INTERNAL

Darwin Ship Lift Project

Dredge and Dredge Spoil Placement Management Plan

41213-HSE-PL-D-0001

REV	DATE	GENERAL DESCRIPTION	PREPARED	REVIEWED	APPROVED
E	10.01.2024	Issued for Client Review	M Pinkerton	J Weir	L Munro
F	17.01.2024	Issued for Client Review	M Pinkerton	J Weir	L Munro
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Revision History	
REV	**DETAILED DESCRIPTION**
A	Issued for Internal Review
B	Draft for Client Review
C	Issued for Internal Review
D	Issued for Client Review – Internal Comments Incorporated
E	Issued for Client Review - Client Comments Incorporated
F	Issued for Client Review - Client Comments Incorporated
G	Issued for Client Review - Client Comments Incorporated

Acknowledgement of Country

The Clough BMD JV respectfully acknowledges that the proposed Works outlined within this Plan will occur on the traditional Country of the Larrakia people from Darwin and its surrounds. We pay our respect to their elders past, present and emerging.

As the current and modern-day Traditional Custodians, we respectfully recognise the Larrakia community's deep-seeded and on-going relationship to the land and sea, through cultural beliefs, cultural heritage, caring for country and dreamtime stories. We embrace seeking greater cultural awareness, respect within the community and creation of beneficial outcomes, as we collaborate going forward.

Contents

1 Introduction

1.1 Purpose

The Dredge and Dredge Spoil Placement Management Plan (DDSPMP) provides a framework for the management of potential impacts to the environment from the dredging and dredged material placement activities associated with the Darwin Ship Lift Project.

This DDSPMP also satisfies condition 2-1 and 2-4 of *Environment Protection Act 2019* Environmental Approval EPA2023/028-001 (EP Approval), and condition 4 of *EPBC Act 1999* Approval EPBC2021/9068 (EPBC Approval).

The DDSPMP has been developed in accordance with the following documents:

- Darwin Shiplift Project Construction Environmental Management Plan (CEMP) (41213-HSE-PL-G-1002)
- Darwin Shiplift Project Marine Megafauna Management Plan (MMMP) (41213-HSE-REP-D-1002)
- Darwin Shiplift Project Draft Environmental Impact Statement (AECOM, 2021)
- Darwin Shiplift Project Supplementary Environmental Impact Statement (AECOM, 2022a)

1.2 Project Overview

The Northern Territory Government (NTG) is delivering the Darwin Ship Lift Project (the Project) which comprises construction and operation of a ship lift facility and an adjacent maintenance facility at East Arm. The early stages of the Project have been managed by the Department of the Chief Minister and Cabinet (DCMC), which is responsible for economic development and supporting business growth and sustainability in the NT. The Project is being managed through the construction and operational phases by the Department of Infrastructure, Planning and Logistics (DIPL).

The Project will enable maintenance and servicing of a broad range of industries, including the Australian Defence Force (ADF) and Australian Border Force (ABF) vessels, as well as commercial and private vessels, including those servicing the oil, gas, pearling, fishing and other marine industries. It will be northern Australia's largest common user ship lift and will provide marine infrastructure that will deliver key services to northern Australia, acting as an enabler for the continued economic growth of Darwin as the logistics and marine services hub of the Northern Territory (NT) and northern Australia.

The Clough Projects Australia Pty Ltd (Clough) and BMD Constructions Pty Ltd (BMD) have established an unincorporated and fully integrated joint venture (Clough BMD Joint Venture / CBJV) for the execution of the Darwin Ship Lift Project to the Northern Territory of Australia (also referred to as the 'Territory') under a Collaborative Construction Contract. Throughout this plan the Northern Territory Government (NTG) is hereby referred to as the Territory or Client.

1.3 Project Description

The Project site is situated approximately 6.5 km south-east of the Darwin Central Business District (CBD), on the East Arm Peninsula within Darwin Harbour, east of East Arm Wharf (EAW) and on the seaward side of Berrimah Road (**Figure 1**).

The facility is proposed to include:

- A shiplift and transfer system, Lloyds Register Certified for Compliance with Code for Lifting Appliances in a Marine Environment, July 2020.
- A shiplift control room for shiplift, SPMT vessel transfer system, SPMT shed, administration building and gatehouse.
- A vessel wash-down bay, blast and paint structure and hardstand.

- A dry berth hardstand for vessel repair and maintenance.
- Trestles for vessel support (out of water), lifting and transfer.
- Quay structures for 6 berths.
- Reclamation and hardstand.
- Marine structures, bunds, revetments, shore protection, and lead-in dolphins.
- Berth fixtures, including fenders, bollards, mooring systems, ladders, and operational safety infrastructure (eye wash stations, buoyancy rings and spill kits).
- Dredged berth pockets, manoeuvring basins, and adjustments to connect to existing shipping channel.
- Services including electrical, communication, potable water, sewerage, waste management, fire water, lighting, access control system and CCTV.
- Security fencing, gates, boom gates.
- An access road, intersection upgrade and internal infrastructure.

The shiplift will have the capacity to lift vessels such as Cape Class Patrol Boat (Australian Border Force) and SEA 1180 Luerssen Arufura Class OPV (Navy), OSV/PSV MMA Plover, Brewster and Responder, and OSV/PSV Pacific Harrier, Hawk, Herron, Hornbill and Navy Frigate ANZAC Class.

The facility will be delineated into two discrete areas, one of which will be privately operated, and the other will be designated as a Common User Facility, which will enable vessel owners to choose and manage their own service and maintenance providers. This will also enable multiple providers to operate concurrently at the facility.

