pumps and interaction of trenching equipment with the seabed. The following source levels are considered representative of trenching vessel non-impulsive noise: + + TSHD: 184 dB re 1µPa @1m + + CSD: 182 dB re 1µPa @1m + + BHD: 175 dB re 1µPa @1m + BHD rock breaking tools will be either non-impulsive from Xcentric Ripper tool or impulsive from hydraulic hammer (contingency only). Representative source levels are: + + Xcentric Ripper: 184.8 dB re 1 µPa2 s m^2 + + Hydraulic hammer: 192 dB 1 µPa2s m^2	dugongs) varied from 100s of metres to 10s of kilometres for scenarios modelled at MSL. Spatial scales for other activities are as follows: + Localised: A support vessel using main engines and bow thrusters to maintain position will become inaudible above background noise within thousands of metres. + Localised: A conservative estimate is that survey equipment (MBES/SSS) will be inaudible within thousands of metres, depending on the activity characteristics. + Localised: Helicopter noise will be highly localised and most of the noise will not transfer into the water. **Temporal** Vessel noise for the duration of the construction activity (12-15 months), with intermittent survey equipment and helicopter noise. Trenching vessel noise expected over indicative period of 2-3 months. Noise will be very infrequent during operations given scale of planned vessel pipeline inspection surveys indicatively every 1-3 years.	orientation. Underwater noise could result in: + + Acoustic masking: + – Disruption to underwater acoustic cues + – Masking of vocalisations and signals from predators and prey + + Behavioural response: + – Modification of fauna behaviour (avoidance, attraction and disruption of normal behaviour) + – Disturbance, leading to behavioural changes or displacement from areas + – Indirectly by inducing behavioural and physiological changes in predator or prey species. + + Physiological impacts: + – Increased stress levels + – Physical injury to fauna from exposure to excessive noise (barotrauma, hearing loss including TTS and PTS + Onshore construction activities are not expected to have an impact as they will not occur in water.	cultural/ spiritual values) + Community and economy (fisheries, commercial and recreational) and tourism).		

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
Light emissions	Construction activities undertaken at night: + Surveys/ROV operations + Pre-lay works, pipeline installation and pre-commissioning + Lighting of Project Area at shore crossing	Potential impacts from light emissions may occur in the Project Area from: + Safety and navigational lighting on the vessels including: - Pipelay vessel - CSD, TSHD and BHD - Construction vessel/survey vessel - Anchor handler (e.g. Multicat) - Platform supply vessel (psv) - SHB + Spot lighting that may also be used as needed, such as equipment deployment and retrieval + Task and security lighting at the shore crossing. Operational (task) lighting will typically consist of bright white (in other words, metal halide, halogen, fluorescent) lights typical of lighting used in the offshore petroleum industry and not dissimilar to lighting used by other vessels in the Project Area, including shipping and fishing vessels.	**Spatial** Localised: Limited light 'spill' or 'glow' on surface waters surrounding a vessel. Light spill modelling conducted for an offshore pipelay vessel and an offshore construction vessel, considered 'worst-case' in terms of vessel lighting for the DPD Project, indicates that vessel light spill intensity is around 10 times that of a full moon at 150-200m from these vessels (either individually or side by side) and drops to the intensity of a full moon at 500-1000m (Pendoley, 2022). At a distance of 2.5-4.5km, light spill was modelled to have dropped to 0.1 (10%) of a full moon. At this level, lighting is considered unlikely to have any impacts on marine turtle hatchlings (which are considered particularly sensitive to lighting impacts) (Pendoley Environmental, 2022). **Temporal** Navigational and task lighting is required 24 hours a day for the duration of the construction activities in the marine environment. When onshore it is expected that night works will be undertaken as required	Change in fauna behaviour due to light emissions from vessels including: + Disrupting nesting turtles + Disorientating hatchlings + Hatchlings getting caught in vessel light pools with increased predation + Attract seabirds and shorebirds	+ Marine ecosystem (marine mammals, Marine reptiles, Pelagic and Demersal fish, Sharks, Rays, Seabirds and Shorebirds) + Marine environmental quality (impact to parameters that support fishing, aquaculture, recreation, aesthetics and cultural/ spiritual values) + Community and economy (fisheries and tourism)	II-Minor	**Section 7.6.5**
Routine vessel discharges	All vessel activities	Planned discharges from vessels to the marine environment include: Deck drainage/run off + Deck drainage from rainfall or wash-down operations would discharge to the marine environment. The deck	**Spatial** Localised: The small volumes of non-hazardous discharges may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity in waters around discharge points	The small volumes discharged may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity.	+ Marine environmental quality (water quality) + Marine Ecosystem (ecosystem health)	I-Negligible	**Section 7.6.6**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. Sewage and grey water + The volume of sewage and food waste is directly proportional to the number of persons on-board the vessels. Depending on waste production rates and the specifications of sewage systems available, the total volume of this waste stream generated typically ranges between 0.04 and 0.45 m^3 per day per person. Treated sewage/greywater will be disposed in accordance with Marine Order 96. Food wastes + Putrescible waste is estimated to consist of approximately 1 L of food waste per person per day. The vessel will dispose of food waste in accordance with AMSA and Marine Order 95, and MARPOL Annex V. Cooling water + Seawater is used as a heat exchange medium for cooling machinery engines. Cooling water temperatures vary, depending on the vessel's engines' workload and activity.	and in the direction of the prevailing current. The environment that may be affected by operational discharges will likely be contained within the Project Area and are predicted to be restricted to within approximately 100 m of the discharge point in the upper 5 m of the water column. Localised: Backflush water will be discharged onto existing disturbed shore crossing construction site to drain into the intertidal area. Backflush water will also potentially be discharged onto the installed rock causeway to baffle the flow of the discharged backflush water. **Temporal** Intermittent and Short-term: During the period of the vessel activities (weeks to months), localised impacts to water quality will occur.		+ Coastal processes (primary productivity/nutrient cycling) + Community and economy (fisheries (commercial and recreational) and tourism)		

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		Bilge water + While in the Project Area, the vessel may discharge oily water after treatment at a concentration of up to 15 ppm through an approved oily water filter system required by Marine Order 91. Brine (if a reverse osmosis unit is used for water treatment) + If a reverse osmosis unit is used for water treatment, waste brine generated will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge depends on the requirement for fresh (or potable) water and demand based on the number of people on-board.					
Pre-commissioning water extraction and discharges	Water winning and filter flushing for pipeline pre-commissioning.	Water winning from Darwin harbour is required to provide water for filling pipeline with treated seawater for flushing, cleaning, gauging and testing (FCGT) activities. Water is required to be filtered to remove particulates prior to being treated with chemical and pumped into pipeline. The filtering equipment will be required to be backwashed back into Darwin Harbour to clean the filter. The backwashed water will have a higher particulate concentration than ambient water conditions and will cause increased turbidity at the discharge point. Total backflush volume is expected to be	**Spatial** Localised: Backflush water will be discharged onto existing disturbed shore crossing construction site to drain into the intertidal area. Backflush water will also potentially be discharged onto the installed rock causeway to baffle the flow of the discharged backflush water. **Temporal** Intermittent and Short-term: During the period of the water winning for pre-commissioning (three days).	The small volumes discharged may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity. Injury or mortality of marine fauna entrained in water extraction.	+ Marine environmental quality (water quality) + Marine Ecosystem (ecosystem health) + Coastal processes (primary productivity/nutrient cycling) + Community and economy (fisheries (commercial and recreational) and tourism)	II - Minor	**Section 7.6.7**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		approximately 300 m^3 over 3 days. TSS concentration of backflush water waster will be approximately 1,500 mg/L in the wet season and 680 mg/L in the dry season. Entrainment of marine fauna during water extraction process.					
Atmospheric emissions	+ Operation of vessel engines, helicopters, generators, mobile and fixed plant and equipment. These emissions will include GHG emissions, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and non-GHG emissions, such as sulphur oxides (SO_X) and nitrogen oxides (NO_X) + Operation of incinerators on vessels Although the vessels may use ozone-depleting substances (ODS), this will be in a closed rechargeable refrigeration system and there is no plan to release ODS to the atmosphere.	Atmospheric emissions from combustion engines associated with vessels, equipment and vehicles impacting on air quality and adding to GHGs in the atmosphere.	**Spatial** Localised: The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. **Temporal** For the duration of the construction activities	Atmospheric emissions from activity vessels can result in deterioration of local air quality. Emissions of GHG can cause an incremental increase in global GHG concentrations. Given the nature and scale of DPD Project construction activities (low frequency and relatively short duration), both risks are considered to have a negligible impact on air quality.	+ Air quality) + Community and economy (tourism)	I-Negligible	**Section 7.6.8**
Contingency pipeline discharges	+ Pipeline installation and pre-commissioning: - Discharge of treated	Contingency flushing and dewatering of treated seawater to the marine environment. During installation and pre-commissioning, in the event of a	**Spatial** Localised reduction in water quality in proximity to the discharge areas as treated	Contamination/toxic effects to marine fauna.	+ Marine environmental quality (water quality, sediment	II-Minor	**Section 7.6.9**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
	seawater in the event of pipeline remedial work during construction such as responding to a wet buckle event or stuck pig that requires flushing, filling and dewatering using treated seawater (Note – the wet buckle event is an unplanned event but in response to a wet buckle or stuck pig, there will be the planned response)	wet buckle or stuck pig, contingency flushing, filling and dewatering may be required in order to displace raw seawater from the pipeline that would otherwise lead to corrosion. Treated seawater discharge was modelled at three location–: + KP114 – 600 m^3 overflow + 19958.3 m^3 dewatering + KP102 – 600 m^3 overflow + 10623.3 m^3 dewatering and + KP84 – 600 m^3 overflow + 4399.9 m^3 dewatering.	seawater discharge modelling found (BAS-210 0035; RPS, 2022): + The discharge at KP84 resulted in a preservation chemical plume that was generally continuous up to ~1.4 km from the release location, with small, isolated patches predicted up to 9.61 km. Isolated patches beyond 2 km were predicted to occur during 2 of the 25 simulations and the plume was predicted to travel a maximum distance of 9.61 km in only one simulation. The isolated patches were due to an accumulation of the treated seawater, which had occurred during a current reversal, causing it to concentrate. The potential areas of exposure based on the PC99%, PC95% and PC90% thresholds 0.40 km^2, 0.17 km^2 and 0.08 km^2, respectively; + the discharge at KP102 resulted in isolated patches of the preservation chemical up to 6.78 km from the release location due to the plume drifting into the shallow intertidal areas, reducing the potential for mixing and dilution. The modelling also predicted a continuous area of exposure up to ~4 km west offset from the release location due to the plume migrating into the shallower waters, mixing less, resulting in the concentration accumulating. The area of exposure for the PC99% threshold was 4.14 km^2; and + the discharge at KP114, resulted in a maximum distance from the release	Potential impacts to fish and fisheries (commercial and recreational). Treated seawater discharge modelling does not identify any areas where dosage of biocide (time and concentration) will exceed the No Observable Effect Concentration (NOEC) and 99% species protection level (PC99%), i.e. 48 – 96 hour dosage of 0.06 – 0.1 mg/L).	quality and physical parameters that support fishing, aquaculture, recreation and aesthetics) + Marine ecosystem (infauna, epifauna and biota quality, marine mammals, marine reptiles, pelagic and demersal fish and sharks and rays) + Community and economy (physical parameters that support fishing and pelagic and demersal fish)		

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
			location of 2.40 km and an area of exposure based on the PC99% threshold of 1.45 km^2. The preservation chemical concentrations did not trigger any other threshold over a 12-hour continuous duration. **Temporal** Temporary reduction in water quality in proximity to the discharge areas as treated seawater discharge modelling found (BAS-210 0035; RPS, 2022): + The release duration for pipeline overfilling or overflow has been estimated to be 38 minutes at all three locations + the release duration for dewatering activities varied due to the length of the pipeline at the given locations (KP84 >21.4 hours, KP102 >11.4 hours and KP114 >4.7 hours)				
Unplanned events							
Dropped objects	Vessel activities including: + Surveys/ROV operations + Pre-lay works + Pipeline installation and pre-commissioning, e.g. post-lay span rectification	Solid objects such as those listed below can be accidentally released to the marine environment + Non-hazardous solid wastes, such as paper, plastics and packaging, personal protective equipment, small tools and unsecured deck equipment + Hazardous solid wastes, such as batteries, fluorescent tubes, medical wastes, and aerosol cans + Equipment and materials, such as hard hats, tools or	**Spatial** The event will only occur within the Project Area, and all non-buoyant waste material or dropped objects are expected to remain within the Project Area. Buoyant objects could potentially move beyond the Project Area. **Temporal** An unplanned release of solids may occur during construction activities. Water contamination from hazardous objects could cause prolonged or permanent reduction in water quality.	If an object is dropped overboard, potential impacts would be limited to minor and localised disturbance of the seabed and benthic habitats near the dropped object. Benthic habitat loss. Potential damage to communication cables in Darwin Harbour Potential damage to cultural heritage objects and sites. Potential reduction in water quality from water contamination, cause by objects such as batteries.	+ Marine environmental quality (water quality and sediment quality) + Marine ecosystem (benthic habitats, infauna and epifauana and protected areas [Charles Point Wide RFPA]) + Community and economy (oil and gas operations,	Low	**Section 7.7.1**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		infrastructure (e.g., pipe joints, mattresses, frames) Dropped could result from: + Loss of control of suspended loads (e.g. concrete mattresses for pipeline stabilisation) may also be accidentally dropped through operator error or mechanical failure + Loss of equipment and waste off vessel deck Larger objects, such as A-frames and sea containers, are secured to the vessel deck and cannot credibly be lost overboard Dropped objects resulting in damage to the Bayu-Undan to Darwin pipeline and subsequent dry natural gas release is covered specifically as a separate unplanned event below.			other users, e.g. fisheries, tourism and recreational fishers and other industries e.g. telecommunications)		
Introduction of invasive marine species (IMS)	Vessel activities including: + Surveys/ROV operations + Pre-lay works Pipeline installation and pre-commissioning, e.g. post-lay span rectification	Introduction of IMS may occur due to: + Biofouling on vessels and external/internal niches (such as sea chests, seawater systems) + Biofouling on equipment that is routinely submerged in water (such as survey equipment) + Discharge of high-risk ballast water + Cross-contamination between vessels	**Spatial** Localised (seabed and water column within the Project Area) to widespread if successfully translocated to new areas via ocean currents or project equipment transit. **Temporal** Temporary to long-term (in the event of successful translocation).	Potential establishment of IMS in the marine environment as a result of the project requires IMS to: + Be present on a vector (biofouling on activity vessels and ballast water are considered credible vectors) + Be released from the vector + Establish in the receiving environment If established, impact could include localised (seabed and water column near the Project Area) to widespread impacts, if IMS successfully establish to new areas.	+ Marine environmental quality (ecosystem health) + Marine ecosystem (benthic habitats, benthic communities and ecological function and processes) + Coastal processes (ecological processes) + Community and economy (other users e.g.	Low	**Section 7.7.2**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		Once established, IMS have the potential to out-compete indigenous species and affect overall native ecosystem function.		IMS could displace and outcompete local species.	commercial and recreational users and ports and shipping)		
Unplanned marine fauna interactions	Vessel activities including: + Surveys/ROV operations + Pre-lay works + Pipeline installation and pre-commissioning, e.g. Post-lay span rectification Trenching activities – TSHD	There is the potential for vessels or equipment (for example, TSHD, CSD, and ROV) involved in construction activities to interact with marine fauna, including potential strike or collision, potentially resulting in severe injury or mortality.	**Spatial** Within the Project Area, in the immediate vicinity of the vessels or subsea equipment. **Temporal** During all construction activity.	Collisions may result in behavioural impacts, physical injury to, or the death of the fauna involved.	+ Marine ecosystem (marine fauna – marine mammals, reptiles, fish and sharks)	Low	**Section 7.7.3**
Release of liquid hazardous material (excluding diesel release from bunkering and vessel tank rupture which is presented below)	Vessel activities including: + Surveys/ROV operations + Pre-lay works Pipeline installation and pre-commissioning, e.g. Post-lay span rectification	Hazardous liquids used on the DPD Project include fuels and oils for equipment and machinery and other task-specific chemicals required for construction activities. Causes for accidental hazardous liquid releases include: + ROV failure (including oil seal, hydraulic system hose and quick-disconnect system failures) (approximately 0.05 m^3 (50 L)) + Stern tube oil (non-hydrocarbon-based lube oil) from the vessel thruster/propeller stern tube (approximately less than 1 m^3) + Loss of primary containment (drums, tanks, intermediate bulk containers (IBCs)) due to handling, storage and dropped	**Spatial** Volumes are likely to be small and limited to the volume of individual containers (such as IBCs, 44 gallon drums) stored on the deck of supply vessels or tank/hose sizes within equipment/machinery. A worst-case credible spill for this scenario is considered to be the loss of an intermediate bulk container (1 m^3). Spills to the marine environment of this size will disperse rapidly. Concentrations above toxic or harmful thresholds are expected to occur at short distances from the release point, and should a spill occur, potential impacts beyond the Project Area are not expected in the event of a worst-case spill. **Temporal** Potentially toxic or harmful threshold concentrations will be limited to a very short period following a release, as a spill is expected to disperse rapidly.	Decreases in water and sediment quality. The potential impacts to water and sediment quality are expected to be localised and temporary given the volumes of hazardous materials that may credibly be lost overboard. Impacts to fauna may result in injury or mortality through contact and/or ingestion; however, while this would reasonably be expected to impact upon individual animals; no population-scale impacts would credibly occur.	+ Marine environmental quality (water quality and sediment quality) + Marine ecosystem (marine fauna – marine mammals, reptiles, fish, sharks, seabirds and shorebirds)	Low	**Section 7.7.4**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
		objects (such as swinging load during lifting activities) + Vessel pipework failure or rupture, hydraulic hose failure and inadequate bunding + Spills or leaking machinery accidentally discharged overboard in deck drainage water + Overflow of the open and closed drainage systems Oily water from vessels includes bilge water and deck drainage water.					
Release of hydrocarbon (offshore bunkering or vessel tank rupture)	Vessel activities including: + Surveys/ROV operations + Pre-lay works + Pipeline installation and pre-commissioning, e.g. Post-lay span rectification Vessel bunkering	A minor spill (of up to ~10 m^3) of marine gas oil (MGO) or marine diesel oil (MDO) could occur during vessel to vessel refuelling. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling. It is considered credible that a release of diesel to the marine environment could occur from a vessel fuel tank rupture. For the purpose of risk assessment, a worst-case discharge of up to 700 m^3 of MDO or MGO is considered credible from the offshore pipelay vesseland a spill of up to 300 m^3 is considered credible for project vessels in Darwin Harbour (e.g., the nearshore pipelay barge)	**Spatial** MDO spill trajectory modelling (BAS-210 0030; RPS, 2022) at KP 91.5 (just outside Darwin Harbour) indicated that there was some probability of a 700 m^3 marine diesel oil (MDO) spill, extending as follows (using the moderate exposure thresholds): + Shoreline loading was predicted to occur along the Cox-Finniss region, outside the Harbour to the west and within the West Arm in the dry season and along the Cox-Finniss region, outside the Harbour to the East and west and within the East Arm in the wet season. + Surface oil was predicted to occur within approximately 19.9 km (Dry season) and 19.3 (Wet season) of the release location. + Total submerged oil was predicted to occur within approximately 36.9 km (Dry season) and 51.3 km (Wet season) of the release location	A release to the marine environment, would be likely to rapidly disperse and evaporate but could lead to a reduction in: + Water quality + Sediment quality + Ecosystem health and impact to parameters supporting commercial and recreational uses Behavioural/physiological impact to marine fauna (particularly those associated with the surface such as cetaceans and marine turtles) and plankton within the upper water column and/or associated with shallow waters and shorelines. Impact to other users due to spill response activities. Impacts to benthic habitats, including intertidal habitats and primary producers.	+ Marine environmental quality (water quality, physical parameters that support socio-economic activities) + Marine ecosystem (marine fauna, benthic habitats, intertidal habitats, protected areas [Charles Point Wide RFPA]) + Coastal processes (primary productivity e.g. mangroves) + Community and economy (community and economy e.g.	Low	**Section 7.7.5**