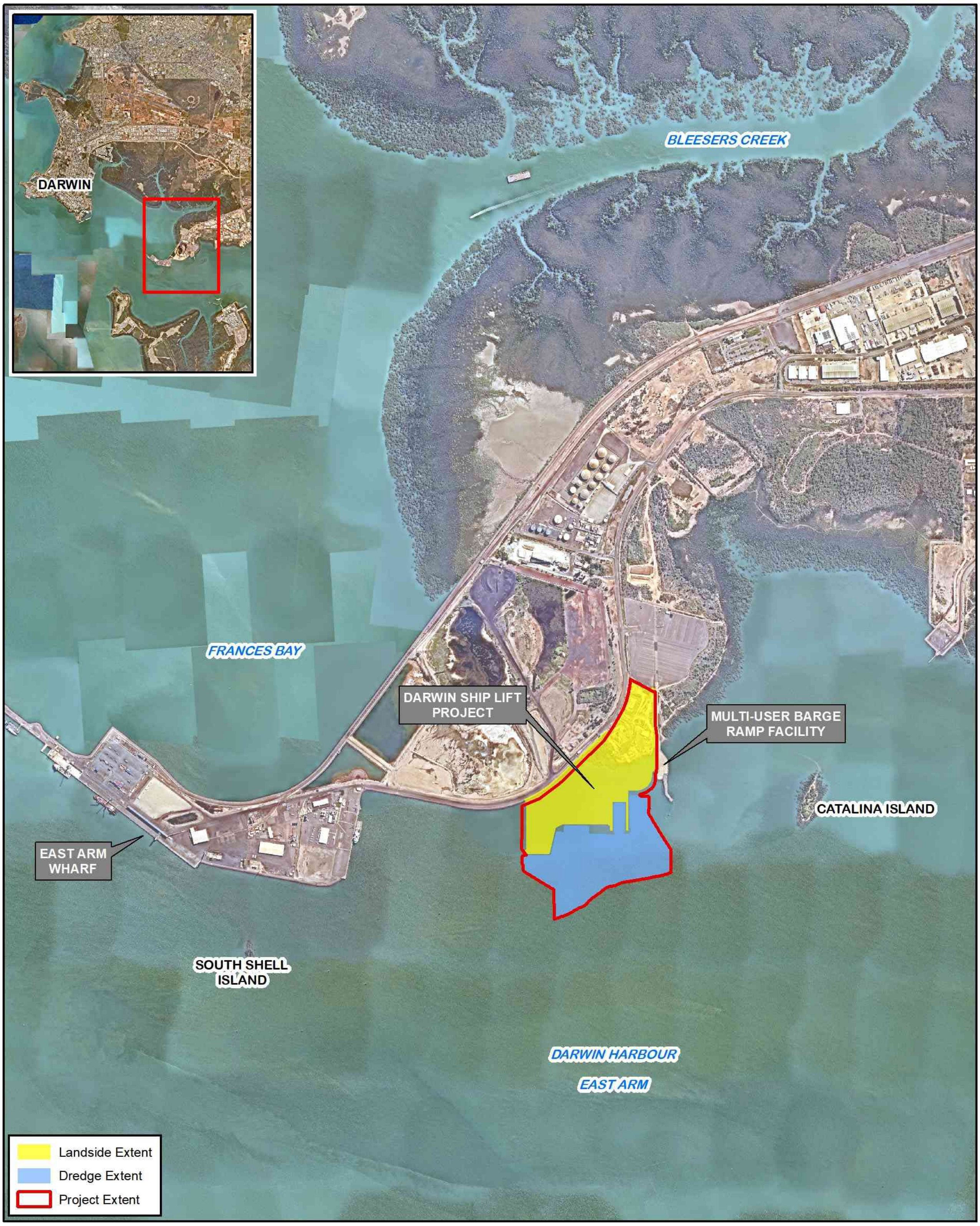

Figure 1 Darwin Ship Lift Project Location

Figure 2 shows the location of the Darwin Shiplift facility, and the location of the settlement ponds used during dredging. Development of the Project will require dredging of a manoeuvring basin, berth areas and ship lift zone to provide safe navigable water depths for the proposed vessel sizes and access to the deeper waters within East Arm.

Figure 2 Darwin Ship Lift Project Location and Settlement Ponds

The areas to be dredged will comprise:

- ship lift at declared dredge depth -7.5 m lowest astronomical tide (LAT) (Declared dredge level – 7.2mLAT)
- wet berths at -6.8 m LAT (Declared dredge level – 6.5mLAT)
- manoeuvring basin areas at -3.3 m LAT (Declared dredge level – 3.0mLAT)

There are two components to the dredging program:

Capital dredging (excluding maintenance dredging) shall not exceed 520,000m³ and shall occur within the approved extent, of which:

- 173,430m³ is Estuarine sediments (unconsolidated material) which are intended on being dredged with a Cutter Suction Dredge (CSD) and the balance of:
- 343,675m³ comprises material beneath the estuarine sediments including residual soil, weathered rock, bedrock (Laterite, Siltstone, Sandstone, Shale, Conglomerate) and bedrock (quartzite) (consolidated materials) which is intended to be dredged using a large Backhoe Dredger (BHD) for incorporation into the reclamation.

The above dredging figures are based on detail design drawings WGA230105-DR-CV-104110, WGA230105-DR-CV-104111, Amendment A. The dredging quantities are subject to change based on design layout, however, shall not exceed the approved quantity of 520,000m³ outlined in EP2023/028-001.

The approved extent as constrained by the EP Act Approval EP2023/028-001 is provided in **Figure 3**. The action area is represented by the brown shaded zone and Ponds K and E spoil disposal areas. The cation area includes the area between the brown shaded area and Pond K for the purposes of the pipeline used for the transport of dredged material.

Details of the proposed dredging and dredged material placement methodologies are presented in Section 4.

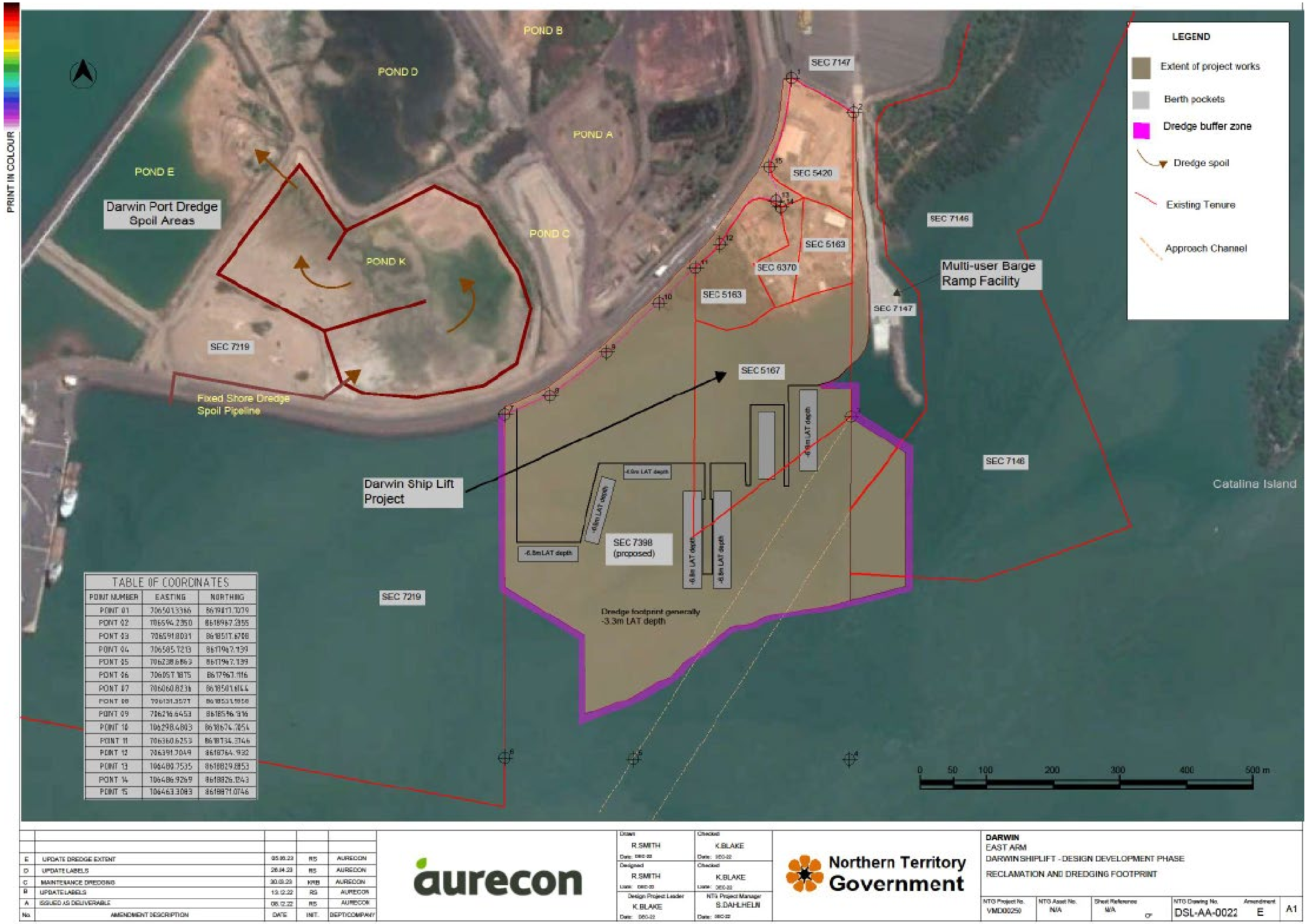

TABLE OF COORDINATES		
POINT NUMBER	EASTING	NORTHING
POINT 01	706501.3366	8618817.7079
POINT 02	706594.2350	8618967.2355
POINT 03	706591.8031	8618517.6708
POINT 04	706585.7213	8617967.139
POINT 05	706238.6863	8617967.139
POINT 06	706057.1875	8617963.116
POINT 07	706060.8236	8618501.6144
POINT 08	706131.3571	8618531.1958
POINT 09	706216.6453	8618596.316
POINT 10	706298.4803	8618674.7054
POINT 11	706360.6253	8618734.3746
POINT 12	706391.7049	8618764.932
POINT 13	706480.7535	8618829.6853
POINT 14	706486.9269	8618826.1243
POINT 15	706463.3083	8618871.0746

Figure 3 Location for the proposed Action

1.4 DDSPMP Objectives and Targets

The Objectives relevant for this DDSPMP are:

Project construction activities must be carried out to achieve the environmental objectives included in Environmental Approval (EP2023/028-001), including the following:

- Protect the quality and productivity of water, sediment and biota so that environmental values are maintained within Darwin Harbour beyond the approved extent of the project.
- No material environmental harm to the environmental values and declared beneficial uses of Darwin Harbour beyond the approved extent, including but not limited to the quality or productivity of water, sediment and biota [2-1(1) of the EP approval].
- Minimise risks of physical injury, mortality, behavioural changes and health impacts on marine megafauna [2-1(3) of the EP approval].
- Dredging and land reclamation must not cause any adverse impact on water quality, or the condition or distribution of benthic communities or marine megafauna outside of the footprint and immediate surrounds, as indicated by monitoring required by condition 2-4(3) [of the EP Approval]**.**
- To implement measures for avoidance and minimisation of impacts on marine megafauna, as indicated by condition 2-4(7) [of the EP Approval

1.5 Abbreviations

Abbreviation	Definition
AAPA	Aboriginal Areas Protection Authority
ABF	Australian Border Force
ADF	Australian Defence Force
AIMS	Australian Institute of Marine Science.
ANC	Acid neutralising capacity
ANZG	Australian and New Zealand Governments
BHD	Backhoe Dredger
CBD	Central Business District
CBJV	Clough Projects Australia Pty Ltd and BMD Constructions Pty Ltd Joint Venture
CD	Chart Datum
CEMP	Construction Environmental Management Plan
CSD	Cutter Suction Dredge
DCA	NT Development Consent Authority
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DCMC	Department of the Chief Minister and Cabinet
DDSPMP	Dredge and Dredge Spoil Placement Management Plan
DEPWS	Department of Environment, Parks and Water Security
DGV	Default guideline values
DIPL	Department of Infrastructure, Planning and Logistics
EAW	East Arm Wharf
EIS	Environmental Impact Statement
EMF	Environmental Management Framework
EPBC	Environment Protection and Biodiversity Conservation Act
MMP	Marine Megafauna Management Plan
MSB	Marine Supply Base
MUBRF	Multi-User Barge Ramp Facility

NATA	National Association of Testing Authorities
NT	Northern Territory
NTEPA	Northern Territory Environmental Protection Authority
NTG	Northern Territory Government
PASS	Potential Acid Sulfate Soils
RAAF	Royal Australian Air Force
SSC(s)	Suspended Sediment Concentration(s)
TSS	Total Suspended Solids
UXO	Unexploded Ordnance
WDL	Waste Discharge Licence
WQMF	Water Quality Management Framework

2 Legislative Requirements

The legislation, policies, standards and guidelines of specific relevance to dredging activities are described below:

International

- *Guidelines for the Development of Garbage Management Plans for compliance with Regulation 9(2), Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL)*
- *International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)*
- *International Convention for the Control and Management of Ships' Ballast Water and Sediments*
- *The Convention on the Conservation of Migratory Species of Wild Animals*
- *International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978 relating thereto and Annex V (Prevention of Pollution by Garbage from Ships) (IMO 1973)*

Commonwealth

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Biosecurity Act 2015 and Biosecurity Regulations 2016*
- *Environment Protection and Biodiversity Conservation Act 1999*
- *Hazardous Waste (Regulation of Exports and Imports) Act 1989*
- *Hazardous Waste (Regulation of Exports and Imports) Amendment Act 1996*
- *Protection of the Sea (Harmful Anti- fouling Systems) Act 2006*
- *Biosecurity Amendment (Ballast Water and Other Measures) Act 2017,* Biosecurity (Ballast Water and Sediments) Determination 2017 and the Biosecurity (Ballast Water Same Risk Area) Instrument 2017.
- *Intergovernmental Agreement on a National System for the Prevention and Management of Marine Pest Incursions* (Commonwealth of Australia, 2005)
- *National Water Quality Management Strategy* (Commonwealth of Australia, 1992)
- *National Assessment Guidelines for Dredging* (NAGD, Commonwealth of Australia, 2009)
- *National Acid Sulfate Soils Guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management* (Simpson et al, 2018)