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
			+ Dissolved hydrocarbons were predicted to occur with approximately 10 km (Dry season) and 13.7 km (Wet season) of the release location. MDO spill trajectory modelling for vessel fuel tank rupture (BAS-210 0030; RPS, 2022) at KP 114 (in the middle of Darwin Harbour) indicated that there was some probability of a 300 m^3 marine diesel oil (MDO) spill respectively, extending as follows (using the moderate exposure thresholds): + Shoreline loading was predicted to occur within the East Arm, Middle Arm, West Arm of the Harbour and at Wickham Point in both wet and dry seasons. During the wet season shoreline loading is also expected outside the harbour to the east and west. + Surface oil was predicted to occur within approximately 19.6 km (Dry season) and 18.9 km (Wet season) of the release location. + Total submerged oil was predicted to occur within approximately 30.3 km (Dry season) and 32.4 km (Wet season) of the release location + Dissolved hydrocarbons were predicted to occur with approximately 0.6 km (Dry season) and 7.3 km (Wet season) of the release location. The extent of shoreline loading, and distance travelled of MDO from smaller spills of 87.5 m^3 and 10 m^3 modelled at KP 114 will be lower than that described for the 300 m^3 scenario	Impact to culture and heritage areas.	commercial and recreational users) + Culture and heritage (impacts to sacred sites or important cultural heritage significance)		

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
			Temporal + MDO spill trajectory modelling at KP 91.5 for 700 m^3 indicated that within a 50-day simulation: 85% of spilled oil will have evaporated into the atmosphere. + 5% of spilled oil will remain on the shoreline. + 8% of spilled oil will have decayed by the end of the simulation. + No spilled oil will remain on the water's surface MDO spill trajectory modelling at KP 114 for 87.5 m^3 indicated that within a 20-day simulation: + 85% of spilled oil will have evaporated into the atmosphere. + 12% of spilled oil will remain on the shoreline. + 2% of spilled oil will have decayed by the end of the simulation. + No spilled oil will remain on the water's surface MDO spill trajectory modelling at KP 114 for 10 m^3 indicated that within a 10-day simulation: + 80% of spilled oil will have evaporated into the atmosphere. + 20% of spilled oil will remain on the shoreline. MDO spill trajectory modelling at KP 114 for 300 m^3 indicated that within a 30-day simulation: + 71% of spilled oil will have evaporated into the atmosphere.				

Aspect	Activity	Description of hazard	Spatial and temporal scale	Potential impacts / risks	Sensitive receptors	Residual consequence level/ risk rating (planned impact / (unplanned risk)	Management strategy
			+ 25% of spilled oil will remain on the shoreline. + 3% of spilled oil will have decayed by the end of the simulation. No spilled oil will remain on the water's surface				
Release of dry natural gas	During DPD Project construction – dropped object damages the existing Bayu-Undan to Darwin GEP.	A Bayu-Undan pipeline leak would result in a release of dry gas to the environment. Damage to the Bayu-Undan pipeline during construction activities could occur due to anchor impact/drag or objects being dropped from vessels	**Spatial** The scale of a pipeline leak is dependent on the nature of the damage. Small 'pinhole' leaks will result in a stream of bubbles which may dissolve before reaching the surface. A major rupture (e.g. catastrophic failure) would result in the discharge of a large volume of dry gas forming a large plume in the water column and dispersing into the atmosphere. A catastrophic failure is considered to be the worst-case credible release from the pipeline. **Temporal** The worst case discharge could occur during construction.	The gas cloud may result in impacts to air-breathing fauna, such as marine mammals, marine reptiles and birds. Animals breathing in the immediate vicinity of the release may be asphyxiated, potentially resulting in mortality. Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location. The gas cloud poses a risk to the health and safety of other users, such as fishers (traditional and commercial), tourism and recreational users. A gas cloud could potentially form an explosive mix which, if ignited, result in injury/death and damage to property. However, all other marine users will be excluded from the exclusion zone and therefore will not be within 500 m of an event, if it occurs.	+ Marine environmental quality (water quality, ecosystem health and physical parameters tat support socio-economic activities) + Marine ecosystem (marine fauna and protected areas [Charles Point Wide RFPA]) + Community and economy (other users e.g. commercial and recreational activities) + Culture and heritage	Very Low	**Section 7.7.6**

6.5 Assessment of potential for cumulative impacts

The following sections provide a summary of the assessment of potential cumulative impacts associated with DPD Project construction activities within the DPD Project Supplementary Environmental Report (SER) (BAS-210 0020).

6.5.1 Cumulative assessment methodology

Existing activities and proposed projects in the Darwin region were screened to determine their potential to cumulatively interact with the DPD Project impacts. This included government and private infrastructure projects, Darwin Harbour dredging projects and resource processing operations. The degree of cumulative impact between the DPD Project and identified nearby projects and activities was determined based on the potential for spatial and temporal interaction. The list of projects and activities considered to have a high or medium potential to interact cumulatively with DPD Project impacts, based on spatial and temporal overlap, is provided within the SER (BAS-210 0020). The potential cumulative impacts are discussed in further detail within the SER (BAS-210 0020) and have been summarised below. Cumulative impacts to all NT EPA Environmental Factors from the DPD Project and other projects/activities are not considered to be significant.

6.5.2 Cumulative impacts to marine environmental quality

This CEMP's activities have the potential to elevate turbidity levels within Darwin Harbor due to sediment suspension from trenching activities. Sediment dispersion modelling completed for the DPD Project (BAS-210 0036; RPS, 2022) predicted that there will be no exceedance of suspended sediment concentration (SSC) thresholds where influence or impact to sensitive benthic habitats (hard corals and seagrass) could occur, with modelling showing that sedimentation threshold exceedance would be restricted to within or immediately adjacent to the trenching footprint (RPS, 2022). These zones do not overlap with equivalent zones for other dredging activities in Darwin Harbour that may occur at the same time or close to the time of DPD Project trenching (including Mandorah Marine Facilities, HMAS Coonawarra dredging, INPEX maintenance dredging and Darwin Shiplift and Marine Industries dredging). Therefore, there is low potential for turbidity to result in cumulative impacts to water and sediment quality with other projects activities.

6.5.3 Cumulative impacts to marine ecosystems

This CEMP's activities will have direct impacts to the benthic habitats which will all be restricted to within or immediately adjacent to Project infrastructure footprints, including the designated spoil disposal ground. Benthic habitats in the infrastructure footprints do not consist of rare or sensitive receptors (i.e., hard corals or seagrass) and are predominately hard substrate or sediment substrates supporting filter feeding biota; these habitats are well represented throughout the Project Area. Direct impacts to benthic habitat are not predicted to have significant impacts to ecosystem functions. Although other projects will have direct impacts to benthic habitats, the cumulative impacts are unlikely to be significant when considered against the total available benthic habitat within Darwin Harbour.

There is also potential from indirect impacts to marine ecosystem, for example impacts to benthic habitats from increased SSC and sedimentation. As described above, SSC and sedimentation from DPD Project trenching is unlikely to interact significantly with water quality impacts from other dredging projects in Darwin Harbour, therefore the DPD Project is unlikely to result in significant cumulative indirect impacts to marine ecosystems.

Construction activity will temporarily increase vessel traffic in Darwin Harbour and if construction activity timing overlaps with other projects activities then vessel traffic will be further increased. Increased vessel activity has the potential to result in higher levels of sound and light emissions. It is

however unlikely that cumulative activity from noise and light emissions will have a significant impact, as Santos considers proposed controls and management actions to be effective.

6.5.4 Cumulative impacts to atmospheric processes

This CEMP's activities will generate atmospheric emissions during construction which will contribute to the overall concentration of greenhouse gases (GHG) in the Earth's atmosphere. Emissions resulting from construction activities (i.e., vessel combustion engines) will occur on a short-term basis and be limited to the construction phase of the project. As an overall contribution to GHG gas levels, this will be a negligible increase. The DPD Project is included in Santos' Climate transition action plan and will adhere to the Santos GHG Management plan and energy management program.

6.5.5 Cumulative impacts to coastal processes

This CEMP's activities are not expected to significantly alter hydrological or geophysical process. The trenching activity and the installation of temporary (e.g., causeways at the shore crossing) or longer-term infrastructure (e.g., pipeline and rock protection) may have a slight and local effect on water movement, however not to the extent where this would be expected to change coastal geomorphology or coastal ecosystem processes. Furthermore there are no known projects which would interact with any localised changes in hydrology from the DPD Project to create cumulatively impacts.

6.5.6 Cumulative impacts to community and economy

This construction activities will increase vessel activity within Darwin Harbour, which has the potential to cause cumulative impacts to other commercial and recreational harbour users, in particular if the timing of construction activities overlap with other projects activities. It is important to note that the potential for cumulative impacts from vessel activities would occur primarily during the construction phase, which will be temporary (12 – 15 months). Furthermore, the increase in vessel activity related to the DPD Project is not expected to add significantly to the overall movements within Darwin Harbour based on annual harbour statistics and historical year to year variation. Therefore, DPD Project vessel activities are unlikely to contribute a significant extent to cumulative vessel impacts on harbour marine users.

6.5.7 Cumulative impacts to culture and heritage

Following controls in place, the DPD Project will not impact on indigenous sacred sites and will avoid maritime heritage objects as far as practical, with any maritime heritage disturbance localised to the pipeline route and done in accordance with regulatory requirements. There are no other activities or projects which are considered to have the potential for cumulative impacts with the DPD Project to identified cultural heritage sites.

7 Environmental management strategies

This section outlines the environmental management strategies (EMS) that will be implemented for management of areas and activities associated with the DPD Project construction works, therefore minimising and/or mitigating impacts and risks to the environment.

The EMS to be implemented as part of this CEMP comprise the following:

+ Planned impact management strategies (**Section 7.6**)
+ Unplanned risks management strategies (**Section 7.7**).

These EMS outline environmental performance objectives (EPOs) and measurable targets and management actions in place to ensure that the EPOs and targets are met. Performance indicators and monitoring activities (where applicable) are used to quantify success in meeting targets and identify the need for corrective actions. This ensures the continuous improvement of the effectiveness of the DPD Project's EMS. The EMS define the reporting requirements, terms, and responsibilities.

All EMS are structured to align with the template presented in **Table 7-1**.

Table 7-1: Environmental management strategy template

Item	Content
Environmental Performance Objectives (EPO)	Environmental management goal(s) tailored to each aspect per NT EPA requirements.
Target	Aspect specific measurable performance necessary to successfully achieve objective. Part 1 of NT EPA required performance criteria.
Performance Indicator	Quantitative or qualitative measures representing the performance related to Target(s). Part 2 of NT EPA required performance criteria.
Management actions	Tasks to be undertaken to meet objective/s. For example, install turtle deflection chains on TSHD drag head, comply with Darwin Port vessel speed restrictions etc.

7.1 NT EPA hierarchy

In the development of the EMS outlined within this CEMP Santos applied the Environmental Decision-Making Hierarchy outlined within the EP Act. This hierarchy being:

+ To ensure that actions are designed to avoid adverse impacts on the environment
+ To identify management options to mitigate adverse impacts on the environment to the greatest extent practicable
+ And if appropriate, provide for environmental offsets in accordance with the EP Act for residual adverse impacts on the environment that cannot be avoided or mitigated[2].

[2] No offsets were deemed appropriate for this project.

7.2 Environmental performance objectives

Environmental performance objectives (EPOs) have been defined and are listed in following sections for each planned and unplanned event. The EPOs set the desired outcomes/goals for the activity, consistent with the NT EPA environmental factor objectives, and guide the setting or performance criteria.

7.3 Performance criteria

To assess whether EPOs are being achieved, specific performance criteria have been defined, taking the form of targets and performance indicators. Detailed specific measurable targets must be defined and then met to achieve overarching EPOs. Performance indicators are the factor that is measured to assess whether the performance targets have been achieved.

7.4 Management actions

To mitigate impacts of the DPD project construction activities and to achieve EPOs and performance criteria, management actions have been defined. This will include standard management actions that will be implemented as part of normal operations, and adaptive management actions that will be implemented if triggered.

7.5 Adaptive management mechanism

While the consequences of all planned impacts were assessed as either minor or negligible and the level of unplanned risks were assessed as low or very low, a monitoring and adaptive management mechanism will be applied to the following events to ensure EPOs are met:

+ Seabed and benthic habitat disturbance via generation of turbid plumes and sedimentation during trenching. These adaptive management actions are detailed in **Table 7-6** and the TSDMMP [BAS-210 0023]
+ Disturbance of marine fauna via noise generated during construction activities. These adaptive management actions are detailed in **Table 7-10** and the MMNMP [BAS-210 0045].

Adaptive management can also be triggered through Santos' incident response and assurance processes (**Section 8.3**), with corrective actions implemented and management adapted as required to address any identified incidents and non-conformances.

7.6 Planned event - impact management strategies

Santos' environmental impact assessment identified impacts related to nine planned events associated with DPD Project construction activities in the Project Area (Refer to **Section 6**).

7.6.1 Interaction with other marine users

7.6.1.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-2**.

Table 7-2: Interaction with other marine users (including construction activities and Project infrastructure) EPOs and associated performance criteria

EPO	Performance criteria	
	Target/s	Performance Indicator/s
Avoid incidents resulting from interaction with other marine users	Zero incidents resulting from interactions.	Number of recorded incidents
Minimise impacts to other marine users	Zero impacts to other marine users activities	Number of complaints from other marine users
Stakeholders are well-informed of the DPD Project and its associated restrictions	Stakeholder Engagement process followed	Records demonstrate that stakeholder communications (meetings, publications etc.) performed as indicated in Stakeholder Engagement process

These EPOs in conjunction with the economic benefits of the Project to the Darwin economy align with the following NT EPA Factor objective (NT EPA 2022):

+ Community and economy – Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.

The management actions for this planned event are shown in **Table 7-3**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-3: Management actions for interaction with other marine users

MA Reference	Management Action
Standard management actions	
Avoidance	
DPD-MA01	Intertidal and shoreline construction is in pre-disturbed area (DLNG footprint) with no public access
DPD-MA02	Installation of the pipeline within pre-agreed route, with minimal incursions into the shipping channel (as defined in consultation with the regional harbour master)
Mitigation	
DPD-MA03	Anti-snag protection for mechanical support structures
DPD-MA04	Activity vessels equipped and crewed in accordance with Australian maritime requirements
DPD-MA05	Development and implementation of communication plan (including applicable notifications) for relevant stakeholders (including recreational and commercial fishing bodies and tourism operations) to minimise adverse impacts on other marine users
DPD-MA06	Implementation of cautionary zones around DPD Project vessel to mitigate against adverse interactions
DPD-MA07	One vessel will act as a surveillance vessel within the operational area during gas export pipeline installation and trenching activity
DPD-MA08	The proposed pipeline route will be marked on marine charts, in the same way that the existing pipelines are gazetted and marked on marine charts
DPD-MA09	Construction activities undertaken in accordance with Santos HSE management and marine vessel vetting processes
DPD-MA10	Causeway/s will be temporary structure/s and will be removed following trenching and pipeline installation
Additional (ALARP) management actions	
Avoidance	
DPD-MA11	Pipeline will not be installed in the vicinity of the jewfish aggregation area within the Charles Point Wide RFPA

Table 7-4: Additional management actions not adopted for interaction with other marine users.

Additional management actions not adopted		Reasoning for rejection
1	Signage to alert small boat users of activities and key locations (e.g., boat ramps)	Evidence from previous construction activities in Darwin Harbour indicates that this is not an effective method of public notification. Therefore Santos has committed to ongoing consultation with relevant stakeholders to develop more effective public notification.
2	Divide the pipeline installation scope into multiple campaigns to minimise work performed during the Northern Prawn Fishery season periods of sensitivity (2 April to 15 June and 1 August to 21 November)	The Project Area does not overlap areas historically fished by prawn trawlers.

7.6.1.2 Demonstration of ALARP and residual impact

No alternative options to the use of vessels are possible to undertake the marine activity.

The presence of the vessels, the pipeline and associated infrastructure (together with cautionary zones) and causeway/s is not expected to significantly impact tourism, commercial and traditional fishing operations or shipping traffic, given the localised areas of vessel activities, the relatively short durations of activities at any given point along the pipeline route, the various routes that can be taken to avoid the area and the limited number of users active in the vicinity.

The proposed management controls for marine user interaction are considered appropriate to manage the risk to ALARP. Standard management actions to reduce interaction with other marine users due to vessel presence during construction activities have been adopted.

An additional management actions that was deemed practicable and reduce the consequence of the presence of the pipeline on other marine users has been adopted (**Table 7-3**). Additional management actions that have not been adopted and the reasoning for rejection are found in

Table 7-4. The overall worst-case consequence is assessed as Minor. If the management controls are adhered to, then the risk of interfering with other marine users will be reduced to ALARP and the impact level is considered Minor and acceptable.

Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities and the presence of the pipeline as detailed in **Section 9**.

7.6.2 Seabed and benthic habitat disturbance

7.6.2.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-5**.