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments* (ANZG, 2018)

Northern Territory

- *Northern Territory Aboriginal Sacred Sites Act 1989* and Regulations
- *Crown Lands Act 1992*
- *Dangerous Goods Act 1998 and Amendment Act 2003 (Act No. 20, 2003)*
- *Port of Darwin Act 2015*
- *Environmental Protection (National Pollutant Inventory) Objective 2004*
- *Heritage Act 2011*
- *Water Act 1992*
- *Marine Pollution Act 1999* and Marine Pollution Regulations 2010
- *Waste Management and Pollution Control Act 1998*
- *Environment Protection Act 2019*
- *Fisheries Act 1988*
- *Marine Act 1981 and Marine (Pilotage) Regulations 2001*
- *Ports Management Act 2015*
- *Territory Parks and Wildlife Conservation Act 1976*
- *A Strategy for the Conservation of Marine Biodiversity in the Northern Territory of Australia*, Parks and Wildlife Commission of the NT (PWCNT, 2000)
- *A Review of Environmental Monitoring of the Darwin Harbour Region and Recommendations for Integrated Monitoring* (NTG, 2005)
- Declaration of beneficial uses and water quality objectives for Darwin Harbour region (NTG, 2010)
- *Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory* (NT EPA, 2013)
- *Recommendations for sampling and analysis of Darwin Harbour sediment* (Munksgaard, 2013)
- *Darwin Harbour Water Quality Protection Plan* (DLRM, 2014)
- *Interim Turbidity Water Quality Objectives for Dry season Neap Tide Conditions in Darwin Harbour* (Cassilles Southgate & Fortune, 2018)
- *NT EPA Environmental Factors and Objectives* (NT EPA, 2018)
- *Sediment Quality Sampling Design for Darwin Harbour* (Brinkman & Logan, 2019)
- *Development of Pressure Indicators for Darwin Harbour* (Radke et al, 2019)
- *2020-2025 Darwin Harbour Strategy* (Darwin Harbour Advisory Committee, 2020)

2.1 Project Approvals

Table 1 provides a summary of the approvals for the Project.

Table 1 Summary of approvals

Approval	Legislation	Administrating Authority	Responsibility for Obtaining Approval	Approval Reference and Date
Development Approval	*Planning Act 1999*	NT Development Consent Authority (DCA)	Territory	PENDING (Application: PA2023/0418). On receival of development permit, plan will be amended to include relevant conditions.
EPBC Act Controlled Action	*Environment Protection and Biodiversity Conservation Act 1999*	Department of Climate Change, Energy, the Environment and Water [DCCEEW]	Territory	2021-9068 (dated 03/10/2023)
Environmental Protection Approval	*Environmental Protection Act 2019*	NT Environmental Protection Authority (NTEPA) EPA	Territory	EP2023/028-001 Granted 30/08/2023
Waste Discharge Licence (WDL)	*Water Act 1992*	NT Environmental Protection Authority (NTEPA) EPA	CBJV (on behalf of Territory)	SUBMITTED WDL application submitted for assessment 13/12/2023. On receival of approval from NTEPA, plan will be amended to include relevant WDL approval conditions.

3 Existing Environment and Relevant Studies

3.1 Background

This section of the Plan provides a brief overview of those components of the existing environment that are pertinent to the consideration of impacts from dredging and spoil placement during dredging associated with the Project. This information provides the context for determining the monitoring programs and management strategies detailed in Section 7.

The Darwin Harbour region extends from Gunn Point in the east, to Charles Point in the west, covering an area of over 3200 km^2 comprising 65% terrestrial and 35% marine habitats (at high tide) (Fortune 2016). The Darwin Harbour region includes the catchments of the rivers and streams that flow into the harbour, including the Howard River, Elizabeth River and Blackmore River, as well as the large estuarine/marine water body that is Darwin Harbour. Within the harbour, shores are characterised by extensive intertidal mud flats and mangroves.

3.2 Existing physical environment

3.2.1 Meteorological conditions

Darwin Harbour lies in the monsoonal (wet–dry) tropics of northern Australia and experiences two distinct seasons; a hot Wet season from November to March (when winds are predominantly westerly) and a warm Dry season from May to September (when winds vary from south-easterly through to northerly). The months of April and October are transitional.

Maximum temperatures are defined as hot all year round, but November is the hottest month with a range of 25°C minimum to 33°C maximum, while the lowest average daily temperatures (19°C minimum to 31°C maximum) are normally experienced in July (Bureau of Meteorology [BoM] 2022). The mean annual rainfall for Darwin is 1724 mm, with rain falling on an average of 94 days, mainly from November to March (BoM 2022a).

Cyclone activity occurs intermittently in the Darwin region, mainly between November and April, with cyclones typically causing the most damage within 50km from the coast. Aside from the impacts of strong winds, storm surges can be of concern to vessels and coastal developments surrounding Darwin Harbour. Storm surges result from strong onshore winds and reduced atmospheric pressure and can cause flooding and damage through raised tidal levels and increased wave heights. The height of a storm surge is influenced by many factors, including the intensity and speed of winds within the associated cyclone, the angle at which the cyclone crosses the coast, the speed and direction of tidal flows and the bathymetry of the affected area (NT Emergency Service 2011).

In October 2022, BoM published the cyclone outlook for the tropical cyclone season. In summary, BoM predicts that it is likely there will be an above-average number of tropical cyclones for the 2022–23 Australian tropical cyclone season (BoM, 2022b).

The established La Niña in the tropical Pacific Ocean and warmer-than-average sea surface temperatures to the north of Australia, have influenced this year's tropical cyclone outlook (BoM, 2022b).

In La Niña years, the first cyclone to make landfall on the Australian coast typically occurs earlier than normal. Like tropical cyclones, the number of tropical lows that form during La Niña years is typically greater than the number which form during non-La Niña years. From the 2005–06 season onwards, the typical number of tropical lows has been 7 for all years, and 10 for La Niña years (BoM, 2022b).

3.2.2 Coastal geomorphology and bathymetry

Darwin Harbour is a large ria system, or drowned river valley, formed by post-glacial marine flooding of a dissected plateau. The harbour was formed by rising sea levels about 6000–8000 years ago. Since the formation of the harbour, surface erosion from the adjoining terrestrial environment has carried substantial quantities of sediment into the harbour. This sediment now forms much of the intertidal flats that overlie bedrock around the harbour margins.

The harbour extends for more than 30 km along a north-west to south-east axis. The main channel of the harbour is around 15-25 m chart datum (CD) deep, with a maximum depth of some 36 m. The channel favours the eastern side of the harbour and continues into East Arm, at water depths of more than 10m CD. The bathymetry in this area has been modified by dredging for the development of EAW and the INPEX LNG processing facilities located at Bladin Point.

3.2.3 Marine sediments

3.2.3.1 Darwin Harbour seafloor

Approximately 80% of the Darwin Harbour region's seafloor is estimated to be covered with soft surfaces consisting of mud and fine sand. Soft surfaces containing varying amounts of gravel and sand are found in the main channels around reefs, on beaches and on spits and shoals near the mouth of the harbour (Fortune 2006).

The typical geological profile of the Darwin Harbour seafloor comprises Quaternary age intertidal marine alluvium comprising mud, silt, sand and coral remnants, underlain by the Proterozoic metasediments of the Burrell Creek Formation, consisting of meta-siltstone, meta-sandstone and phyllite. The rocks strike close to north-south and are steeply dipping either to the east or west. Quartz veins are widespread within the Burrell Creek Formation.

Sediments in the river catchments are predominantly fine-grained, mainly clay and silt. Creeks and rivers may transport coarser material (e.g. sand) into the estuary during the Wet season, though much is trapped by coastal vegetation, both riparian and mangrove (McKinnon et al. 2006). The fine sediment delivered to the upper arms of the harbour settles out of suspension and is then eroded and re- deposited mainly by tidal currents, especially at spring tides (Munksgaard 2013).

Hydrodynamic modelling of the fate of suspended sediment plumes has shown that substantial sediment fluxes are directed up-estuary where fine sediments are trapped; the sediment fraction exported to the ocean is relatively small (Williams, Wolanski & Spagnol 2006).

3.2.3.2 Contaminants of potential concern

DLRM (2014) estimated that 30% of the land within the Darwin Harbour catchment was developed. About 13% of the developed area was subject to urban and other intensive land-uses in and around the cities of Darwin and Palmerston, including residential living, manufacturing, industry, roads, airport infrastructure and defence facilities. Skinner et al (2009) note that runoff from urban areas contain a disproportionately high pollutant load relative to that from non-urban areas. The remainder of the developed area comprised rural land-uses, including horticulture and agriculture. Non-polluting uses (e.g. remnant native vegetation, surface water supply, conservation areas) were considered by the Darwin Harbour Advisory Committee (2003) to occupy the remaining 70% of the Darwin Harbour catchment.

The Elizabeth River has the second largest catchment of the rivers entering Darwin Harbour (the largest is the Blackmore River that enters Middle Arm [Padovan 2001]). Skinner et al (2009) estimated that 58% of the Elizabeth River catchment area comprised native vegetation with minimal disturbance, rural land use (such as irrigated crops and rural living) accounted for approximately 39% of the catchment area and only 2% was considered to support urban or industrial land uses. Undeveloped land (predominantly mangrove communities) fringes the river over a distance of some 25 km between the rural land use areas and East Arm; this has the potential to act as a buffer to reduce the amounts of pollutants reaching East Arm from sources in the upper catchment.

Some 3km upstream of the Project location is Hudson Creek, which has a history of livestock export and light industrial uses and which receives inputs from the Darwin Correctional Centre's Sewage Treatment Plant (KBR 2020). It also includes rural and urban land; Skinner et al (2009) calculated that 50% of the catchment supported urban or industrial land uses.

Approximately 6 km upstream of the Project location, the Palmerston Wastewater Treatment Plant discharges treated effluent into Myrmidon Creek; this enters the Elizabeth River estuary at the head of East Arm. The mass loadings of the nutrients in the release from the Plant in 2005-06 were 40 tonnes of ammonia, 69 tonnes of Kjeldahl nitrogen and 18 tonnes of phosphorus (Power and Water Corporation 2006); it appears that no more recent data are publicly available. Skinner et al (2009) note that treated sewage effluent is the dominant anthropogenic point source of nutrients to Darwin Harbour. However, based upon the data of Butler et al (2013), Munksgaard et al (2018) considered that the water body in Darwin Harbour is generally nitrogen limited. Burford et al (2008) determined that the main input of nitrogen to the harbour was from the open ocean, while inputs from rivers and wastewater treatment plants entering the harbour were relatively minor.

Industrial, urban and rural land uses all represent sources of potential pollutants that may accumulate in the Project dredging area. The mean annual pollutant loads contributed to the harbour from the Elizabeth River, Hudson Creek and Myrmidon Creek catchments were estimated by Padovan (2001) based upon the 1995-96 and 1996-97 Wet seasons, and by Skinner et al (2009) for the 2006-07 Wet season. A fourth catchment, Palmerston South, also discharges into the Elizabeth River, though the pollutant loads predicted by Padovan (2001) and Skinner et al (2009) were markedly lower than those from the Elizabeth River and Hudson Creek catchments.

3.2.3.3 Distribution of contaminants

Environmental factors that may potentially affect the distribution of contaminants within Darwin Harbour, and hence could influence the concentrations of contaminants in the sediments of the dredging footprint, include:

- Strong tidal currents that readily mobilise seafloor sediments on flood and ebb tides, especially during spring tide periods.
- Eddies in water flows that enhance the settlement of sediments from the water column in certain areas (such as at the eastern end of EAW).
- Wind-driven water circulation that can redistribute large amounts of seafloor sediments, particularly during tropical storms and cyclones.

Each of these factors would primarily influence the distribution of fine sediment fractions, to which many metals are typically bound at higher densities (Batley 1995, Munksgaard & Parry 2002, Welch et al 2008).

Munksgaard et al (2018) noted that sediments provide time-integrated measures of net accumulation of contaminants at a location; these are independent of the seasonal and tidal variations in contaminant concentrations within the overlying water column.

3.2.3.4 Potential acid sulfate soils (PASS)

In the Darwin region, PASS has been identified in association with mangrove sediments (e.g. Hill & Edmeades 2008).

The materials to be dredged as part of the Project were sampled by AECOM (2020) and an assessment of the potential risk associated with acid sulfate soils was undertaken. All sediments sampled were identified as having the potential to be acid generating (to varying degrees) if left in an oxygenated environment post-dredging. The outcome of that assessment is summarised below:

- No existing acidity (indicated by titratable actual acidity) was reported in any of the samples.
- However, all samples reported potential acidity (chromium reducible sulfur %) ranging between 0.04%S and 0.23%S, indicating presence of PASS (i.e. un-oxidised sulfides) which could generate acidity upon oxidation.
- Hence, the sum of existing and potential acidity in all samples exceeded the action criterion (as per Simpson et al [2018]) of 0.03%S.
- All samples reported some acid neutralising capacity (ANC) ranging between 1.57 %S and 18.5%S. ANC is noted potentially due to the abundance of naturally occurring calcium carbonate such as shell fragments and coral skeletons as observed in the field. The ANC ranged between 19 and 231 times greater than the sum of existing and potential acidity concentrations; well within the adopted criterion of ANC being greater than 15 times the total acidity of samples (as per Simpson et al [2018]).