Table 7-5: Seabed and benthic habitat disturbance EPOs and associated performance criteria

EPO	Performance criteria	
	Target/s	**Performance Indicator/s**
Minimise direct impacts to sensitive marine habitat, cultural values and socio-economic sensitivities	No trenching outside the pre-defined boundaries[1] of the trench areas	Records of dredging activities: + Post trenching hydrographic surveys + Dredge/excavation logs
	No anchoring on sensitive seabed areas	+ Number of recorded occurrences of anchoring inside anchoring exclusion zones
	No installation activities (pipelay, and causeway construction, trench backfill etc.) outside of the proposed footprint	Records of construction areas, including: + Construction activity logs, vessel logs + Post-construction survey

EPO	Performance criteria	
	Target/s	Performance Indicator/s
	No damage to known heritage sites of significance or existing submerged infrastructure	Number of recorded incidents resulting in damage to heritage sites/ artefacts of significance, or existing infrastructure
	Potential culturally significant objects discovered during construction reported and managed as per Unexpected Finds Protocol (BAS-210-0051)	Unexpected finds notification records
Avoid sediment dispersion and sedimentation related impacts on seagrass and hard coral habitats from trenching and spoil disposal activities	No DPD Project related reduction in water quality or sedimentation resulting in impact to seagrass and hard coral marine habitats	+ Water quality and benthic habitat monitoring data (refer to TSDMMP; BAS-210 0023) + Attributability assessments + Reports on adaptive management actions and effectiveness
Minimise impacts from spoil disposal	No spoil disposal outside of DPD spoil disposal ground	+ During and post spoil disposal Hydrographic surveys + Spoil disposal logs

Notes:

1. Boundaries of direct seabed and benthic habitat disturbance are defined by the trench design and any approved changes to that design.

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Coastal processes – Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.
+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.
+ Culture and heritage – Protect culture and heritage.

The management actions for this planned impact are shown in **Table 7-6**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-6: Management actions for seabed and benthic habitat disturbance

MA reference	Management actions
Standard management actions	
Avoidance	
DPD-MA12	Trenching, stabilisation and freespan correction/ prevention will only be undertaken at identified areas (using standard positional accuracy measures used in the industry)
Mitigation	
DPD-MA13	Overflow from the TSHD will be undertaken through the adaptive management processes There will be 'environmental valve' or 'green valve' where available (attached to O/F to reduce air entrained, to reduce billowing and facilitates sediment sinking) as standard which will be used as a first step
DPD-MA14	Standard operating procedure for spoil disposal will be used.
DPD-MA15	Spoil will not be disposed of in a single location, to avoid developing a single large mound.
DPD-MA16	Spoil will only be placed *in situ* within a short section of trenching within intertidal zones and will be removed subsequently where accessible by BHD and SHB for offshore disposal
DPD-MA17	When available, the base case is for the DP pipelay vessel to be used to install as much of the pipeline as depth allows DP vessel can be used in deeper water from KP23 (Territorial water boundary) to ~KP91.5 where the shallow water pipelay (<20 m) and associated anchoring will begin
DPD-MA18	Anchor management plans will be developed to allow safe anchoring of vessels undertaking pipelay, trenching and other support activities in the vicinity of sensitive habitats and nearshore heritage or sacred sites
DPD-MA19	Trained and competent anchor handling operators will be used
DPD-MA20	Anchors exclusion areas will be implemented to avoid sensitive habitats and heritage sites
DPD-MA21	Objects identified as cultural heritage objects that cannot be avoided will be managed as per NT Heritage Branch requirements

MA reference	Management actions
DPD-MA22	Differential global positioning system (DGPS) will be operational on the pipelay vessels to maintain accurate vessel position during installation
DPD-MA23	+ DGPS used to confirm ILT foundation structure position during installation + Underwater positioning system (USBL/ transponders) and ROV to confirm installation location and positioning (within required location accuracy to reduce disturbance to the seabed)
DPD-MA24	Installation plan will be developed and include: + requirement for trained and experienced vessel crews + pipe to be installed in trench as per approved design
DPD-MA25	Span-specific rectification plans developed that include: + pre-span method selection + real-time monitoring of span rectification + post-rectification inspections
DPD-MA26	Permanent rock installation will be limited to only those pipeline sections requiring stabilization and/or anchor protection, as informed by a quantitative risk assessment
DPD-MA27	Causeway/s will be temporary structure/s and will be removed following trenching and pipeline installation
Monitoring	
DPD-MA28	Adaptive management process will be implemented as defined within the TSDMMP (BAS-210 0023) which will include environmental monitoring of water quality with management measures applied if water quality exceeds trigger levels
DPD-MA29	Continuous monitoring of anchor wire tensions to prevent anchor drag on seabed and wire length measurement of the winch will be monitored to prevent anchor drag
Additional (ALARP) management actions	
Avoidance	

MA reference	Management actions
DPD-MA30	Pre-lay surveys will confirm the nature of the seabed within the ILT foundation location to ensure the structure is installed on bare area of the seabed. Post-lay surveys will allow verification of the impact assessment
DPD-MA31	Where practicable rock installation will not exceed seabed level within practical installation tolerances.

Table 7-7: Additional management actions not adopted for seabed and benthic habitat disturbance

Additional management actions not adopted		Reasoning for rejection
1	No trenching using CSD	Not technically feasible to stabilize and protect pipeline without trenching. The CSD is a significant mitigation in the event hard soils are encountered. Not utilizing the CSD may pose substantial schedule and cost impacts if harder soil types are encountered that are beyond the operating limits of the TSHD and BHD.
2	No trenching using TSHD	Not technically feasible to stabilise and protect pipeline without trenching using TSHD
3	No trenching using BHD	Not technically feasible to stabilise and protect pipeline without using BHD
4	Restrict timing of activities to operate outside of known sensitive periods. Flatback turtle peak nesting period is May to October and Dolphin peak calving is October to April.	Beaches closest to the Project Area are not considered significant turtle nesting beaches. Beyond ALARP to prevent trenching in peak dolphin calving period, based on excessive cost and schedule implications relevant to the potential minor impacts identified. Monitoring programs have been unable to determine spatial and temporal patterns in occurrence and abundance of dolphins in Darwin Harbour or any links to anthropogenic activities and behavioural disruption. Trenching areas are adjacent high use areas for vessels and the effects of turbidity are expected to be minor in the context of natural variability.
5	No offshore spoil disposal	Spoil will be generated from trenching activities. The only alternative is for onshore disposal of spoil, however the additional time in the field that would be required, would be prohibitive, prolong impact to other users of Darwin Harbour and additional environmental impacts would occur with onshore disposal. Given the minor impacts predicted from the offshore disposal of spoil, this control is rejected.
6	Spoil to be disposed of in a manner to create a uniform thickness of spoil	Spoil will not be disposed in one area only however will not be uniformly spread. The additional effort to ensure uniform thickness of spoil is not reasonably practicable in comparison to any potential benefits and would create additional turbidity. Sediment modelling has not identified re-suspension and ongoing transportation of sediments to be significant.

Additional management actions not adopted		Reasoning for rejection
7	No vessel anchoring	Given the shallow water depths, it is not feasible to use a DP vessel to install the pipeline and consequently, the use of an anchored pipelay vessel is required. Using a DP vessel will add a lot of noise in the shallow waters which is likely to be a bigger problem and disturbances from anchoring.
8	Pre-lay and post-lay benthic habitat surveys along the full gas export pipeline route	Habitats along the pipeline route are well known having been extensively studied through geophysical surveys and drop camera/ROV survey. The route has been shown to be devoid of unique habitat or high value primary producer habitat and additional surveys would provide no significant further information for informing management measures.
9	Pre-lay and post-lay surveys at anchoring locations	A conservative approach has been adopted for managing anchoring activities. Exclusion zones will apply to seabed areas identified as sacred sites, potential maritime heritage sites (identified by maritime heritage assessment) and mapped sensitive benthic habitat (hard coral and seagrass). Given the numerous anchoring locations which would be required to be surveyed and the conservative approach taken to delineate avoidance areas, pre- and post- anchoring surveys are considered to have a disproportionate level of cost and effort.
10	Pre-lay and post-lay surveys at ILT foundation location	Habitats along the pipeline route are well known as having been extensively studied through geophysical surveys and drop camera/ROV survey. The route has been shown to be devoid of unique habitat or high value primary producer habitat such as seagrass and hard corals. Pre- or pos-lay benthic habitat surveys would provide no significant further information of environmental benefit and have been ruled out.
11	Not using rocks to protect and stabilize the pipeline	Rocks are required to provide anchor protection adequate for mitigating risks associated with current and future vessel use within the Project Area. Rock protection has been reduced as far as practical while still maintaining adequate protection.
12	Do not use temporary causeway/s	Causeway/s required to allow excavator to access into deeper waters.

7.6.2.2 Adaptive management mechanism

An adaptive management process is defined within the TSDMMP (BAS-210 0023) which includes a water quality monitoring program with management measures applied if water quality exceeds turbidity trigger levels.

7.6.2.3 Demonstration of ALARP and residual risk

Trenching has been minimised as far as practicable to reduce impacts and where possible dynamic positioning (DP) vessel will be used to reduce anchoring disturbance.

Standard management actions have been adopted to reduce the impact of construction activities and the presence of the pipeline to the seabed and benthic habitats. Additional feasible management actions that reduce the impacts from seabed and benthic habitat disturbance have been adopted, including an adaptive management strategy designed to reduce turbidity effects from trenching through the application of management actions if monitored turbidity exceeds set threshold levels (detailed in the TSDMMP BAS-210 0023) (**Table 7-6**). Additional management actions that have not been adopted are outlined in **Table 7-6**, with the reasoning for their rejection.

Management actions are considered to manage risks to ALARP. Activities which may cause seabed and benthic habitat disturbance are localised in nature and there is a lack of unique habitats, hard coral or significant seagrass areas within the pipeline route and trenching areas. Additionally, original habitat that will be disturbed or removed is expected to recolonise rapidly on the pipeline and rock installation.

Residual impacts are expected to be temporary, as habitats under the pipeline and trenching zone footprints will be removed permanently but will recover rapidly as new habitat establishes. The area potentially impacted is small compared to the total area that the same habitats occupy outside of the disturbance footprint. The habitats in the direct disturbance footprint are not considered rare nor identified as critical foraging habitats for marine species. Additionally, no impacts are predicted to benthic habitats outside of the direct disturbance footprint. Therefore, no long-term impacts to marine species are expected.

Seabed disturbance created from trenching activities and construction activities associated with the causeway/s are not expected to significantly impact coastal processes, given the large volumes of water movement and temporary and localised nature of activities.

To avoid/manage impacts to maritime heritage, Santos has followed guidance provided by Department of Territory Families, Housing, and Communities – Heritage Branch. Additionally, Santos has received an Authority Certificate from AAPA for the DPD Project (Authority Certificate C2022/098) and will ensure conditions of the certificate and the requirements of the *Northern Territory Aboriginal Sacred Sites Act 1989* are met.

The residual impacts are therefore considered acceptable.

7.6.3 Onshore ground disturbance

7.6.3.1 Environmental performance objectives, performance criteria and management actions

The EPOs and performance criteria are described in

Table 7-8.

Table 7-8: Ground disturbance and clearing EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
Avoid impacts to native vegetation and fauna from ground disturbance and clearing	Ground disturbance within previously cleared areas	+ Recorded areas disturbed via excavation logs
	Zero incidents of disturbance to vegetation outside previously cleared areas	+ Number of recorded incidents of damage to environment outside of previously cleared areas
	Zero incidents of injury to terrestrial native fauna as a result of the DPD construction activities	+ Number of recorded incidents relating to terrestrial fauna injury or mortality as a result of ground disturbance.
Prevent project attributable mobilisation of heavy metals and acidification products to the surrounding environment	No incidents of project attributable mobilisation of heavy metals and acidification products to the surrounding environment	+ Records of ASS presence in sediment/soil via excavation logs/ daily observations/ photographs + Incident investigation records

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Terrestrial environmental quality – Protect the quality and integrity of land and soils so that environmental values are supported and maintained.
+ Terrestrial ecosystems – `Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.
+ Marine environmental quality (coastal water quality)
+ Marine ecosystem (marine fauna)

The management actions considered for this planned event are shown in **Table 7-9**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-9: Management actions for onshore ground disturbance during offshore DPD construction activities

MA Reference	Management Action
Standard management actions	
Avoidance	
DPD-MA32	Restrict disturbance to within the onshore Project Area and existing DLNG site area
DPD-MA33	Establish appropriate access restrictions into the onshore Project Area
Mitigation	
DPD-MA34	Direct stormwater runoff from the open trench to filter through the rock causeway, when present
DPD-MA35	Install geotextiles under primary construction area (i.e., site pad)
DPD-MA36	Return area to natural grade to match existing topography
DPD-MA37	All personnel to complete the DLNG HSE site induction
DPD-MA38	Maintain batters or install fauna ladders on trench entry and exit to allow fauna to exit the trench
DPD-MA39	Implement ASS and groundwater management and monitoring requirements within the ASSDMP (BAS-210-0049). The ASSDMP includes requirements for: + Soil stockpiling, laboratory testing and treatment, dependent upon location of work and encountering ASS + Groundwater laboratory testing and treatment, if groundwater is reached + Maintenance of testing and inspection records
DPD-MA40	Plan onshore works to minimise the amount of time soil is exposed to the air
DPD-MA41	Trench inspections to be performed daily to check for trapped wildlife

MA Reference	Management Action
DPD-MA42	Insert caps on ends of pipe if the pipe is to be unattended for periods >12 hours; to prevent fauna ingress.
DPD-MA43	Ensure any native vertebrates injured by DPD construction activities are referred to an appropriate wildlife carer group or veterinarian
Additional (ALARP) management actions	
Avoidance	
DPD-MA44	Limit vehicles to access roads, prepared site pad or defined boundaries within the onshore Project Area/DLNG disturbance
Mitigation	
DPD-MA45	Use water truck for dust suppression
DPD-MA46	Establish and implement vehicle speed controls
DPD-MA47	Wet parking area will be monitored daily, with photographs taken.

7.6.3.2 Demonstration of ALARP and residual impact

Construction works for the activities in this CEMP will be confined to the Project area and existing disturbed areas within the DLNG site area. Given the type of construction occurring there are no credible alternatives to reduce ground disturbance. **Table 7-9** details the management actions to reduce impact to onshore sediment quality, water quality, air quality, vegetation, and terrestrial fauna.

There will be regular inspections of trenches and preventative measures in place to control fauna egress. Engineering design will also prevent fauna entrapment.

During the construction of the Bayu-Undan pipeline natural material within the onshore Project Area was replaced by imported (non-ASS) fill material (generally sand) up to a depth of approximately 6 m below ground level. Hence it is considered that material at the site is likely to be non-ASS. None-the-less, should ASS material be encountered during earthworks within the onshore Project Area, it will be managed in line with the ASSDMP (BAS-210-0049).

Terrestrial fauna and vegetation may interact with stockpiled soils, however given that these will be managed within short temporal scales in accordance with the ASSDMP there would be an insignificant impact.

Given the temporary and localised nature of the impacts, and the existing disturbance at the site, the implementation of standard and additional (ALARP) management actions in place, including the implementation of the ASSDMP (BAS-210 0049) are appropriate for the nature and scale of this activity. Therefore, the assessed residual consequence for the impact of physical presence is minor and acid sulfate soils is negligible and both cannot be reduced further. Additional known residual impacts have been reduced to ALARP and are considered acceptable noise emissions

7.6.4 Noise Emissions

7.6.4.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-10**.

Table 7-10: Noise emissions EPOs and associated performance criteria

EPO	Performance criteria	
	Target/s	**Performance Indicator/s**
No significant impacts to protected marine fauna from noise generated during the DPD construction activities	Zero incidents of injury or mortality to EPBC Act listed marine fauna from noise generated during DPD construction activities	+ Activity logs in conjunction with MFO reports
	Zero incidents of dredging while EPBC Act listed marine fauna observed in exclusion zone	+ Activity logs in conjunction with MFO reports

This EPO aligns with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.

- Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this planned impact are shown in **Table 7-11**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-11: Management actions for noise emissions during routine construction including the use of an Xcentric Ripper tool

MA reference	Management actions
Standard management actions	
Avoidance	
DPD-MA46	Observation and exclusion zones for marine fauna developed based on noise modelling results and standard protocols
Mitigation	
DPD-MA49	Vessel inductions for all crew to address marine fauna risks and the required management controls
DPD-MA50	Vessel and helicopter to complete Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna
DPD-MA51	Personnel trained in MFO to be present on pipelay, dredge and rock installation vessels/barges during daylight hours, including one crew member with MFO training on the bridge at all times
DPD-MA52	All marine fauna interactions and observations to be appropriately recorded and reported to DEPWS/NT EPA and DCCEEW as required
DPD-MA55	Maintenance of vessel, vehicle and equipment combustions engines and vessel incinerators as per planned maintenance system
Additional (ALARP) management actions	
Avoidance	

MA reference	Management actions
DPD-MA56	Observation and shut-down zones for marine fauna have been developed based on noise modelling results for trenching and standard protocols and include: + Observation (150 m) and exclusion (50 m) zones for marine mammals and turtles. + Observation zone monitored for 10 minutes prior to commencing trenching during daylight only. A Marine Megafauna Observation and Adaptive Management Protocol for routine trenching operations, including the use of Xcentric Ripper tool, is to be followed as per MMNMP (BAS-210 0045)
Mitigation	
DPD MA62	+ Soft start (ramp-up) of hydraulic tools (rock breaking) by BHD, where practicable + Soft start (ramp-up) of trenching equipment, where practicable, will apply to the CSD and TSHD

Table 7-12: Additional environmental management actions for contingency rock breaking using hydraulic hammer

MA reference	Management actions
Contingency management actions	
1	Increased Observation and Exclusion Zones for hydraulic hammering based on noise modelling results will be applied as follows: + If up to 8 hours of rock breaking is required, an increased Observation Zone of 2.5km (marine mammals) and 1km (turtle) will apply and an increased Exclusion Zone of 150m for marine mammals and turtles will apply + If up to 6 hours of rock breaking is required, an increased Observation Zone of 2 km (marine mammals) and 750 m (turtle) will apply and an increased Exclusion Zone of 100m for marine mammals and turtles will apply + If up to 4 hours of rock breaking is required, an increased Observation Zone of 1.5 km (marine mammals) and 750 m (turtle) will apply and an increased Exclusion Zone of 100 m for marine mammals and turtles will apply + If up to 2 hours of rock breaking is required, an increased Observation Zone of 1 km (marine mammals) and 500 m (turtle) will apply and an increased Exclusion Zone of 50 m for marine mammals and turtles will apply

MA reference	Management actions
2	Contingency hydraulic hammering protocols for managing noise impacts will be followed as per MMNMP (BAS-210 0045)
3	Hydraulic hammering for no greater than 8 hrs over a 24 hr period.
4	No hydraulic hammering at night
5	A separate vessel with MFO onboard will be required to patrol the Observation Zone prior to and during hydraulic hammering

Table 7-13: Additional (ALARP) management actions not adopted for noise emissions

Additional management actions not adopted		Reasoning for rejection
1	Schedule trenching activities outside of peak flatback turtle nesting period (May to October) or outside of peak Darwin Harbour dolphin calving period (October to April).	+ It would not be possible to avoid both peak periods. + The potential benefit of avoiding locations of higher marine megafauna sensitivity at certain times of the year, such as nesting periods for turtles and dolphin calving periods, is considered disproportionately low compared to the implications to Project scheduling and costs - While there are known flatback turtle nesting sites (Cox Peninsula and Casuarina Beach), and a known period of increased nesting activity (May to October), the densities of nesting turtles in these areas are very low and not significant on a regional scale (Chatto and Baker, 2008). Furthermore, these sites are on a scale of 1000s of meters away from the pipeline route and trenching areas (as they are from existing vessel traffic using navigation channels) and the relative risk of behavioural effects to turtles at this scale from vessel noise is considered low (Popper et al., 2014). For dolphins, there is evidence that there is a peak in calving within Darwin Harbour between October and April (Palmer, 2010). Important areas have not been defined however and given the high mobility of dolphin species within Darwin Harbour and the use of adjoining coastal areas (Griffiths et al., 2019) it is unlikely that behavioural disturbance around DPD Project activities, relative to the total area of Darwin Harbour and surrounding coastal waters, would have a significant impact on calving behaviour.