Based on the PASS with an ANC in excess of 15 times the total acidity, acid sulfate soils will be monitored throughout the dredge works, however active management is not expected to be required during the works Monitoring requirements are outlined in Section 7.

3.2.4 Hydrodynamics and sediment transport

The tidal range in Darwin Harbour is between 0 m (i.e. LAT) and approximately 8.2 m above LAT (**Table 2**). The mean spring tide range is approximately 5.6m and the approximate mean neap tide range is 1.8m. Tides within Darwin Harbour are predominantly semidiurnal, with a slight inequality between the successive tides during a single day.

Rigby et al. (2014) indicate that the wave climate in the region is dominated by locally generated waves, with little incident swell entering the harbour from the west, except under monsoonal cyclone or tropical low events. Between November and March, north-westerly winds blow over the uninterrupted fetch of the Timor Sea, increasing incident wave energy in Beagle Gulf and at the entrance to Darwin Harbour. Due to the alignment and narrow nature of the harbour entrance and the presence of the Tiwi Islands to the north, the interior of the harbour is sheltered from long period swell, and any swell that does enter the harbour is quickly dissipated by the generally shallow bathymetry and indented nature of the harbour shoreline.

The daily harbour inflow and outflow is approximately 216 million m^3 on a spring tide and 71 million m^3 on a neap tide. These flows represent 69% and 29% of water flows in Darwin Harbour respectively (Williams et al 2006). Tidal flows are strongest in the narrowest sections of the harbour, including sections of the East Arm channel.

Modelling by Brinkman and Logan (2019) indicates that flood tidal current velocities within the harbour are generally higher than ebb tide velocities. Elevated tidal energy, particularly during spring tides, results in the regular resuspension of fine sediments from the seabed, leading to naturally high turbidity levels within the harbour. The suspended sediments are then carried into areas within the harbour where they are deposited but are not resuspended on ebb tides (Williams et al 2006, Brinkman & Logan 2019).

It is noted that Baird (2019) found ebb tidal flows (measured between May and July 2019) at a site within the body of East Arm tended to be stronger than flood tidal flows, with peak current speeds of 0.6-0.7 m/s during spring tides and 0.2-0.25 m/s during neap tides. This suggests that the relative ebb/flood tidal flows within the main East Arm channel are contrary to those within the harbour in general. As the Project location is outside of the channel, the relative flows at the site are likely to be aligned with those within the harbour in general.

Table 2 Darwin Harbour tidal planes

Tidal Plane	Description	LAT (m)
HAT	Highest Astronomical Tide	8.2
MHWS	Mean High Water Springs	7.0
MHWN	Mean High Water Neaps	5.1
MSL	Mean Sea Level	4.24
AHD	Australian Height Datum	4.105
MLWN	Mean Low Water Neaps	3.3
MLWS	Mean Low Water Springs	1.4
LAT	Lowest Astronomical Tide	0.0

Brinkman and Logan (2019) consider that, during the Wet season, there is a significant contribution of fine sediments to the harbour from terrestrial sources draining into the harbour via the reaches of West, Middle and East Arms. McKinnon et al. (2006) calculated that the annual total suspended sediment load transported to the harbour had increased by a factor of 1.3 compared to the pre-urbanisation load.

Nawaz (2010) estimated that in the order of 80% of terrestrial sediment transported into the harbour was from channel erosion rather than from sheet erosion; the latter being a more likely source of contaminant inputs than the former.

Previous investigations within the harbour have demonstrated that complex circulation occurs near headlands and embayment's that includes jets, eddies, separation points and stagnation zones. This may result in trapping of fine sediments at headlands and in embayment's; modelling by Brinkman and Logan (2019) predicts that the nearshore portion of the Project footprint lies within an area of net sediment deposition, while net erosion is predicted in the portion further from shore.

3.2.5 Geochemical assessment of material to be dredged

In August 2020, AECOM undertook a geochemical assessment of the sediments within the dredging footprint. A summary of the potential contaminant inputs to the dredging area is provided above.

Following the completion of the geochemical assessment sediment sampling campaign, the area to be dredged was modified as part of the ongoing engineering design phase of the Project.

The full geochemical assessment report (AECOM 2020) is included as Appendix H of the Draft EIS for the Project. Key findings from the assessment were:

- Within the dredging footprint for the ship lift, berth and manoeuvring basin no contaminants of potential anthropogenic origin were detected at levels above the criteria levels within the NAGD. That is, all contaminants of potential anthropogenic origin in these areas were present at concentrations at which, under the NAGD, toxic effects on organisms are not expected. Hence there was no evidence of inputs of contaminants to the sediments arising from the operation of EAW.
- All samples collected within the dredging footprint returned TBT concentrations below the laboratory limit of detection and therefore the NAGD Low Screening level.
- Arsenic concentrations typically exceeded NAGD criteria levels. Previous studies (e.g. Padovan 2003, Fortune 2006, URS 2009) have attributed elevated arsenic concentrations in Darwin Harbour sediments to local geological influence (e.g. weathering of bedrock in the catchment). Some of these studies (e.g. URS 2009) have demonstrated that, in the natural marine environment, the arsenic has low bioavailability. That is, the arsenic is bound to the sediment in such a way that it will not readily enter the food chain.
- The distribution of potentially acid producing sediments within the material to be dredged cannot be accurately mapped. Hence it must be assumed that potentially acid-producing sediments could be dredged at any time during the campaign. It should be noted that only the surface layer of the deposited sediments will be exposed to air and hence potentially acid producing. As sediments are progressively buried as the dredging campaign progresses, they will again become anoxic and their potential to generate acid will decrease accordingly.

The tailwater discharged from the settling pond system will be monitored to ensure compliance with pH criteria levels, and also to monitor metals concentrations in the tailwater as decreased pH levels could stimulate the release of metals into the overlying water column; this monitoring is detailed in Section 7 of this Plan. During monitoring, there will be a particular focus on arsenic; whilst it is considered to have low bioavailability in the natural seawater of Darwin Harbour, in the presence of reduced pH the concentrations of arsenic in the tailwater may gradually trend upwards over the course of dredging. As described in Section 6.2.4 of this Plan, management measures will be implemented in the event that tailwater pH levels become unacceptably low, or metals concentrations become unacceptably high.

With respect to the reclamation area within the Project site, the porewater will not be retained within the dredged material for a sufficient period of time for release of toxicants (from the sediment into the porewater) to occur; rather, the porewater will percolate into the harbour waters and be rapidly diluted under the influence of the prevailing currents.

In conclusion, the investigation has shown that the sediments are suitable, from a geochemical standpoint, to be disposed into both the settling ponds at EAW and within the reclamation area within the Project site.

3.2.6 Marine water quality – Darwin Harbour

Water quality in Darwin Harbour is typically described as generally high, although naturally turbid most of the time. Water quality parameters vary greatly with the tide phase (spring versus neap; flood versus ebb), location (inner versus outer harbour), and with the season (Wet season versus Dry season).

Duggan (2006) conducted research on the water quality of Darwin Harbour from 2002 to 2004. Seasonal aspects, rather than spatial or tidal aspects, were found to be the most important determinant of water quality within the harbour in general, with rainfall considered to have the greatest impact on water quality (increasing nutrients, suspended solids and chlorophyll a).

Tidal movement can play an important role in re-suspending material from the harbour floor into the water column and water quality in the dredging areas is predominantly impacted by suspended sediments resulting from fast moving currents.

Water quality is typically higher in outer harbour waters than within the inner harbour, though turbidity at the harbour mouth can be elevated in shallow areas due to re-suspension of sediments from intertidal flats, especially during spring tides.

A typical Darwin Wet season extends from November to April and is characterised by warm air temperatures, convective storms and monsoonal weather which brings heavy rain and strong north- westerly winds and, in some years, cyclonic weather (Fortune 2016). These Wet season conditions affect harbour water quality due to high surface runoff from the land (URS 2011).

There is no evidence of widespread water or sediment pollution in the Harbour (Fortune 2016, DENR 2020), although there some localised pollution has been identified in the past (e.g. Padovan 2003, Water Monitoring Branch 2005, Drewry et al 2011). Anthropogenic influences on Harbour water quality include the EAW port operations, historic industrial activities at Darwin Waterfront, Sadgroves Creek and wastewater outfalls (URS 2004); however, there has been no evidence of widespread or persistent hydrocarbon or pesticide pollution in the harbour (Darwin Harbour Advisory Committee 2007).

The harbour may be subject to occasional pollution events such as hydrocarbon spills, from potential sources such as:

- seasonal stormwater inflow from Darwin and Palmerston stormwater drainage networks
- creeks with industrial developments in their catchments (e.g. Hudson Creek, Sadgroves Creek)
- bulk hydrocarbon storage (e.g. at East Arm Peninsula, Darwin LNG plant and Channel Island Power Station)
- inventories in recreational vessels and commercial ships
- refuelling locations (e.g. HMAS Coonawarra, Cullen Bay, Fishermans Wharf).

Darwin Harbour water quality has been monitored against a series of Water Quality Objectives (WQOs) and reported by DENR (now DEPWS) in annual report cards since 2009. The annual report cards provide a score based on the following parameters:

- dissolved oxygen (DO)
- Total Suspended Solids (TSS) (by way of a TSS – turbidity relationship)

- chlorophyll a (as an indicator of algae)
- nutrients (nitrogen and phosphorus)
- temperature, pH and salinity are also measured but not included in the determination of the report card score.

In 2020, water quality in East Arm was monitored at 23 sites through this process. The East Arm region has consistently met water quality objectives over the period since the program began in 2009.

3.2.7 Water quality baseline data

Between 2008 and 2011, a number of water quality investigations were undertaken by URS on behalf of INPEX to characterise the existing conditions in East Arm (URS 2009, 2011). **Table 3** presents summary statistics for Dry and Wet season water quality, as recorded at a site off the southern tip of South Shell Island (URS 2011).

These data were collected every 15 minutes over a year-long program. Data were grouped and averaged based on tidal cycle and seasonal variation, allowing seasonal means, medians and percentiles to be calculated. This gives a robust body of data to compare background levels of turbidity with potential increases associated with various natural and artificial turbidity-generating events in the harbour.

Water quality data from South Shell Island are considered applicable to the dredging and reclamation works as this site has the nearest sensitive receptors (hard coral communities) to them, although modelling does not predict that the communities are at risk of detectable impacts from the works.

Table 3 Summary water quality statistics for East Arm Wet and Dry season (URS 2011)

	Dry season			Wet season		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**
Temperature (°C)	28.1	25.3	32.1	30.4	28.1	32.0
Conductivity (mS/cm)	48.7	40.2	52.9	46.2	36.7	49.8
Depth (m)	6.3	2.4	11.0	6.7	2.5	11.3
pH	8.0	7.7	8.5	8.0	7.6	8.2
DO (%)	93.5	73.4	121.1	88.5	67.3	106.4
Turbidity (NTU)	4.4	0.1	46.4	8.3	0.2	68.0
SSC (mg/L)*	10.8	7.1	46.4	14.1	7.2	64.7

* Calculated from NTU using relationship in URS (2011): SSC = 0.848 * NTU + 7.0477 Source: URS (2011)

3.3 Environmental receptors

3.3.1 Marine communities

Darwin Harbour has a complex assemblage of marine ecological communities, including rocky shore biota, hard corals, filter feeders (primarily soft corals and sponges), macroalgae, seagrasses, soft sediment biota, mangroves and fish communities. Smit, Penny and Griffiths (2012), in their summary of previous benthic habitat mapping of Darwin Harbour, suggest that the benthic habitats present in the inner and outer harbour differ significantly and are typically characterised as follows:

- Outer harbour:
  - extensive seagrass communities occur in shallow waters
  - corals and algae dominate on hard substrates in shallow waters.
  - deeper waters are characterised by filter feeder communities (e.g. sponges, soft corals).
- Inner harbour:
  - hard substrates in shallow and deeper waters consist of mixed communities or are dominated by sponge communities
  - no seagrass communities are present (though it is noted that, subsequent to the Smit, Penny and Griffiths [2012] report, there have been unpublished records of seagrasses around Wickham Point, and opposite the Channel Island boat ramp in Middle Arm).

Predictive modelling of the benthic habitats within, and in the vicinity of, the Project area was encompassed within the modelling of major habitat classes within Darwin and Bynoe Harbours that was undertaken by the AIMS in 2019 (Galaiduk et al 2019). This extensive program considered bathymetric, physical seabed and biological data collected during Project-specific and historical field sampling campaigns to produce spatial predictive habitat models (Galaiduk et al 2019).

Subsequent habitat modelling undertaken by the Australian Institute of Marine Science (2021) built on the 2019 habitat modelling by incorporating additional field observation data and new and higher resolution datasets. The resultant benthic habitat predictions were presented at a 1m x 1m resolution and showed habitat suitability for six biological communities in Darwin Harbour: Filter Feeders / Octocorals, Hard Corals, Macro Algae, Seagrasses, Sponges and Bare Ground and Bare Ground (**Figure 4**).