Additional management actions not adopted		Reasoning for rejection
2	The observation period for marine megafauna prior to commencing dredging and pile driving is 20 minutes and the MFO is solely dedicated to the task of sighting and recording marine megafauna interactions prior to, and during, dredging and pile driving operations.	+ A 20-minute observation period was considered excessive for the size of the Observation Zone (150 m) and a 10-minute observation period was considered sufficient to monitor this zone for marine fauna. An additional 10 minutes would prolong dredging operations without any appreciable benefit. + A MFO for the pre-start up observation period was considered warranted however a MFO solely to the task of sighting and recording marine megafauna for the entirety of dredging operations was not considered warranted given that the dredging vessel to have multiple crew with marine fauna observation training onboard during daylight hours and the vessel bridge to be constantly manned with at least one crew with MFO training on the bridge at all times.
3	No use of DP vessels.	Not using DP vessels will cause additional seabed and benthic habitat impacts through the need to use anchoring to hold position during pipelay. The use of DP also decreases pipelay duration and reduces impact to other users through shorter timeframe.
4	Cease noise generating activities (e.g. DP) when near marine fauna.	Ceasing DP activities when near sensitive fauna may reduce the potential for impacts, however, the potential for impacts beyond behavioural disturbance are very low. Engine/DP thruster noise cannot reliably be ceased due to the safety critical role of vessel propulsion. It is also not practical to cease pipelay or other critical construction activities in a short timeframe as safely abandoning such operations can often take a number of hours (namely laying down the pipeline or disconnecting from a structure), during which time the impacted fauna will have left the area. Therefore, this control is not deemed feasible.
5	Soft start/power-up procedures for use of sonar equipment and use of fauna observation and shutdown zones.	The systems being used are at a low power or are an intermittent type such that the reduced cumulative exposure would reduce TTS or PTS impacts for marine fauna and behavioural impacts were not considered credible
6	No use of helicopters.	Use of helicopters required (e.g. vessel/crew transfers) and restriction will result in an overall longer duration construction activity and therefore noise impacts

Additional management actions not adopted		Reasoning for rejection
7	Avoidance of night work for routine trenching and Xcentric Hammer use.	Avoidance will result in an overall longer duration construction activity and therefore noise impacts and also increase the safety risk profile. The cost of implementing this far exceeds the benefit gained.

7.6.4.2 Adaptive management mechanism

Adaptive management mechanisms related to noise emissions are outlined in the MNMMP (BAS-210 0045).

7.6.4.3 Demonstration of ALARP and residual impact

Use of vessels and subsea equipment will be required to complete construction activities, therefore underwater noise emissions are unavoidable if the planned activity is to proceed.

Trenching and rock breaking activities will follow industry standard measures to prevent physiological impact to marine megafauna from noise, including implementation of Observation and Exclusion Zones and associated adaptive management measures, use of marine fauna observers to monitor zones and use of soft-starts where practicable. These zones have been informed by underwater noise modelling and appropriate thresholds to ensure the scale of these zones are sufficient to meet environmental objectives. In addition to the implementation of monitored zones, marine megafauna are expected to display avoidance behaviour of sound source at close ranges, thereby reducing the potential for physiological impact. For contingency hydraulic hammering, while not expected to be required, the zones have been increased significantly and additional measures put in place to ensure physiological impacts to do not occur to marine megafauna.

While there is the potential for behavioural response on larger scales of 100s of metres to 1000s of metres from continuous noise from trenching activities, depending upon fauna type, the activities are not expected to produce emissions significantly louder than other marine vessels that frequent or transit through the vicinity of the Project Area (e.g. cargo ships, LNG tankers, cruise ships and offshore oil and gas vessels). Given construction activity is temporary and trenching is expected to last for ~2-3 months, the addition of Project noise sources to the existing ambient noise environment is not expected to result in any significant additional behavioural effects within Darwin Harbour. The activity is unlikely to affect the health of and/or displace marine megafauna, as biologically important behaviours can continue given the widespread availability of suitable habitat within Darwin Harbour relative to the size of behavioural effect ranges.

Santos has considered the actions prescribed in various recovery plans and conservation advice, such as the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), when developing the controls relevant to potential construction activities to minimise noise impacts on marine fauna. Management controls are in place to reduce operating noise, including vessel operational protocols, and to adhere to the fauna interaction management stated in EPBC Regulations (Part 8). As such, noise emitted during the activities is not expected to significantly impact on marine fauna within the Project Area.

The potential benefit of avoiding locations of higher marine megafauna sensitivity at certain times of the year, such as nesting periods for turtles and dolphin calving periods, is considered disproportionately low compared to the implications to Project scheduling and costs. There are also mutually exclusive sensitivity periods for dolphins and turtles. While there are known flatback turtle nesting sites (Cox Peninsula and Casuarina Beach), and a known period of increased nesting activity (May to October), the densities of nesting turtles in these areas are very low and not significant on a regional scale (Chatto and Baker, 2008). Furthermore, these sites are on a scale of 1000s of meters away from the pipeline route and trenching areas (as they are from existing vessel traffic using navigation channels) and the relative risk of behavioural effects to turtles at this scale from vessel noise is considered low (Popper et al., 2014).

For dolphins, there is evidence that there is a peak in calving within Darwin Harbour between October and April (Palmer, 2010). Important areas have not been defined however and given the high mobility of dolphin species within Darwin Harbour and the use of adjoining coastal areas (Griffiths et al., 2019)

it is unlikely that behavioural disturbance around DPD Project activities, relative to the total area of Darwin Harbour and surrounding coastal waters, would have a significant impact on calving behaviour.

Other additional management actions were considered but rejected due to lack of feasibility, the associated cost or because the effort was disproportionate to any benefit (**Table 7-11**). Therefore, the risks to marine fauna from noise associated with the DPD Project activities are considered to be ALARP.

The potential consequence of noise emissions on receptors is assessed as II - Minor following the implementation of standard and additional (ALARP) management actions and will not have a significant impact on any habitat identified as critical to the survival of marine megafauna. With the management actions in place, no significant impacts are expected. Therefore, the impacts of noise emissions to the receiving environment are ALARP and considered environmentally acceptable.

7.6.5 Light emissions

7.6.5.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-14**.

Table 7-14: Light emissions EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
Minimise light disturbance to fauna and fauna habitat (including to turtle nesting beaches and turtle hatchlings)	Nighttime task light generation is minimised as described in management actions.	+ Records of vessel light spill on Darwin Harbour turtle nesting beaches + Records of HSE inspections. + Records of inductions i.e., inductions cover use of excessive task lighting at night

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this planned impact are show in **Table 7-11**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-15: Management actions for light emissions

MA Reference	Management actions
Standard management actions	
Avoidance	
DPD-MA58	Pipelay vessels will have enclosed pipe welding decks
Mitigation	
DPD-MA59	Shielding, where practicable, and/or orienting operational lights (excluding navigational lighting) on vessels to limit light spill to the environment
DPD-MA60	Housekeeping measures will be adopted, including requiring all crew to keep shutters on windows closed at night, to limit light emissions from vessels
Additional (ALARP) management actions	
Mitigation	
DPD-MA61	Vessel searchlights will only be operated in an emergency situation.
Monitoring	
DPD-MA62	Santos will document vessel light spill on Darwin Harbour turtle nesting beaches as part of the DPD Project's environmental monitoring program

Table 7-16: Additional management actions not adopted for light emissions

Additional management actions not adopted		Reasoning for rejection
1	Crew transfers or loading of supplies (not including linepipe deliveries) which require direction of floodlights outside vessel will not occur during hours of darkness within 10 km of turtle nesting beaches during peak hatchling season. Linepipe loading may require additional lighting as deemed necessary during operation to maintain a safely lit work area.	Nearby beaches are not significant turtle nesting beaches. Significant turtle nesting beaches are >10 km from the Project Area. Therefore, the cost of this management action is disproportionately higher than the change to environmental impact.

Additional management actions not adopted		Reasoning for rejection
2	Do not undertake gas export pipeline installation during peak turtle nesting and hatchling emergence season.	Nearby beaches are not significant turtle nesting beaches. Significant turtle nesting beaches are >10 km from the Project Area. Therefore, the cost of this management action is disproportionately higher than the change to environmental impact.
3	Sequence activities to limit the time pipelay, and associated activities, are performed within peak internesting periods and near important habitat for listed marine turtles.	Nearby beaches are not significant turtle nesting beaches. Significant turtle nesting beaches are >10 km from the Project Area. It is additionally not practicable to time the start date of the activity due to scheduling constraints. Therefore, the cost of this management action is disproportionately higher than the change to environmental impact.
4	Vessels shall be fitted with turtle friendly (low vapour sodium or LED) directional lighting (requirement applies to external lighting only).	Nearby beaches are not significant turtle nesting beaches. Significant turtle nesting beaches are >10 km from the Project Area. Not practicable to change out vessel lights for short duration activities and also lighting must meet navigational requirements. White lights required for operational requirements will be directed onto work areas and/or shielded to limit external light spill. It is therefore not feasible.
5	Marine fauna observers specifically looking out for turtle hatchlings entrapped within light spill with adaptive management measures should a significant number be spotted.	Possibility of entrapment will be low, due to use of shaded and directed inward lighting and with only very low density turtle nesting locations nearby. Nearby beaches are not significant turtle nesting beaches. While dedicated observers for turtle hatchlings are not proposed, project vessels will record all fauna interactions and incidents observed. Corrective actions will apply as part of the incident reporting and investigation process.
6	Do not perform pipe transfer operations at night when operating within 10 km of marine turtle nesting habitat during peak hatchling emergence season.	Nearby beaches are not significant turtle nesting beaches. If pipe transfer is restricted to day light hours, the pipelay vessel will run out of pipe and it will have to slow lay, stop laying or lay down the pipe . Slowing down pipelay will result in an increase in the amount of time that the pipelay is operating within 10 km of marine turtle nesting habitat. Light spill during pipe transfer will be minimal as flood lights will be directed onto the deck of the PSV and not the surface of the water. It is also temporary. Therefore, the cost of this management action is disproportionately higher than the change to environmental impact.

Additional management actions not adopted		Reasoning for rejection
7	Restrict lighting to navigation lights only	Operational lighting, including lighting of work areas and decks, is required for safe working conditions. Therefore, the cost and increased risk of this management action is disproportionately higher than the change to environmental impact.

7.6.5.2 Demonstration of ALARP and residual impacts

Artificial lighting is required 24 hours a day during the activity to maintain operational and navigational safety. A minimum level of artificial lighting is required on a 24-hour basis to alert other marine users of the activity. There are also minimum light requirements that will be necessary to provide safe working conditions. To reduce lighting at night further would restrict the activity hours resulting in the activity taking approximately twice as long to complete. This would increase the period of time the Project Area would need to be avoided by other marine users and the amount of waste, discharges and emissions produced. The larger scale consequences associated with reducing light levels during construction activities are disproportionate to the environmental benefits.

Lighting of the vessels is industry standard and required to meet relevant maritime and safety regulations. The potential consequences of the anthropogenic light sources in the Project Area are considered to be restricted to short-term behavioural impacts on individual fauna that may be present in the Project Area during the activity.

The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), the Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2020c) or the National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020b), as biologically important behaviours of nesting turtle adults and emerging/dispersing hatchlings at important sites can continue given that there are no regionally significant turtle nesting beaches close to the Project Area. Additional management actions that were considered feasible and cost effective were adopted (**Table 7-15**). Therefore, the use of 24-hour per day artificial lighting at an intensity to allow work to proceed safely is considered ALARP.

BIAs for flatback turtles overlap the Project Area. Significant impacts are not expected on nesting turtles or emerging/dispersing hatchlings, and light emissions from the activity will not cause turtles to be displaced from these habitats. The nearest known nesting sites are at Cox Peninsula and at Casuarina Beach, although these are not considered significant nesting areas and Casuarina Beach is additionally a popular recreational area with significant potential for land disturbance from people and animals, including lighting (e.g., bonfires).

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

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

The Project Area overlaps an internesting buffer habitat critical to the survival of flatback turtles, which extends 60 km from key nesting locations. However, internesting female turtles are not impacted by light emissions from either natural or anthropogenic sources, as they do not use light as a cue for this behaviour. Therefore, light emissions will not have a significant residual impact on marine turtles or any habitat identified as critical to the survival of marine turtles and residual impact is considered environmentally acceptable.

7.6.6 Routine vessel discharges

7.6.6.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-17**.

Table 7-17: Routine vessel discharges EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
Minimise environmental impacts from waste and liquid discharges generated during DPD construction activities	Zero environmental harm resulting from mismanagement of waste or liquid discharges	+ Number of recorded incidents and severity of incidents

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this planned impact are shown in **Table 7-18**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-18: Management actions for routine vessel discharges

MA reference	Management Action
Standard management actions	
Mitigation	
DPD-MA63	Vessels will comply with relevant Marine Orders with respect to planned discharges, including: + Marine Order 91 – Marine Pollution Prevention: Oil, which implements Annex I of the MARPOL + Marine Order 96 – Marine Pollution Prevention: Sewage, which implements Annex IV of the MARPOL
DPD-MA64	Santos Marine Assurance Process
Additional management actions	
N/A	

Table 7-19: Additional management actions not adopted for routine vessel discharges

Additional management actions not adopted		Reasoning for rejection
1	Storage and transport of sewage, putrescible and waste for disposal onshore regardless of legislative requirement.	Waste is managed in accordance with required legislative controls and discharge of sewage, greywater, and putrescible results in a negligible impact. The additional costs for transport and disposal, increased health, and safety risks (e.g., hygiene) and increased environmental impact (e.g., atmospheric emissions from vessels transporting waste) outweigh any environmental benefit gained.

7.6.6.2 Demonstration of ALARP and residual impact

Vessel waste is managed in accordance with marine legislation and results in negligible impacts in the discharge of sewage, greywater, and putrescibles. The additional costs, health and safety risks (i.e., hygiene) and environmental impact (i.e., emissions) outweigh any environmental benefit gained by taking vessel waste for onshore disposal. The Project Area is within NT waters i.e., within 3 nm of 'nearest land' (territorial baseline) therefore discharges of sewage and food wastes cannot occur in the Project Area (i.e., within 3 nm of land) as per MARPOL Annex IV and V. To reduce the impacts and risks associated with discharging liquid wastes, these wastes will be treated in line with industry best practice. Discharge of sewage and other liquid wastes from vessels in Australian waters is permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which reflects requirements of MARPOL 73/78 Annexes IV, V and I and AMSA Marine Orders 95 and 96. The MARPOL standard is considered to be the most appropriate standard, given the nature and scale of the activities. These standards are internationally accepted and used industry wide.

Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities as detailed in **Section 9**.

The proposed standard management actions and additional management actions that are considered feasible and cost effective for routine vessel discharges are considered appropriate to manage the risk to ALARP. Additional management actions that were not adopted are detailed in **Table 7-19**, with reasoning for their rejection.

Routine vessel discharges are not expected to have significant residual impact to the receiving environment with the management controls proposed, including compliance with all MARPOL requirements. Therefore, compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the residual impacts to a level which is considered environmentally acceptable.

7.6.7 Pre-commissioning water extraction and discharges

7.6.7.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-20**.

Table 7-20: Pre-commissioning discharges EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
Minimise environmental impacts from pre-commissioning water extraction and discharges generated during DPD construction activities	Zero environmental harm resulting from mismanagement of pre-commissioning water extraction and discharges	+ Number of recorded incidents and severity of incidents

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this planned impact are shown in **Table 7-21**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-21: Management actions for pre-commissioning water extraction and discharges

MA reference	Management Action
Standard management actions	
Mitigation	
DPD-MA65	Protection/screening of abstraction hose end to prevent fauna entrainment
DPD-MA66	Backflush water will be discharge onto existing disturbed shore crossing construction site so that it drains into the intertidal area and solids disperse with tidal movement, minimising turbidity effects
Additional management actions	
DPD-MA67	Where possible, and dependant on the progress of shore crossing rock installation at time of FCGT activities, backflush water will be discharged onto installed rock, to baffle the flow of discharged backflush water

Table 7-22: Additional management action not adopted for pre-commissioning water extraction and discharges

Additional management actions not adopted		Reasoning for rejection
1	Use of potable water instead of sea water for pre-commissioning activities	Potable water isn't typically used for pre-commissioning due to the difficulties in obtaining the large volumes required –potable water is normally transported by road tankers with only 20 – 30m^3 capacity, compared with ~ 50,000 m^3 required to fill the DPD Pipeline. Potable water would also require treatment with some chemicals such as oxygen scavengers and biocides to mitigate oxygen or bacterial corrosion. A reverse osmosis (RO) plant could be set up on site to manufacture "potable water" from sea water, but normally the chloride levels will be higher from an RO plant than potable water which could lead to corrosion. This would also need a sea water winning spread. This would introduce additional impacts such as discharge of a high salinity waste stream and would have large pumping/energy requirements.

7.6.7.2 Demonstration of ALARP and residual impact

There are no additional practicable alternatives to using seawater for pre-commissioning. Potable water is not used for testing due to the difficulties in obtaining the large volumes required. As discussed in **Table 7-22**, the use of potable water or an RO plant are not practicable.

The proposed standard management actions and additional management actions that are considered feasible and cost effective for pre-commissioning water extractions and discharges are considered appropriate to manage the risk to ALARP. Additional management actions that were not adopted are detailed in **Table 7-21**, with reasoning for their rejection.

Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities and the presence of the pipeline as detailed in **Section 9**.

Pre-commissioning discharges are not expected to have significant residual impact to the receiving environment with the management controls proposed, including compliance with all requirements. Therefore, compliance with the relevant and appropriate requirements and standards is expected to reduce the residual impacts to a level which is considered environmentally acceptable. Although, there is potential for marine fauna entrainment from water winning activities the abstraction hose will be fitted with protection/screening preventing this, which is deemed environmentally acceptable.

Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan and some bird and shark species. However, the routine vessel and pre-commissioning discharges are not expected to have significant residual impact to the receiving environment with management controls proposed. Therefore, the impact level of routine vessel and pre-commissioning discharges due to vessel-based activities is considered acceptable.

7.6.8 Atmospheric emissions

7.6.8.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-23.**

Table 7-23: Atmospheric emissions EPOs and associated performance criteria

EPO	Performance criteria	
	Target/s	Performance Indicator/s
Minimise environmental impacts from atmospheric emissions generated during DPD construction activities	Compliance with preventative maintenance procedures for equipment utilised for construction activities that generate atm emissions combustion engines, incinerators and ozone depleting substances (ODS) containing equipment	+ Planned maintenance records

These EPOs align with the following NT EPA Factor objective (NT EPA 2022):

- Air quality – Protect air quality and minimise emissions and their impact so that environmental values are maintained.

The management actions for this planned impact are shown in **Table 7-24.** Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-24: Management actions for atmospheric emissions

MA reference	Management actions
Standard management actions	
Mitigation	
DPD-MA55	Maintenance of vessel, vehicle and equipment combustions engines and vessel incinerators as per planned maintenance system
DPD-MA68	Atmospheric emissions from combustion, incinerators and ODS managed in accordance with standard maritime practice (MARPOL) MARPOL standards include no incineration in harbour
DPD-MA69	Monitoring and reporting of fuel consumption and calculated GHG emissions
DPD-MA70	Use of low sulphur diesel
Additional (ALARP) management actions	
N/A	

7.6.8.2 Demonstration of ALARP and residual risk

Power generation through combustion of fossil fuels is essential to undertaking the construction activities. There are no practicable alternatives to the use of equipment, vessels and vehicles powered by combustion engines for the activity. Given the routine maintenance of these systems by suitably qualified personnel, all practicable management measures are considered to have been implemented.

Atmospheric emissions from vessels are managed in accordance with marine legislation and results in negligible impacts. Part of the Project Area is within Darwin Harbour, where incineration is prohibited. The additional costs, health and safety risks and environmental impact (i.e., emissions) from returning waste to shore for vessel operating outside of the harbour (i.e., hygiene additional increased fuel combustion for additional vessel trips) outweigh any environmental benefit gained by preventing incineration.

There is no option other than to use refrigeration systems (e.g., air conditioning and food refrigeration) to provide acceptable workplace conditions and meet food hygiene standards. Additionally, there is no practical alternative to using ozone depleting substances (ODS) as refrigeration chemicals. Accidental release and fugitive emissions of ODS has the potential to contribute to ozone layer depletion. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with controls implemented, the likelihood of an accidental ODS release of material volume is considered rare.

Records of fuel consumption during construction works will be maintained to identify the quantity of GHG emissions generated from fuel combustion. This information would inform annual reporting under the *National Greenhouse and Energy Reporting Act 2007*. Atmospheric emissions from vessels are permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which is enacted in Australian waters by Marine Order 97 (Marine pollution prevention – air pollution) (which also reflects MARPOL Annex VI requirements). This is an internationally accepted standard that is used industry wide, and compliance with MARPOL standards is required under Australian law. Regulations include the requirement to control the level of NO_X and SO_X from vessel engines. Compliance with these requirements, together with implementation of the controls listed above, reduces to ALARP the environmental impacts associated with air emissions.

The assessed residual consequence for this impact is negligible and cannot be reduced further. It is considered therefore that the impact of the activities conducted is ALARP and considered environmentally acceptable.

7.6.9 Contingency pipeline discharges

7.6.9.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-25**.

Table 7-25: Contingency construction and pre-commissioning pipeline discharges EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	**Performance Indicator/s**
	No significant impact to marine water quality from due to	+ Water quality monitoring report

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
Minimise environmental impacts from contingency treated seawater discharge	contingency pipeline dewatering	
	Treated seawater chemical usage and discharge preformed as detailed in management actions (**Table 7-26)**	Contingency treated seawater discharge procedure and post-discharge report

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this planned impact are shown in **Table 7-26.** Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-26: Management actions for contingency construction and pre-commissioning pipeline discharge

MA reference	Management actions
Standard management actions	
Avoidance	
DPD-MA71	Pipeline installation procedures Maintenance requirements for pipelaying equipment to minimise risk of operational failure Redundancy in nearshore pipelay vessel anchors Pipelay vessel will have redundancy in station keeping capabilities in operating in DP2 (as a minimum)
Mitigation	
DPD-MA72	Chemical selection procedure for all chemicals planned to be release to the marine environment
DPD-MA73	Calibrated chemical dosing system in place to ensure accuracy of chemical dosing
DPD-MA74	If contingency use and discharge of treated seawater is required, the lowest required concentration of treated chemical will be evaluated and used (up to a maximum of 550 ppm) in order to meet pipeline preservation requirements.
DPD-MA75	Release of treated seawater from pipeline will be through a valve orientated vertically to promote dispersion and direct discharge away from seabed
Monitoring	
DPD-MA76	In the unlikely event that the pipeline requires contingency filling and subsequent dewatering of treated seawater in response to a wet buckle event and prolonged repair, water quality monitoring at the discharge location will be conducted to confirm the concentration and dispersion of treatment chemicals.

Table 7-27: Additional management actions not adopted for contingency pipeline discharges

Additional management actions not adopted		Reasoning for rejection
1	Do not discharge treated seawater	Chemically treated seawater will be used as a last resort, should it be necessary to ensure the long-term integrity of the Nearshore GEP Pipeline. If recovery from a wet buckle does not occur within a short period (days to 1-2 weeks), then the risk of corrosion beyond that already that already allowed for in the pipeline design will need to be mitigated, with the displacement of any raw seawater with treated seawater. Company requires the ability to use treated seawater to protect the integrity of the pipeline to cover all possible scenarios.

7.6.9.2 Demonstration of ALARP and residual impact

Contingency treated seawater discharge is a planned response to prolonged wet buckling or a stuck pig which is an unplanned event. The use of chemically treated seawater will only occur if it is necessary to ensure the long-term integrity of the DPD Pipeline (NT). If recovery from a wet buckle does not occur within a short period (days to 1 – 2 weeks), then the risk of corrosion beyond that already allowed for in the pipeline design will need to be mitigated, with the displacement of any raw seawater with treated seawater. Santos requires the ability to use treated seawater to protect the integrity of the pipeline to cover all possible scenarios.

Standard management actions have been adopted to reduce the impact of treated seawater discharge. All feasible and cost-effective additional management actions have been adopted to manage the risks to ALARP. Additional management actions that have not been adopted are described in **Table 7-26**, with the reasoning for rejection.

The potential consequences of contingency pipeline discharges has been determined by discharge modelling and impacts are predicted to be minor and not significant. The assessed residual consequence for this impact cannot be reduced further and is considered ALARP and acceptable.

7.7 Unplanned event - risk management strategies

The Santos environmental assessment identified six unplanned events associated with for the activities to be undertaken in the Project Area. Risk management strategies have been adopted in this CEMP based on the ENVID undertaken for construction activities in June 2022 (Refer to **Section 6**).

7.7.1 Dropped objects

7.7.1.1 Environmental performance objectives, performance criteria and management actions

The EPO relevant to this impact, including performance criteria, are described in **Table 7-28**.

Table 7-28: Dropped objects (including accidental release of non-hazardous waste) EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
No environmental impact resulting from accidental release of non-hazardous solid waste and dropped objects	Zero incidents of loss of equipment/cargo overboard from vessels resulting in a consequence II – Minor or above	+ Number of recorded incidents

These EPOs align with the following NT EPA Factor objectives (NT EPA 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this unplanned risk are shown in **Table 7-29**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-29: Management actions for dropped objects

MA reference	Management Actions
Standard management actions	
Avoidance	
DPD-MA63	Vessels will comply with relevant Marine Orders, including: + Marine Order 95 – Marine Pollution Prevention: Garbage
DPD-MA77	Implementation of Santos approved standards and procedures for outboard lifts
DPD-MA78	All lifting and winching equipment will undergo inspection, testing and certification as per applicable Laws, Codes and Standards
Mitigation	
DPD-MA79	Dropped object recovered where safe and practicable to do so
DPD-MA80	Identification of no lift zones where relevant in proximity to subsea assets and infrastructure as documented in relevant lifting and operational procedure/s
DPD-MA81	No outboard lifting operations will be completed in Company defined “no lifting zones” which will be identified in navigational systems
DPD-MA82	Emergency response implemented to minimise potential for impacts in the event a dropped object causes a loss of containment from the existing Bayu-Undan GEP
Additional management actions	
Avoidance	
DPD-MA83	Pipeline installed along pre-approved route, which is designed where practicable to avoid the potential for impact to habitat / cultural seabed features or assets from a dropped object.
Additional management actions not adopted	

MA reference	Management Actions
N/A	

7.7.1.2 Demonstration of ALARP and residual risk

Table 7-17 details the management actions adopted to reduce impacts of dropped objects to ALARP. These control measures are well understood and defined through legislative requirements and are standard industry practice. With the above controls in place, Santos considers the residual risk arising from a dropped object is ALARP.

The activity, and management actions will be conducted in a manner that is acceptable under the Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (Commonwealth of Australia, 2018), relevant recovery plans, conservation advice, and wildlife conservation plans.

With the controls in place to prevent accidental release of dropped objects the residual impact to the marine environment is considered low and reduced to a level that is considered acceptable.

7.7.2 Introduction of invasive marine species

7.7.2.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-30**.

Table 7-30: Introduction of invasive marine species EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
No introduction of invasive marine species (IMS) into NT waters as a result of the DPD construction activities	+ DPD Project vessels assessed as low risk for IMS prior to entry into Project Area/Darwin Harbour + Ballast water management will be done according to the Australian Ballast Water Management Requirements	+ Records of vessel IMS risk assessment + Ballast water records system maintained by vessels

These EPOs align with the following NT EPA Factor objective (NT EPA 2022):

+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this unplanned risk are shown in **Table 7-31**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-31: Management actions for introduction of invasive marine species

MA reference	Management Action
Standard management actions	
Avoidance	
DPD-MA84	Vessels equipped with effective anti-fouling coatings as required for class
DPD-MA85	Ballast water management will comply with MARPOL requirements (as applicable to class), Australian Ballast Water Management Requirements and *Biosecurity Act 2015*
DPD-MA86	Apply risk-based IMS management for vessels and immersible equipment – vessel and immersible equipment mobilised from outside of the Project Area/Darwin Harbour must be assessed as having a low risk of IMS prior to entering the Project Area/Darwin Harbour
DPD-MA87	Vessels having suitable anti-fouling coating (marine growth prevention system) in accordance with the *Protection of the Sea Act 2006*

Table 7-32: Additional management actions not adopted for the introduction of invasive marine species

Additional management actions not adopted		Reasoning for rejection
1	Use of Australian vessels only	Not feasible to only use Australian vessels given constraints on availability and suitability. This also doesn't guarantee that a vessel is IMS free depending on where in Australia the vessel is mobilised.
2	All vessels to be dry docked, cleaned, and inspected for IMS	Santos requires a risk assessment to be undertaken for project vessels which considers factors that lessen the risk of IMS incursion and requires vessel to achieve a low risk score. These factors include a vessel's history of dry-docking, cleaning and IMS inspection but these activities are not necessarily mandatory depending upon vessel history and other risk factors. The costs of applying mandatory dry-docking and cleaning is considered disproportionate given the existing risk-based approach being applied.
3	Heat or chemical treatment of ballast water to eliminate IMS	Cost and effort is considered to outweigh benefits given existing regulatory requirements for ballast exchange will be adhered to

7.7.2.2 Demonstration of ALARP and residual risk

Vessels and submersible equipment are required for the DPD Project.

Ballast water exchange will be managed consistent with the Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020a), and a vessel biosecurity risk assessment in accordance with the Santos IMSMP (EA-00-RI-10172) will be undertaken to demonstrate vessels have low risk of IMS introduction. The vessels and equipment that are internationally mobilised will meet Australian biosecurity requirements, and proposed management is consistent with National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia, 2009c).

Santos has adopted a risk-based approach to managing biofouling. Such an approach is consistent with other petroleum operators and is beyond that enforced on the majority of commercial and recreational vessels that regularly transit the same bioregion. International vessels are given the highest priority to prevent the introduction of IMS into Australian waters. However, domestic vessels (interstate and locally sourced) mobilising from outside of the Project Area/Darwin Harbour are also risk-assessed to reduce the likelihood of spreading marine pest species already established in Australian waters. The biofouling risk assessment approach adopted by Santos will ensure the associated regulations prohibiting the introduction of non-endemic marine species will be met.

A combination of international and domestic vessels will be sourced for construction activities. Standard management actions to reduce the risk of an introduction of IMS to ALARP have been adopted. Other identified management actions were deemed not feasible and the reasoning for their rejection is provided in **Table 7-31**. Therefore, with the above management actions and adherence to legislation and regulations , the risk of introducing IMS has been reduced to ALARP. Therefore, the residual risk associated with IMS is considered by Santos to be environmentally acceptable.

Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities and the presence of the pipeline as detailed in **Section 9** and have not raised any concerns regarding this aspect.

7.7.3 Unplanned marine fauna interaction

7.7.3.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-33**.

Table 7-33: Unplanned marine fauna interactions EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
No injury to or mortality of protected marine megafauna	Zero incidents of interactions resulting in the injury or mortality of marine megafauna	Number of recorded incidents relating to marine fauna injury or mortality MFO reports of sightings of live, injured or dead marine megafauna

These EPOs align with the following NT EPA Factor objective (NT EPA, 2022):

- Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this unplanned risk are shown in **Table 7-34**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-34: Management actions for marine fauna interaction

MA reference	Management Actions
Standard management actions	
Avoidance	
DPD-MA50	Vessel and helicopter contractor procedures will comply with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna
DPD-MA51	Personnel trained in marine fauna observation (MFO) will be present on pipelay, dredge and rock installation vessels during daylight hours, including one crew member with MFO training on the bridge at all times
DPD-MA65	Protection/screening of abstraction hose end to prevent fauna entrainment during water winning activities
DPD-MA88	Inductions to include observing marine fauna (e.g., crocodiles and shorebirds)
DPD-MA89	The TSHD shall be fitted with pre-sweeping mechanisms / chain curtains to mitigate turtle entrapment (fauna strike – unplanned)
Mitigation	
DPD-MA52	All marine fauna interactions and observations will be appropriately recorded and reported to DEPWS/NT EPA and DCCEEW
Additional management actions	
N/A	

Table 7-35: Additional management actions not adopted for unplanned marine fauna interactions

Additional management actions not adopted		Reasoning for rejection
1	Restrict the timing of activities to operate outside of known sensitive periods only. Flatback turtle peak nesting period is May to October and Dolphin peak calving is October to April	Project schedule is unable to avoid sensitive periods. Additionally, there is a low risk of impacts to individual fauna, and there is not expected to be an impact at population level or significant impacts on migratory or breeding behaviours.

Additional management actions not adopted		Reasoning for rejection
		Beaches closest to the project area are also not considered significant turtle nesting beaches so this control is not considered relevant.
2	Activities will only occur during daylight hours	Construction works need to occur 24/7 to maintain project schedule. Increased project schedule may result in increase in vessel movements and potential for more cumulative impacts.

7.7.3.2 Demonstration of ALARP and residual impact

No alternative options to the use of vessels are possible in order to undertake the activity. Any impact caused by the physical presence of vessels is likely to be localised and temporary behavioural impacts only (e.g., avoidance behaviour) and are not expected to significantly impact any key life-cycle processes of marine fauna. Marine species are expected to resume normal behavioural patterns in the waters surrounding the Project Area in a short time frame following completion of the construction activities.

TSHD and water winning activities pose a risk of fauna entrainment. Dredging has been listed as a key threatening process for turtles (Commonwealth of Australia, 2017a) with dredging equipment potentially being the direct source of turtle mortality however the TSHD shall be fitted with pre-sweeping mechanisms / chain curtains to mitigate unplanned impact with turtles. Additionally, the abstraction hose for water winning activities will have protection/screening for marine fauna. This is considered to manage this to ALARP.

The inherent likelihood of encountering fauna in the Project Area is limited by the expected behaviour of individuals to move away from vessel noise. With low vessel speeds and compliance with fauna interaction procedures, including Regulation 8 of the EPBC Regulations 2000, which aim to prevent adverse interactions of vessels with marine megafauna, a fauna collision is considered very unlikely. With the controls adopted, the assessed residual risk for this impact is ALARP.

Marine fauna interaction risks are well understood and subject to regulation. The vessels and personnel that are mobilised will meet Australian requirements, and proposed management is consistent with relevant recovery plans, conservation advice, wildlife conservation plans, including the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a). Vessel personnel will complete Inductions outlining fauna interaction requirements and, there will be watchkeeping maintained from the vessel bridge further reducing the impact.

Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities and the presence of the pipeline as detailed in **Section 9**.

It is considered that the proposed controls will reduce the residual level of impact to minor. Therefore, the residual risk associated with marine fauna interactions is considered by Santos to be environmentally acceptable.

7.7.4 Release of liquid hazardous materials

This section does not include management strategies for the release of fuels due to a vessel bunkering incident or a vessel tank rupture; these risks are discussed in **Section 7.7.5**.

7.7.4.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-36**.

Table 7-36: Release of liquid hazardous materials EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	**Performance Indicator/s**
No significant environmental impact resulting from release of hazardous materials	Zero incidents of release of hazardous materials to the marine environment during DPD construction activities	+ Number of recorded incidents
	Response to incident implemented as per the relevant emergency response plans	+ Incident report including details of response

These EPOs align with the following NT EPA Factor objectives (NT EPA, 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this unplanned risk are shown in **Table 7-37**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-37: Management actions for release of hazardous material

MA reference	Management actions
Standard management actions	
Avoidance	
DPD-MA90	Inspection and maintenance for all equipment containing chemicals/ hydrocarbons and chemical/ hydrocarbon storage areas
DPD-MA91	Santos chemical selection procedure applied for chemicals
DPD-MA92	ROV operations undertaken in accordance with good industry practice (in relation to hydraulic fluid control)
DPD-MA93	Procedures for helicopter refuelling
Mitigation	
DPD-MA95	Chemical storage areas designed to contain leaks and spills and inspected routinely
DPD-MA96	Spills will be managed in accordance with standard maritime practices as per vessel shipboard oil pollution emergency plan (SOPEP)
DPD-MA97	Spill clean-up kits available in high-risk areas
DPD-MA98	Bunding/secondary containment
Additional management actions	
N/A	

7.7.4.2 Demonstration of ALARP and residual impact

Storage and use of chemicals and hydraulic and lubricating oils or fluids for equipment and machinery, including for ROV operations, are required to undertake the DPD Project. While the use of hazardous chemicals cannot be avoided, the Santos chemical selection process will ensure that project chemicals are risk assessed and selected with consideration of alternatives, so hazardous chemicals are not discharged.

Only volumes of hazardous materials as required for maintaining vessel capabilities or for project-specific purposes will be stored or handled on-board the vessels. The vessels will implement safeguards, as per relevant AMSA Marine Orders/MARPOL and Santos requirements. Such safeguards include (but are not limited to) designated storage and handling areas, correct stowage, accurate labelling and marking, Safety Data Sheet (SDS) information, spill clean-up equipment and containment.

Other management actions will be implemented include vessel maintenance systems, chemical management procedures, and shipboard marine pollution emergency plan (SMPEP)/ spill response procedures included in shipboard oil pollution emergency plan (SOPEP) which will reduce the likelihood of an accidental release, and reduce the residual impact if a release does occur.

Containment of small spills and use of spill containment kits on-board vessels will reduce the risk of spills reaching the marine environment. The inspection and maintenance of bunding and drainage systems and of spill response kits provides assurance that these are available to contain spills. Hazardous liquids will be managed in accordance with relevant legislation and industry standards and Santos' procedures. Stakeholders have been informed throughout the preparation of the CEMP of the proposed vessel activities and the presence of the pipeline as detailed in **Section 9**.

The management actions proposed are in line with applicable actions described in relevant recovery plans and conservation advice to reduce the risk of habitat degradation and deteriorating water quality (for example, from pollution) to a level considered to be ALARP by Santos. The assessed residual risk for this impact is low. It is considered therefore that the impact of the activities conducted is ALARP.

With the management actions in place to prevent and mitigate accidental spills and the minor impacts predicted from a minor spill of hazardous chemicals/ hydrocarbons, the environmental risk is considered low. Potential risks are unlikely to be greater than those caused by other commercial marine vessels or offshore petroleum activities in deep water using the Project Area. Therefore Santos deems the risk acceptable.

7.7.5 Release of hydrocarbon (offshore vessel bunkering or vessel tank rupture)

7.7.5.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-38**.

Table 7-38: Hydrocarbon release (offshore vessel bunkering or vessel tank rupture) EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	Performance Indicator/s
No release of hydrocarbons to the marine environment as a result of the DPD Construction Activities	Zero incidents of unplanned discharge of hydrocarbons into the marine environment as a result of DPD construction activities	+ Number of recorded incidents

These EPOs align with the following NT EPA Factor objectives (NT EPA, 2022):

+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions for this unplanned risk are shown in **Table 7-39**. Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-39: Management actions for hydrocarbon release (offshore bunkering incident or vessel fuel tank rupture)

MA reference	Management Actions
Standard management actions	
Avoidance	
DPD-MA07	One vessel will act as a surveillance vessel within the operational area during gas export pipeline installation
DPD-MA99	Vessel-specific bunkering procedures and equipment consistent with Santos marine vessel vetting requirements including: + Use of bulk hoses that have quick connect 'dry break' couplings + Correct valve line-up + Defined roles and responsibilities, and the specific requirement for bunkering to be completed by trained personnel only + Visual inspection of hoses prior to bunkering to confirm they are in good condition + Testing of the emergency shutdown mechanism on the transfer pumps + Assessment of weather/sea state + Maintenance of radio contact with Vessel during bunkering operations + Bunkering checklist + Visual monitoring during bunkering + Ensuring deck drainage bungs are in place prior to bunkering + Marine Order 91 – Marine Pollution Prevention: Oil + Bunkering to commence in daylight hours
DPD-MA100	Vessel equipped and crewed in accordance with Australian maritime requirements
DPD-MA101	Safety exclusion zone around DPD Project construction vessels, e.g. pipelay vessels, and an NTM will be issued for offshore works advising all major shipping traffic formally. In addition, pipelay vessels will have attendant vessels that may act as guard vessels for work within the harbour
DPD-MA102	No intermediate fuel oil (IFO) or heavy fuel oil (HFO) will be used in activity vessels working in the Project Area

MA reference	Management Actions
Mitigation	
DPD-MA97	Spill clean-up kits available in high-risk areas
DPD-MA103	Implement tiered spill response as per DPD Project specific OPEP in the event of an MDO spill
Additional management actions	
Monitoring	
DPD-MA104	Santos to make oil spill tracking buoys available on primary project vessel/s with Santos CSR/s and/or at local supply base for immediate deployment to assist with tracking of an oil spill

Table 7-40: Additional management actions not adopted for release of hydrocarbon (offshore bunkering incident or vessel fuel tank rupture)

Additional management actions adopted		Reasoning for rejection
1	No bunkering of fuel during the pipeline installation activity	Vessels will routinely bunker when in port, as this is the safest and most cost effective means to refuel vessels. However due to the gas export pipeline installation method, the pipelay vessel cannot bunker alongside port facilities and requires bunkering within the operational area to undertake the activity. Following implementation of the selected existing controls, the risk reduction associated with eliminating bunkering at sea is considered to be negligible. The potential impacts to schedule and associated cost of implementing the control is considered to be grossly disproportionate to the reduction in risk. The control has not been adopted.
2	Bunkering only during daylight hours	Bunkering only during daylight hours increases the likelihood of detecting a leak, as surface hydrocarbon sheens are typically more visible under sunlight. Bunkering operations are typically completed during daylight hours; however, circumstances may occur where bunkering is required during darkness (e.g., large volume transfers at slow rates or when bunkering is safer to perform at night due to prevailing metocean conditions). Bunkering will only commence in daylight hours however.

Additional management actions adopted		Reasoning for rejection
		Following implementation of the selected existing controls, the risk reduction associated with prohibiting bunkering during darkness is considered to be negligible. The cost of implementing the control is considered to be grossly disproportionate to the reduction in risk. The control has not been adopted.
3	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the operational area	Project schedule is unable to avoid sensitive periods. Beaches closest to the Project Area are also not considered significant turtle nesting beaches. The cost of limiting the timing of activities would be excessive compared to the little to no reduction in risk of oil spill to significant turtle nesting beaches. Therefore, the impact to the Project schedule is greater than the environmental risk reduction.
4	Require all support vessels involved in the activity to be double hulled.	Cost and availability of double hulled vessels make this control not feasible.

7.7.5.2 Demonstration of ALARP and residual impact

The use of vessels is integral to activity and therefore risk of an unplanned hydrocarbon fuel releases cannot be eliminated completely.

Offshore vessel refuelling is standard industry practice and oil pollution legislation (*Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and MARPOL Annex I) has been developed to safeguard against the risk of a hydrocarbon spill occurring during refuelling. Other hydrocarbon types such as heavy fuel oil and intermediate fuel oil have specifically been prohibited as DPD Project vessel fuels, only MDO/marine gas oil (MGO) and aviation fuel will be used in the Project Area to ensure potential environmental impacts are reduced to ALARP.

The combination of the standard prevention management actions (**Section 7.7.5**) (which reduce the likelihood of the event happening), the spill response strategies (which will reduce the consequence) together reduce the overall hydrocarbon spill risk. Management controls that will be implemented, including pre-bunkering checklists spill clean-up equipment and SMPEP/SOPEP not only to minimise the risk of an accidental release, but also to reduce the impact if a release does occur. In addition to the vessel's SMPEP/SOPEP, Santos will provide support as required to a shipboard spill through the implementation of its DPD Project OPEP (BAS-210 0026). Resources available to be deployed by Santos to support a vessel base spill include spill tracking buoys which will be located onboard primary project vessels.

Barriers in place to contain spills (e.g. ensuring deck drainage bungs are in place prior to start of bunkering and spill containment kits) would prevent spills from reaching the marine environment. A vessel will act as a surveillance/guard vessel during gas export pipeline installation which will prevent collisions with Project vessels and other marine users. Santos will implement a safety exclusion zone around DPD Project construction vessels e.g. pipelay vessels and issue an NTM for offshore works further preventing vessel collisions.

Additional controls have been identified and given the controls in place detailed in **Table 7-40**, the assessed residual risk for this impact is Low and cannot be reduced further. It is considered therefore that the impact of the activities conducted is reduced to ALARP.

The potential impacts from an MDO/MGO release from a vessel collision are acceptable based on the residual risk ranking.

Relevant requirements have been met, including Santos' internal processes, COLREGS, SOLAS, STWC Convention and related Marine Orders. Pollution, such as could occur from a hydrocarbon spill, is identified as a threat in conservation advice for several marine species that may occur in the Project Area and as a threat in the North Marine Parks Network Management Plan (2018). Santos considers the selected controls are effective in managing the risk to these species and the to a level that is acceptable.

7.7.6 Release of dry natural gas

7.7.6.1 Environmental performance objectives, performance criteria and management actions

The EPOs relevant to this impact, including performance criteria, are described in **Table 7-41**.

Table 7-41: Release of dry natural gas EPOs and associated performance criteria

EPO	Performance Criteria	
	Target/s	**Performance Indicator/s**
No environmental impacts from the accidental release of dry natural gas	No releases of gas from the Bayu-Undan pipeline to the environment as a result of impact/drag or dropped object from the DPD construction activity	+ Number of recorded incidents
	Response to incident implemented as per the relevant emergency response plans	+ Incident report including details of response

These EPOs align with the following NT EPA Factor objectives (NT EPA, 2022):

+ Air quality – Protect air quality and minimise emissions and their impact so that environmental values are maintained.
+ Marine environmental quality – Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.
+ Marine ecosystems – Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.

The management actions considered for this unplanned risk are shown in **Table 7-42.** Environmental Performance Standards for these management actions will be defined and documented prior to finalisation of the CEMP.

Table 7-42: Management actions for release of dry natural gas

MA reference	Management actions
Standard management actions	
Avoidance	
DPD-MA77	Implementation of Santos approved standards and procedures for outboard lifts (including lifts over live infrastructure)
DPD-MA81	No outboard lifting operations will be completed in Company defined “no lifting zones”
DPD-MA82	Emergency response implemented to minimise potential for impacts in the event a dropped object causes a loss of containment from the existing Bayu-Undan GEP
DPD-MA105	Trenching will only occur within pre-programmed areas (using standard positional accuracy measures used in the industry)
DPD-MA106	Exclusion zones programmed on all primary vessels associated with the works to clearly indicate no entry zones and nearby pipelines – this will clearly identify areas for spud placement, anchor positioning and trenching activities
DPD-MA107	Navigation charts
Additional management actions	
Avoidance	
DPD-MA80	Identification of no lift zones where relevant in proximity to subsea assets and infrastructure as documented in relevant lifting and operational procedure/s

7.7.6.2 Demonstration of ALARP and residual impact

The proposed DPD pipeline will typically be within 100 m of the existing Bayu-Undan Pipeline; therefore vessels will be operating in the vicinity of the Bayu-Undan pipeline. Damage to the Bayu-Undan pipeline may be caused by structure impact/drag or a dropped object with potential to result in a release of dry gas to the environment. By having the DPD Project pipeline in close proximity (<100 m) to the Bayu-Undan pipeline, incursion into the shipping channel is reduced and seabed disturbance is concentrated adjacent to a previously disturbed corridor.

Stakeholders have been informed throughout the preparation of the CEMP of the presence of the pipeline as detailed in **Section 9**.

Implementation of the management actions relating to Santos standard lifting procedures and lifting procedures over live infrastructure and emergency response procedures reduces the risks to the environment and other users to ALARP. All additional management actions that were deemed feasible have been adopted to reduce the impact to ALARP (**Table 7-42**). There were no additional management actions that were identified and not adopted.

With the management actions in place to prevent an accidental release of dry natural gas, the likelihood level of 'unlikely' for a release and the minor impacts predicted from an unplanned release, the residual impact to sensitive receptors is reduced to very low and is environmentally acceptable.

8 Implementation strategy

This section presents the processes and procedures that will be implemented to ensure the environmental requirements within this CEMP will be met, including:

- Specific systems, practices and procedures that ensure both environmental impacts and risks are reduced to ALARP and Environmental Performance Objectives (EPOs), Performance Criteria and Performance Standards of this CEMP are being met;
- A clear chain of command, outlining roles and responsibilities of personnel involved in the implementation, management and review of this CEMP;
- Measures to ensure that employees and/or contractors working in relation to this activity are aware of their responsibilities regarding the environment and have the appropriate skill and training;
- Auditing, review and revision processes;
- Incident recording and reporting in line with Santos and regulatory requirements;
- Maintenance of quantitative records of discharges and emissions; and
- Details of emergency response and oil spill arrangements.

This implementation strategy is consistent with the Barossa Health, Safety & Environment Management Plan for Execute (BAA-200 0003).

Stakeholder engagement is assessed separately for the requirements of the activity. Ongoing stakeholder management strategies are discussed in **Section 9**.

8.1 Leadership, accountability and responsibility

To enable the DPD Project to succeed in meeting environmental objectives as outlined within this CEMP, the following measures apply:

- Appropriately skilled and qualified DPD Project team is established with HSE accountabilities, responsibilities, and resources clearly defined;
- Setting of EPOs and Performance Criteria (incl. Targets and Performance Indicators) and establishment of the practices and tools used to measure performance and drive continual improvement (**Section 7**); and
- Implementing HSE Leadership Teams with key contractors to discuss HSE performance and improvement

The Barossa Project Director is responsible for delivery of the Barossa Development, including the DPD Project, and has responsibilities for:

- Accountability for project HSE performance
- Demonstrating strong and visible HSE leadership
- Endorsing HSE performance indicators and targets
- Communicating HSE performance and events to the Chief Operating Officer, Upstream Oil & Gas
- and Group Executive Committee.
- Providing HSE resources.
- Engaging with senior regulatory managers.

The Barossa Project Director is supported by the Barossa Project Management Team. The effective implementation of this CEMP requires collaboration and cooperation among Santos Barossa Team personnel and contractors. The accountabilities of key Santos and contractor personnel in relation to the implementation, management and review of the CEMP is outlined in **Table 8-1**. Santos' OPEP will outline the roles and responsibilities in an emergency.

Table 8-1: Chain of command, key leadership roles and responsibilities

Title (role)	Environmental responsibilities
Office-based personnel	
Santos Barossa Subsea and Pipelines Manager	+ Confirm that the campaign is undertaken in accordance with this CEMP. + Provide sufficient resources to implement the management controls in this CEMP. + Confirm Contractor personnel attend an environmental induction (**Section 8.2.1**) upon commencing work on the campaign. + Action the management actions, as detailed in the EPSs in this CEMP (**Section 7**), as required, prior to the commencement of the activity. + Confirm the Contractor meets the requirements of the Santos management system and relevant standards/procedures.
Santos Barossa HSE Manager	+ Provide assurance that adequate resources are provided to support all environmental activities associated with this CEMP. + Develop a program to implement and monitor CEMP commitments. + Liaise with NT EPA, DITT, DCCEEW and other regulators. + Ensure incident notification process is in place and investigations completed to identify root causes. + Review and submit environmental performance reports and external environmental incident notification reports.
Santos Barossa GEP Package Lead	+ Confirm the campaign is undertaken in accordance with this CEMP. + Communicate any changes to the activity that may affect the risk and impacts assessment, EPOs, EPSs and MAs detailed in this CEMP to the Santos HSE team. + Coordinate resources required to enable the commitments in this CEMP to be maintained. + Confirm the reporting of environmental incidents meets both external and Santos' incident reporting requirements. + Liaise with Santos Environmental Advisor on environmental incidents and what constitutes a reportable incident. + Track and close out of any corrective actions raised from environmental audits as required by this CEMP.
Santos Marine Manager	+ Confirm vessel vetting as per the Santos Offshore Marine Assurance Procedure (SO 91 ZH 10001).

Title (role)	Environmental responsibilities
	+ Ensure relevant inspections are undertaken to confirm vessels comply with relevant Marine Orders and Santos marine standards/procedures and on boarding requirements to meet safety, navigation and emergency response requirements.
Santos Barossa Crisis and Emergency Management Specialist	+ Develop Santos Crisis Management and Emergency Response Plans and procedures. + Ensure emergency response drills are undertaken as per Santos Crisis Management and Emergency Response plans and procedures.
Santos Emergency Response Coordinator	+ Undertake Santos Incident Management Team (IMT) drills and exercises in accordance with the Crisis and Incident Management Exercise Schedule. + Undertake assurance activities on oil spill response arrangements + Review Santos Emergency Response Plans and procedures.
Santos Barossa Environmental Advisor/s	+ Develop offshore environmental approval documents, including DPD Project EMPs and OPEP, for submission and acceptance by DITT. + Provide environmental inductions to contractor personnel. + Ensure environmental inspections and audits are undertaken against CEMP commitments as per the Barossa Project Environmental Compliance Assurance Plan (BAA-200 0635). + Review and approve chemical products that will be discharged to the marine environment and require assessment. + Review biofouling risk assessments undertaken by Contractors. + Prepare environmental performance reports. + Advise on environmental incident reporting requirements, including what constitutes a reportable incident
Santos Barossa External Relations Advisor	+ Prepare and implement the relevant and interested persons consultation program for the DPD activity. + Manage and report on any relevant and interested persons consultation received in relation to the activity. + Undertake ongoing engagement with relevant and interested persons, for the duration of the activity, as required.
Contractor Project Manager	+ Undertake the pipelay installation in accordance with this CEMP. + Provide the resources required to enable the commitments in this CEMP to be maintained. + Confirm vessel management system and procedures are implemented and comply with the requirements detailed in this CEMP. + Confirm personnel receive an environmental induction that meets the requirements outlined in this CEMP

Title (role)	Environmental responsibilities
	+ Ensure invasive marine species and pests are risk assessment on all vessels mobilised to the operational area. + Ensure that all crew attend HSE inductions and that attendance records saved. + Ensure incidents are reported and investigated, as required.
Site and offshore based personnel	
Santos Senior Client Site Representative	+ Confirm contractors undertake the activity in a manner consistent with the EPOs and environmental management procedures detailed in this CEMP. + Confirm the management measures detailed in this CEMP are implemented. + Communicate any changes to the activity to the Santos Environmental Advisor. + Confirm all subsea chemical components and other fluids that may be discharged to the marine environment are approved for use. + Confirm that the Vessel Master and all crew adhere to the requirements of this CEMP. + Advise the Santos GEP Package Lead of any changes in activities that may lead to nonconformance with the EPOs in this CEMP. + Report environmental incidents to Santos GEP Package Lead.
Vessel Master (contractor personnel)	+ Confirm vessel management system and procedures are implemented and comply with the requirements detailed in this CEMP. + Confirm personnel receive an environmental induction that meets the requirements outlined in this CEMP on commencing work on the vessel. + Confirm crew personnel are competent to undertake the assigned work tasks. + Confirm SOPEP drills are undertaken in accordance with the vessel's schedule. + Comply with vessel entry and movement requirements within exclusion zones. + Maintain ballast water management plan, valid ballast water management certificate, ballast water management records, and Antifouling System Certificate specific to the vessel. + Maintain records of fuel use and vessel discharges/ transfers (including waste, sewage and oily water) as per MARPOL and Santos requirements + Confirm vessel crew are provided with sufficient training to implement the SOPEP/SMPEP (as appropriate to vessel class). + Ensure supervision of all bunkering/transfer operations to the vessel.

Title (role)	Environmental responsibilities
	+ Report any environmental incidents or non-conformance with the EPOs, EPSs or MA in this CEMP in accordance with Santos and statutory requirements.
Offshore Construction Superintendent (Contractor Personnel)	+ Responsible for ensuring that pipeline construction activities are performed in accordance with this CEMP.
Offshore HSE Advisors (Santos and/or Contractor)	+ Support the Santos Senior Client Site Representative to ensure that the controls detailed in this CEMP relevant to offshore activities are implemented and assist in collection and recording of evidence of implementation (other controls are implemented and evidence collected onshore). + Support the Santos Senior Client Site Representative to ensure environmental incidents or breaches of objectives and/ or standards outlined in this CEMP, are reported, and corrective actions for incidents and breaches are developed, tracked and closed out in a timely manner. + Ensure periodic environmental inspections/reviews are completed and corrective actions from inspections are developed, tracked and closed out in a timely manner. + Review Contractors procedures, input into Toolbox talks and JSAs. + Provide day to day environmental support for activities in consultation with the Santos Environmental Advisor.
All Project personnel	+ Act in an environmentally responsible manner. + Undertake work in accordance with accepted HSE systems and procedures. + Comply with this CEMP and all regulatory requirements as applicable to assigned role. + Report any unsafe conditions, near misses or environmental incidents immediately to supervisors. + Attend environmental inductions and HSE meetings, and complete training as required. + Report marine megafauna sightings as applicable to role in accordance with Project requirements

8.2 Workforce training and competency

This section describes the mechanisms that will be in place, so all Project personnel (including employee and contractor roles) are aware of his or her responsibilities in relation to the CEMP and has appropriate training and competencies.

8.2.1 Inductions

Santos and its contractors will develop a mandatory project induction, which will detail CEMP requirements. Project induction attendance will be logged and held with the Project Administration Assistant. Santos personnel will be required to complete required contractor site and facility inductions, including DLNG facility inductions, including permitting requirements, as applicable for working in and around the DLNG facility.

All Project site roles will complete an induction that will include a component addressing their CEMP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information about:

+ Environment, Health and Safety Policy
+ Regulatory regime
+ Operating environment (for example, nearby marine protected areas)
+ Activities with highest risk
+ CEMP EPOs, Performance Indicators and management commitments
+ Incident reporting and notifications
+ Regulatory compliance reporting
+ Importance of marine communications regarding any potential interactions with other marine users
+ Process for assessing changes to CEMP activities
+ Oil pollution emergency response.

8.2.2 Training and competency

The implementation of training requirements will ensure project personnel have the skills, knowledge and competencies to conduct work in a safe manner without harm to their health or the environment.

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

Santos and its contractors are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed using online databases, staff on-boarding process and training departments, etc. Personnel qualification and training records will be sampled before and/or during an activity. Such checks may be performed during the procurement process, inductions, crew change, and operational inspections and audits.

Crew trained in marine fauna observation will ensure marine megafauna can be reliably identified to species during observation periods.

8.2.3 Workforce involvement and communication

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

HSE performance will be monitored and reported during the activity, and performance metrics (including environmental performance indicators and the number of environmental incidents) will be regularly communicated to the workforce. Workforce involvement and environmental awareness will also be promoted by encouraging offshore personnel to report marine fauna sightings and marine

pollution (for example, oil on water, dropped objects). Findings, learnings and corrective actions identified from assurance activities and incident investigations will be communicated to project personnel to drive continuous improvement (e.g., through HSE Alerts, pre-shift / toolbox meetings).

8.3 Audits and inspections

Environmental Audits and Inspections undertaken to provide assurance of requirements within this CEMP are being met may include:

+ Vessel pre-mobilisation inspections
+ Routine vessel environmental inspections (weekly / monthly during Project execution)
+ Contractor Environmental Audits
+ Regulator Inspections and Audits (as required by Regulator)

For this CEMP the environmental audit and inspection processes are described in the Barossa Project Environmental Compliance Assurance Plan (BAA-200 0635).

An Environmental Assurance Activities Schedule (EAS) will be developed and maintained by the Barossa HSE Team which will align with the Barossa Project Integrated Audit Schedule. The EAS will provide an overview and schedule of assurance (verification) activities required to meet compliance for each activity (e.g., inspections, audits, assessments, and reviews). Additionally, it will allow Santos and the Barossa HSE Team to plan and resource appropriately to ensure all environmental assurance requirements can be met.

Audit criteria, as included within a terms of reference (ToR), will typically include a selection of management actions and environmental performance standards and outcomes; however, may also include parts of the activity description, stakeholder consultation and implementation strategies.

Audit findings may include opportunities for improvement and non-conformances (requirements not met). Audit non-conformances are managed as described in **Section 8.3.6**.

8.3.1 Environmental Incident Reporting

8.3.1.1 Internal incident reporting

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings and will be documented in the incident management systems as appropriate. HSE incidents will be investigated and reported in accordance with the Santos Incident Reporting and Investigation Procedure (SMS-HSS-OS07-PD01) and contractor procedures.

The incident reporting requirements will be provided to all crew on-board the facilities and support vessels with special attention to the reporting time frames to provide for accurate and timely reporting.

8.3.1.2 External incident reporting

Certain incidents will require notification to external Regulatory authorities under NT and Commonwealth legislation. This includes requirements below; additional requirements may apply as conditions of approval of the DPD Project.

8.3.2 Reportable incident – Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (Cth)

Reportable Incidents, defined as *"…an incident arising out of operations for the activity that is not within the parameters of the environmental performance standards in the environment plan in force for the activity"*, will be reported to DITT in accordance with Part 3 of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 which requires the following:

+ The operator of an activity must give notice of a reportable incident (either oral or written), with all material details of the incident that are reasonably available to the operator, to the Designated Authority as soon as possible after the first occurrence of the incident.
+ The operator must give a written report of the incident to the Designated Authority:
  - if the Designated Authority specifies a reasonable period for giving the report — within that period; or
  - in any other case — as soon as practicable after the first occurrence of the incident.
+ The report must set out fully:
  - all the material facts and circumstances of the incident that the operator knows or is able, by reasonable search and inquiry, to find out; and
  - the action (if any) taken to avoid or mitigate any adverse effects of the incident on the environment; and
  - the corrective action that has been taken, or is proposed to be taken, to prevent another incident of that kind.
+ The operator must keep a record of reports of each reportable incident, and of the details, in each case, of any corrective action taken.

8.3.3 Reportable incident – Waste Management and Pollution Control Act 1998 (NT)

As per Part 3 Section 14 of the Waste Management and Pollution Control Act 1998 (WMCA Act 1998), incidents causing, or that may threaten to cause, pollution resulting in material environmental harm or serious environmental harm, will be reported to the NT EPA as soon as practicable after (and in any case within 24 hours after) becoming aware of the incident. An incident includes "*an accident, emergency or malfunction and a deliberate action, whether or not that action was taken by the person conducting the activity in the course of which the incident occurred*".

A notification to the NT EPA of an incident as per Part 3 Section 14 of the WMCA Act 1998 will specify:

+ the incident causing or threatening to cause pollution;
+ the place where the incident occurred;
+ the date and time of the incident;
+ how the pollution has occurred, is occurring or may occur;
+ the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and
+ the identity of the person notifying.

8.3.4 Wildlife incident reporting

Any incident resulting in a significant impact to a species listed as threatened or migratory under the *Environmental Protection and Biodiversity Protection Act 1999* (EPBC Act 1999) is to be reported to DCCEEW as soon as practicable (and in any case within 24 hours) of becoming aware of the event occurring. For the Project Area, marine species listed as threatened or migratory under the EPBC Act include marine turtles (all species), dolphins, dugongs and crocodiles.

The report will contain:

+ time, location and description of the incident;
+ a summary of the response being undertaken; and
+ details of the relevant contact person.

Any occurrences of stranded, injured or entangled marine megafauna are also to be reported to NT Marine Wild Watch (1800 453 941) (DEPWS) as soon as practicable after observing.

8.3.5 Hydrocarbon/ hazardous substance spill reporting

External reporting requirements will include reporting to Darwin Port (for incidents within Darwin Port limits), NT EPA (as above) and the Australian Maritime Safety Authority (AMSA), including completion of a marine pollution notification (POLREP). Oil spill reporting is to follow any additional reporting requirements outlined within the DPD Project Oil Pollution Emergency Plan (BAS-210 0026).

8.3.6 Corrective actions

Corrective actions identified from environmental assurance activities and incident investigations will be derived in collaboration with contractors. For this CEMP, corrective actions and contingency processes are described as per the Barossa Project Environmental Compliance Assurance Plan (BAA-200 0635) and Barossa Health, Safety & Environment Management Plan for Execute (BAA-200 0003).

CEMP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Management System. Santos' incident and action tracking management system (HSE Toolbox) will be used to track corrective actions in the following instances:

+ Where there has been or potentially been a reportable incident
+ Where there has been a non-compliance in accordance with a statutory plan
+ Where any corrective action requires notification to an external regulatory or statutory body
+ Where there are corrective actions from formal audits (Contractor Pre-Start Audit, external regulator audit etc.).

Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

Environmental corrective actions identified through compliance assurance activities are to be promptly managed to ensure timeframes for external reporting are met and that decision making is made visible.

8.3.7 Continuous improvement

For this CEMP, continuous improvement will be driven by the list below and may result in a review of the CEMP, with changes applied in accordance with **Section 8.6.2**.

+ Improvements identified from the review of business-level HSE key performance indicators

- Actions arising from Santos and departmental HSE improvement plans
- Corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews
- Opportunities for improvement and changes identified during pre-activity reviews and MoC documents
- Actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 9**).

Identified continuous improvement opportunities will be assessed in accordance with the MoC process (**Section 8.6.2**) to ensure any potential changes to this CEMP are managed in a controlled manner.

8.4 Emergency preparedness and response

Emergency preparedness and response arrangements, applicable to activities covered by this CEMP, including for oil spill response, will be included in Santos and Contractor procedures.

8.4.1 Contractor emergency and oil spill response plans

DPD Project contractors are responsible for having comprehensive Emergency Response Plans (ERPs) that address emergency response actions associated with all credible incidents for the activity. These will describe the interface arrangements between Contractor and Santos Incident Management structures and cover all aspects of emergency response including technical, logistical and medical support.

Contractor ERPs will outline roles and responsibilities of contractor personnel for emergency events. The ERPs are accepted by Santos and reviewed on an annual basis by the contractor or if a significant change has occurred to the incident management or emergency response arrangements.

Scenario-based drills are performed to test the emergency response arrangements and updates are made to improve the ERPs, if required.

Contractor vessels undertaking activities covered by this CEMP are required, where applicable to vessel class, to have Shipboard Oil Pollution Emergency Plans (SOPEP) and/or Shipboard Marine Pollution Emergency Plans (SMPEPs) outlining hydrocarbon/ hazardous substance spill response arrangements, including response actions and equipment requirements. Vessels are required to conduct regular spill response drills as per arrangements detailed in these plans.

8.4.2 Santos incident management and oil spill response arrangements

Santos maintains Incident and Crisis Management Teams (IMT and CMT) and support arrangements to respond to all-hazard incidents, including oil spill incidents, at its sites and for activities under its control or influence, including activities covered under this CEMP. Santos' crisis and incident management arrangement are outlined within the Crisis, Incident Management & Emergency Response Procedure (SMS-HSS-OS05-PD01) and Incident Management Plan – Upstream Offshore (SO-00-ZF-00025). IMT and CMT training and exercise requirements, including OPEP exercises, are included within an annual training and exercise plan and schedule.

Specific oil spill response support strategies and arrangements for hydrocarbon spill scenarios covered in this CEMP will be outlined within the DPD Project Oil Pollution Emergency Plan (BAS-210 0026). This will include roles and responsibilities and response strategies / resources applicable for responding to worst case spill scenarios for DPD activities covered by this CEMP. The arrangements within the OPEP will provide support to, and interface with, response activities undertaken by onsite personnel (e.g., vessel oil spill response activities), as well as response activities coordinated by designated NT Control Agencies.

8.5 Reporting and notifications

Environmental reporting for the DPD Project construction activities will include reports between Subcontractors and Contractors, Contractors and Santos, and Santos and Stakeholders, including Regulatory authorities. Reports will be delivered within agreed upon timeframes. **Table 8-2** outlines an initial assessment of reporting requirements relevant to this CEMP.

External reporting requirements may be dictated by approval conditions associated with the DPD Project and finalisation of this CEMP will include all relevant external regulatory reporting requirements.

A detailed schedule of reporting requirements and submission dates for the DPD Project will be developed as per the Barossa Project Environmental Compliance Plan (BAA-200 0635).

Table 8-2: Summary of reporting requirements

Report/ Notification	Responsibility	Content	Frequency	Recipient
Pre-start				
OVID inspection reports	Santos Marine Assurance Team	Provides a summary of the findings of the support vessel inspection which assesses compliance with relevant international (e.g. MARPOL 73/78), Australian and Santos requirements.	Prior to commencement of the activity	Santos
Pre-start contractor audit	Santos Barossa Team	Confirmation of compliance with CEMP commitments relating to operational procedures and processes that Santos require to be in place prior to the commencement of the activity.	Prior to commencement of the activity	Santos
Pre-start notifications	Santos Barossa Team / Contractors	Details on DPD Project commencement to meet requirements of stakeholders (including Regulatory authorities)	Prior to commencement of the activity	Various stakeholders
Execution and completion				
Regular Stakeholder updates	Santos Barossa Team	Regular updates on DPD Project during planning and execution as per Stakeholder Management Plan (refer **Section 9**)	Throughout planning and execution	Various stakeholders
Contractor environmental execution audit	Santos Barossa Team	Confirmation of compliance with CEMP commitments relevant to execution of the activity.	Prior to completion of the activity	Santos
Vessel Daily Reports	Contractor Vessel Master	Update on day's activities, including any identified non-conformance against this CEMP, and any issues that may need addressing.	Daily	Santos

Report/ Notification	Responsibility	Content	Frequency	Recipient
Vessel Environmental Reports/Checklists	Contractor Vessel Master	Compliance against key regulatory and contractual commitments (including CEMP commitments). Reporting of fuel usage, vessel discharges and emissions etc.	Weekly/ Monthly[1]	Santos
HSE Meetings Records	Contractor and Santos Barossa Team	Monthly, dedicated HSE meetings are held with the offshore and Perth-based management (including contractor management) and advisors to address targeted health, safety and environment incidents and initiatives. Minutes of these meetings are produced and distributed as appropriate.	Monthly	Santos
Completion notifications	Santos Barossa Team /Contractors	Details on DPD Project completion to meet requirements of stakeholders (including Regulatory authorities)	Following completion of the activity	Various stakeholders
Unexpected Finds Notification	Contractor and Santos Barossa Team	Notification by Contractor of potential unexpected find of heritage value. Further notification to Maritime Archaeologist and NT Heritage Branch, as required, following Unexpected Finds Protocol.	Dependent upon occurrence of unexpected find of cultural value	NT Heritage Branch
Environmental Monitoring Reports	Santos Contractor and Santos Barossa Team /Environmental Monitoring Contractor	Reporting on the outcomes of environmental monitoring activities (including water quality and benthic habitat monitoring) associated with the DPD Project construction activities.	Various dependent upon program	Santos DEPWS DITT NT EPA DCCEEW (if required)

Report/ Notification	Responsibility	Content	Frequency	Recipient
Environmental Performance/ Compliance Assurance Report	Santos Barossa Team	Provides a summary of compliance performance, including the environmental performance objectives, standards and measurement criteria within this CEMP and any other conditions of approval on the DPD Project.	At completion of the activity and not less than annually	DITT NTEPA (DEPWS) DCCEEW (if required)
Incident reporting				
Incident Report – Internal	Contractor and Santos Barossa Team	Provides framework for Internal notification of incidents including spills. The first report contains tools for assessing the severity of the incident and escalating as per the incident notification procedure. Incident reporting will also be undertaken through Santos' online EHS Toolbox system.	Incident specific	Santos
Incident Report – Reportable Environmental Incident (P(SL)(MoE) Regs 1999)	Santos Barossa Team	Reporting of Reportable Incidents as per Part 3 of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (P(SL)(MoE) Regs 1999) (Refer **Section 8.3.2**)	Incident specific	DITT
Incident Report – Reportable Environmental Incident (WMPC Act 1998)	Santos Barossa Team	Reporting of Reportable Incidents as per Part 3 of the Waste Management and Pollution Control Act 1998 (WMPC Act 1998) (Refer **Section 8.3.3**)	Incident specific	NT EPA
Incident Report – Wildlife Incidents	Santos Barossa Team	Reporting of incidents involving EPBC Act species and reports of stranded, injured or entangled marine megafauna (Refer **Section 8.3.4**)	Incident specific	DCCEW DEPWS

Report/ Notification	Responsibility	Content	Frequency	Recipient
Incident Report – Hydrocarbon/ hazardous substance spill	Contractor and Santos Barossa Team	Reporting of NT oil spill incidents to Darwin Port (within port limits), AMSA and NT EPA. Additional oil spill reporting requirements as stated within the DPD Project Oil Pollution Emergency Plan (BAS-210 0026)	Incident specific	Darwin Ports AMSA NT EPA
Incident Report – Egress into wreck exclusion zone	Santos Barossa Team	Reporting of any egress into or disturbance of the exclusion zones of the Booya and Catalina 6 wrecks	Incident specific	Darwin Ports Harbour Master

1. As per the Barossa compliance assurance plan

8.6 Document management

This CEMP will be revised based on conditions of environmental approvals and/or licences and submitted to the appropriate regulator, for review and approval as required, prior to DPD Project implementation (i.e., commencement of construction activities).

8.6.1 Information management and document control

This CEMP, as well as any approved management of change (MoC) documents, are controlled documents and current versions will be available on Santos' document control system and made available to Project contractors.

As per the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (Cth)* the CEMP and all records associated with monitoring and reporting against CEMP commitments will be maintained for a period of five years. This includes revisions of the CEMP, and subordinate EMPs, written reports relating to environmental performance (monitoring, audit and review), records of emissions and discharges, records of calibration and maintenance of monitoring devices and records of reportable incidents.

The management and transfer of environmental assurance evidence between Santos and the primary construction contractor will be undertaken as per the Barossa Project Gas Export Pipeline (GEP) Environmental Compliance Assurance Plan (ECAP) Evidence Management and Transfer Procedure (BAS-210 0050).

8.6.2 Management of change

Following regulatory review and approval of this CEMP any changes to Project activities as described in this document, which have the potential to materially increase environmental impacts and risks, will be evaluated and controlled following the impact and risk assessment process followed in **Section 6**. The documentation and approval of management of change (MoC) assessments will follow the process outlined within the Santos Management of Change Procedure (SMS-LRG-OS01-PD04). MoC records will be retained and details of MoCs outlined within Regulatory compliance/performance reports.

As per the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (Cth)*, if a significant new environmental effect or risk is identified, or a significant increase in environmental effect of risk identified, which is not already provided for in the CEMP, a revision of the plan will be submitted to DITT as soon as practicable after the occurrence or identification of the significant effect or risk.

If there is a change in the petroleum instrument holder, or operator for the activity, a revision of the CEMP will be submitted to DITT as soon as practicable after the change.

8.6.3 Reviews

This CEMP addresses a temporary construction activity. Following approval, the CEMP will be reviewed annually, or as required in response to regulatory requirements and any changes to impacts, risks or management actions raised in Santos' assurance processes, incident response, stakeholder engagement or contractor engagement. These changes will be evaluated through the MoC process, and significant updates required to be communicated to regulators will be sent for review.

9 Stakeholder consultation

The stakeholder engagement approach used for the Project is in accordance with Santos's corporate approach to stakeholder engagement and industry leading standards and practice. The approach recognises and is aligned with the NT EPA's Guidance for Proponents – Stakeholder Engagement (NT EPA 2021a), the NT EPA's guidance for Preparing a Supplementary Environmental Report (NT EPA 2021b) and the International Association for Public Participation's (IAP2) Quality Assurance Standard for Community and Stakeholder Engagement (IAP2 2015).

Due to the iterative nature of the stakeholder process all relevant details have been contained in one document, the SER (BAS-210 0020), to contain updates to one location. The SER provides an outline of the objectives, process and key stakeholders consulted for the DPD Project. Additionally, the Stakeholder Engagement Plan (SEP) is attached to the SER. It details all consultation undertaken to date and information on future engagement activities.

In preparing the SER, and project management plans, Santos has considered and assessed each submission individually, and taken into consideration the issues raised when engaging with stakeholders to assess potential impacts and proposed management measures.

The SER provides a summary of the issues raised relevant to the Project and Santos' assessment and response to these issues. A full register, with all submissions and responses, is provided as an attachment to the SER.

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Attachment 1 Santos Environment, Health and Safety Policies

Environment, Health & Safety

Santos SMS

Policy

Our Commitment

Santos is committed to being the safest gas company wherever we have a presence and preventing harm to people and the environment

Our Actions

We will:

1. Integrate environment, health and safety management requirements into the way we work
2. Comply with all relevant environmental, health and safety laws and continuously improve our management systems
3. Include environmental, health and safety considerations in business planning, decision making and asset management processes
4. Identify, control and monitor risks that have the potential for harm to people and the environment, so far as is reasonably practicable
5. Report, investigate and learn from our incidents
6. Consult and communicate with, and promote the participation of all workers to maintain a strong environment, health and safety culture
7. Empower our people, regardless of position, to "Stop the Job" when they feel it necessary to prevent harm to themselves, others or the environment
8. Work proactively and collaboratively with our stakeholders and the communities in which we operate
9. Set, measure, review and monitor objectives and targets to demonstrate proactive processes are in place to reduce the risk of harm to people and the environment
10. Report publicly on our environmental, health and safety performance

Governance

The Environment Health Safety and Sustainability Committee is responsible for reviewing the effectiveness of this policy.

This policy will be reviewed at appropriate intervals and revised when necessary to keep it current.

Kevin Gallagher

Managing Director & CEO

Status: APPROVED

Document Owner:	Jodie Hatherly, General Counsel and VP Legal, Risk and Governance		
Approved by:	The Board	Version:	3

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Attachment 2 Summary of management actions

Management Action Reference	Management Action
Planned Events	
DPD-MA01	Intertidal and shoreline construction is in pre-disturbed area (DLNG footprint) with no public access
DPD-MA02	Installation of the pipeline within pre-agreed route, with minimal incursions into the shipping channel (as defined in consultation with the regional harbour master)
DPD-MA03	Anti-snag protection for mechanical support structures
DPD-MA04	Activity vessels equipped and crewed in accordance with Australian maritime requirements
DPD-MA05	Development and implementation of communication plan (including applicable notifications) for relevant stakeholders (including recreational and commercial fishing bodies and tourism operations) to minimise adverse impacts on other marine users
DPD-MA06	Implementation of cautionary zones around DPD Project vessel to mitigate against adverse interactions
DPD-MA07	One vessel will act as a surveillance vessel within the operational area during gas export pipeline installation and trenching activity
DPD-MA08	The proposed pipeline route will be marked on marine charts, in the same way that the existing pipelines are gazetted and marked on marine charts
DPD-MA09	Construction activities undertaken in accordance with Santos HSE management and marine vessel vetting processes
DPD-MA10	Causeway/s will be temporary structure/s and will be removed following trenching and pipeline installation
DPD-MA11	Pipeline will not be installed in the vicinity of the jewfish aggregation area within the Charles Point Wide RFPA
DPD-MA12	Trenching, stabilisation and freespan correction/ prevention will only be undertaken at identified areas (using standard positional accuracy measures used in the industry)

Management Action Reference	Management Action
DPD-MA13	Overflow from the TSHD will be undertaken through the adaptive management processes There will be 'environmental valve', 'green valve' where available (attached to O/F to reduce air entrained, to reduce billowing and facilitates sediment sinking) as standard which will be used as a first step
DPD-MA14	Standard operating procedure for spoil disposal will be used.
DPD-MA15	Spoil will not be disposed of in a single location, to avoid developing a single large mound.
DPD-MA16	Spoil will only be placed *in situ* within a short section of trenching within intertidal zones and will be removed subsequently where accessible by BHD and SHB for offshore disposal
DPD-MA17	When available, the base case is for the DP pipelay vessel to be used to install as much of the pipeline as depth allows DP vessel can be used in deeper water from KP23 (Territorial water boundary) to ~KP91.5 where the shallow water pipelay (<20 m) and associated anchoring will begin
DPD-MA18	Anchor management plans will be developed to allow safe anchoring of vessels undertaking pipelay, trenching and other support activities in the vicinity of sensitive habitats and nearshore heritage or sacred sites
DPD-MA19	Trained and competent anchor handling operators will be used
DPD-MA20	Anchors exclusion areas will be implemented to avoid sensitive habitats and heritage sites
DPD-MA21	Objects identified as cultural heritage objects that cannot be avoided will be managed as per NT Heritage Branch requirements
DPD-MA22	Differential global positioning system (DGPS) will be operational on the pipelay vessels to maintain accurate vessel position during installation
DPD-MA23	+ DGPS used to confirm ILT foundation structure position during installation + Underwater positioning system (USBL/ transponders) and ROV to confirm installation location and positioning (within required location accuracy to reduce disturbance to the seabed)

Management Action Reference	Management Action
DPD-MA24	Installation plan will be developed and include: + requirement for trained and experienced vessel crews + pipe to be installed in trench as per approved design
DPD-MA25	Span-specific rectification plans developed that include: + pre-span method selection + real-time monitoring of span rectification + post-rectification inspections
DPD-MA26	Permanent rock installation will be limited to only those pipeline sections requiring stabilization and/or anchor protection, as informed by a quantitative risk assessment
DPD-MA27	Causeway/s will be temporary structure/s and will be removed following trenching and pipeline installation
DPD-MA28	Adaptive management process will be implemented as defined within the TSDMMP (BAS-210 0023) which will include environmental monitoring of water quality with management measures applied if water quality exceeds trigger levels
DPD-MA29	Continuous monitoring of anchor wire tensions to prevent anchor drag on seabed and wire length measurement of the winch will be monitored to prevent anchor drag
DPD-MA30	Pre-lay surveys will confirm the nature of the seabed within the ILT foundation location to ensure the structure is installed on bare area of the seabed. Post-lay surveys will allow verification of the impact assessment
DPD-MA31	Where practicable rock installation will not exceed seabed level within practical installation tolerances.
DPD-MA32	Restrict disturbance to within the onshore Project Area and existing DLNG site area
DPD-MA33	Establish appropriate access restrictions into the onshore Project Area

Management Action Reference	Management Action
DPD-MA34	Direct stormwater runoff from the open trench to filter through the rock causeway, when present
DPD-MA35	Leave trench open at both ends to allow any fauna to egress freely
DPD-MA35	Install geotextiles under primary construction area (i.e., site pad)
DPD-MA36	Return area to natural grade to match existing topography
DPD-MA37	All personnel to complete the DLNG HSE site induction
DPD-MA38	Maintain larger batters on trench entry and exit suitable for fauna to exit the trench or include fauna ladders or similar
DPD-MA39	Implement ASS and groundwater management and monitoring requirements within the ASSDMP (BAS-210-0049). The ASSDMP includes requirements for: + Soil stockpiling, laboratory testing and treatment, dependent upon location of work and encountering of ASS + Groundwater laboratory testing and treatment, if groundwater is reached Maintenance of testing and inspection records
DPD-MA40	Plan onshore works to minimise the amount of time soil is exposed to the air
DPD-MA41	Trench inspections to be performed daily to check for trapped wildlife
DPD-MA42	Insert caps on ends of pipe if the pipe is to be unattended for periods >12 hours; to prevent fauna ingress.
DPD-MA43	Ensure any native vertebrates injured by DPD construction activities are referred to an appropriate wildlife carer group or veterinarian
DPD-MA44	Limit vehicles to access roads, prepared site pad or defined boundaries within the onshore Project Area/DLNG disturbance
DPD-MA45	Use water truck for dust suppression
DPD-MA46	Establish and implement vehicle speed controls

Management Action Reference	Management Action
DPD-MA47	Wet parking area will be monitored daily, with photographs taken.
DPD-MA48	Observation and shut-down zones for marine fauna have been developed based on noise modelling results and standard protocols
DPD-MA49	Vessel inductions for all crew will address marine fauna risks and the required management controls
DPD-MA50	Vessel and helicopter contractor procedures will comply with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna
DPD-MA51	Personnel trained in marine fauna observation (MFO) will be present on pipelay, dredge and rock installation vessels during daylight hours, including one crew member with MFO training on the bridge at all times
DPD-MA52	All marine fauna interactions and observations will be appropriately recorded and reported to DEPWS/NT EPA and DCCEEW
DPD-MA53	Soft-start procedures for rock breaking (BHD) for night-time activities where observation is not possible
DPD-MA54	Vessels will adhere to Port of Darwin vessel speed limits
DPD-MA55	Maintenance of vessel, vehicle and equipment combustions engines and vessel incinerators as per planned maintenance system
DPD-MA56	Observation and shut-down zones for marine fauna have been developed based on noise modelling results for trenching and standard protocols and include: + Observation (150 m) and exclusion (50 m) zones for marine mammals and turtles. + Observation zone monitored for 10 minutes prior to commencing trenching. A Marine Megafauna Observation and Adaptive Management Protocol will be included within the MMNMP (BAS-210 0045)
DPD-MA57	Soft start (ramp-up) of hydraulic tools (rock breaking) by BHD Soft start (ramp-up) of trenching equipment, where practicable, will apply to the CSD and TSHD
DPD-MA58	Pipelay vessels will have enclosed pipe welding decks

Management Action Reference	Management Action
DPD-MA59	Shielding, where practicable, and/or orienting operational lights (excluding navigational lighting) on vessels to limit light spill to the environment
DPD-MA60	Housekeeping measures will be adopted, including requiring all crew to keep shutters on windows closed at night, to limit light emissions from vessels
DPD-MA61	Vessel searchlights will only be operated in an emergency situation.
DPD-MA62	Santos will document vessel light spill on Darwin Harbour turtle nesting beaches as part of the DPD Project's environmental monitoring program
DPD-MA63	Vessels will comply with relevant Marine Orders with respect to planned discharges, including: + Marine Order 91 – Marine Pollution Prevention: Oil, which implements Annex I of the MARPOL + Marine Order 96 – Marine Pollution Prevention: Sewage, which implements Annex IV of the MARPOL
DPD-MA64	Santos Marine Assurance Process
DPD-MA65	Protection/screening of abstraction hose end to prevent fauna entrainment
DPD-MA66	Backflush water will be discharge onto existing disturbed shore crossing construction site so that it drains into the intertidal area and solids disperse with tidal movement, minimising turbidity effects
DPD-MA67	Where possible, and dependant on the progress of shore crossing rock installation at time of FCGT activities, backflush water will be discharged onto installed rock, to baffle the flow of discharged backflush water
DPD-MA68	Atmospheric emissions from combustion, incinerators and ODS managed in accordance with standard maritime practice (MARPOL) MARPOL standards include no incineration in harbour
DPD-MA69	Monitoring and reporting of fuel consumption and calculated GHG emissions

Management Action Reference	Management Action
DPD-MA70	Use of low sulphur diesel
DPD-MA71	Pipeline installation procedures Maintenance requirements for pipelaying equipment to minimise risk of operational failure Redundancy in nearshore pipelay vessel anchors Pipelay vessel will have redundancy in station keeping capabilities in operating in DP2 (as a minimum)
DPD-MA72	Chemical selection procedure for all chemicals planned to be release to the marine environment
DPD-MA73	Calibrated chemical dosing system in place to ensure accuracy of chemical dosing
DPD-MA74	If contingency use and discharge of treated seawater is required, the lowest required concentration of treated chemical will be evaluated and used (up to a maximum of 550 ppm) in order to meet pipeline preservation requirements.
DPD-MA75	Pipeline dewatering of treated seawater will be through valve orientated vertically to promote dispersion and direct discharge away from seabed
DPD-MA76	In the unlikely event that the pipeline requires contingency filling and subsequent dewatering of treated seawater in response to a wet buckle event and prolonged repair, water quality monitoring at the discharge location will be conducted to confirm the concentration and dispersion of treatment chemicals.
Unplanned Events	
DPD-MA07	One vessel will act as a surveillance vessel within the operational area during gas export pipeline installation
DPD-MA50	Vessel and helicopter contractor procedures will comply with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna
DPD-MA51	Personnel trained in marine fauna observation (MFO) will be present on pipelay, dredge and rock installation vessels during daylight hours, including one crew member with MFO training on the bridge at all times

Management Action Reference	Management Action
DPD-MA52	All marine fauna interactions and observations will be appropriately recorded and reported to DEPWS/NT EPA and DCCEEW
DPD-MA63	+ Vessels will comply with relevant Marine Orders, including: + Marine Order 95 – Marine Pollution Prevention: Garbage
DPD-MA65	Protection/screening of abstraction hose end to prevent fauna entrainment during water winning activities
DPD-MA77	Implementation of Santos approved standards and procedures for outboard lifts
DPD-MA78	All lifting and winching equipment will undergo inspection, testing and certification as per applicable Laws, Codes and Standards
DPD-MA79	Dropped object recovered where safe and practicable to do so
DPD-MA80	Identification of no lift zones where relevant in proximity to subsea assets and infrastructure as documented in relevant lifting and operational procedure/s
DPD-MA81	No outboard lifting operations will be completed in Company defined “no lifting zones” which will be identified in navigational systems
DPD-MA82	Emergency response implemented to minimise potential for impacts in the event a dropped object causes a loss of containment from the existing Bayu-Undan GEP
DPD-MA83	Pipeline installed along pre-approved route, which is designed where practicable to avoid the potential for impact to habitat / cultural seabed features or assets from a dropped object.
DPD-MA84	Vessels equipped with effective anti-fouling coatings as required for class
DPD-MA85	Ballast water management will comply with MARPOL requirements (as applicable to class), Australian Ballast Water Management Requirements and *Biosecurity Act 2015*
DPD-MA86	Apply risk-based IMS management for vessels and immersible equipment – vessel and immersible equipment mobilised from outside of the Project Area/Darwin Harbour must be assessed as having a low risk of IMS prior to coming onto activity

Management Action Reference	Management Action
DPD-MA87	Vessels having suitable anti-fouling coating (marine growth prevention system) in accordance with the *Protection of the Sea Act 2006*
DPD-MA88	Inductions to include observing marine fauna (e.g., crocodiles and shorebirds)
DPD-MA89	The TSHD shall be fitted with pre-sweeping mechanisms / chain curtains to mitigate turtle entrapment (fauna strike – unplanned)
DPD-MA90	Inspection and maintenance for all equipment containing chemicals/ hydrocarbons and chemical/ hydrocarbon storage areas
DPD-MA91	Santos chemical selection procedure applied for chemicals
DPD-MA92	ROV operations undertaken in accordance with good industry practice (in relation to hydraulic fluid control)
DPD-MA93	Procedures for helicopter refuelling
DPD-MA95	Chemical storage areas designed to contain leaks and spills and inspected routinely
DPD-MA96	Spills will be managed in accordance with standard maritime practices as per vessel shipboard oil pollution emergency plan (SOPEP)
DPD-MA97	Spill clean-up kits available in high-risk areas
DPD-MA98	Bunding/secondary containment
DPD-MA99	Vessel-specific bunkering procedures and equipment consistent with Santos marine vessel vetting requirements including: + Use of bulk hoses that have quick connect 'dry break' couplings + Correct valve line-up + Defined roles and responsibilities, and the specific requirement for bunkering to be completed by trained personnel only + Visual inspection of hoses prior to bunkering to confirm they are in good condition + Testing of the emergency shutdown mechanism on the transfer pumps + Assessment of weather/sea state

Management Action Reference	Management Action
	+ Maintenance of radio contact with Vessel during bunkering operations + Bunkering checklist + Visual monitoring during bunkering + Ensuring deck drainage bungs are in place prior to bunkering + Marine Order 91 – Marine Pollution Prevention: Oil + Bunkering to commence in daylight hours
DPD-MA100	Vessel equipped and crewed in accordance with Australian maritime requirements
DPD-MA101	Safety exclusion zone around DPD Project vessels and Notice to Mariners will be issued for offshore works advising all major shipping traffic formally. In addition, pipelay vessels will have attendant vessels that may act as guard vessels for work within the harbour
DPD-MA102	No intermediate fuel oil (IFO) or heavy fuel oil (HFO) will be used in activity vessels working in the Project Area
DPD-MA103	Implement tiered spill response as per DPD Project specific OPEP in the event of an MDO spill
DPD-MA104	Santos to make oil spill tracking buoys available on primary project vessel/s with Santos CSR/s and/or at local supply base for immediate deployment to assist with tracking of an oil spill
DPD-MA105	Trenching will only occur within pre-programmed areas (using standard positional accuracy measures used in the industry)
DPD-MA106	Exclusion zones programmed on all primary vessels associated with the works to clearly indicate no entry zones and nearby pipelines – this will clearly identify areas for spud placement, anchor positioning and trenching activities
DPD-MA107	Navigation charts