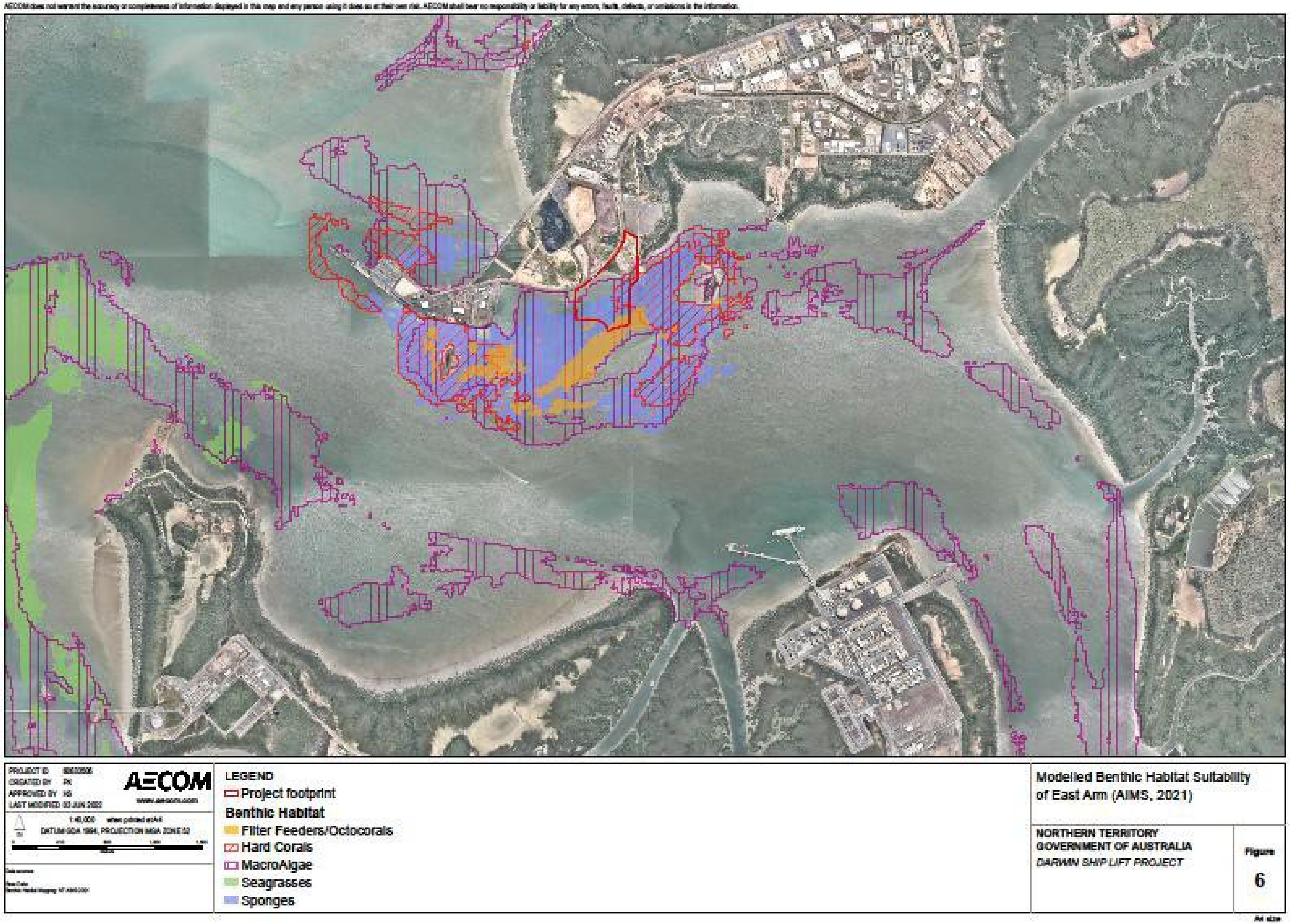

Figure 4 Modelled benthic habitats of the Project region (AECOM, 2022b)

The map presented by AECOM (2022) shows predicted habitat suitability for each habitat type, with the following interpretations provided by AIMS (2021):

- Bare ground having the most extensive coverage across the southern Darwin Harbour region.
- Filter feeder/octocoral habitats were predicted to occur in deeper waters of the outer harbour, with some small patches of suitable habitat also predicted south of the EAW for both habitat types.
- Small patches of habitat suitable for filter feeders/octocorals were predicted south-west of Channel Island.
- Hard coral habitats were far more restricted within Darwin Harbour but predicted in shallower regions of the outer- and mid- Harbour, as well as an area to the south of EAW.
- The areas surrounding South Shell Island and Catalina Island in East Arm were identified as potentially suitable habitats for hard corals.
- Macro Algae habitats were typically predicted in shallower habitats, with the thresholded model predicting extensive patches throughout the mid harbour and within East Arm.
- Suitable habitats for seagrasses were not predicted within East Arm; however, they were predicted in patches throughout the mid-Harbour, with the largest patch predicted within Fannie Bay, and smaller patches predicted to line the top of the Middle Arm channel.
- Overall, areas adjacent to Fannie Bay and the mouth of the East Arm were identified as areas with potentially substantial benthic habitat coverage.

Within the northern East Arm region in the vicinity of the Project, mapping by AIMS (2021) shows:

- Suitable hard coral habitat is predicted to occur surrounding South Shell Island and shallow waters west of Catalina Island and encroaching into the Project footprint.
- Suitable filter feeder habitat within the offshore extremity of the Project footprint, extending offshore into the main channel of East Arm. Further areas are identified as suitable filter feeder habitat to the east and west of South Shell Island.
- No suitable habitat was identified for seagrass in the vicinity of the Project area.
- Large areas of suitable habitat for macroalgae and sponges were identified across wide areas of the northern East Arm region, including within the Project footprint.

For the Project EIS and Supplementary EIS it was necessary for benthic habitat surveys to be undertaken to assess the accuracy of the model predictions in areas of direct and potential indirect disturbance from the construction and operation of the Project. The first of these surveys was undertaken by AIMS in November 2020 (Case et al 2021), with the objective of refining the model in these areas, although the modelling undertaken by AIMS (2021) was deemed to provide a better representation of modelled habitats in East Arm. A review of all of the video records from the AIMS November 2020 survey transects within the area of direct disturbance from the Project was conducted, supplementing the five-points-per-frame analysis of selected frames from the video records undertaken by AIMS. This review confirmed AIMS' conclusion that the seabed in this area was predominantly bare substrate, with only scattered filter feeders and no visible hard corals or seagrasses.

The second survey was conducted by SLR Australia in May 2022 and focussed on collecting data in the vicinity of South Shell Island and Catalina island, the closest sponge and hard coral communities to the Project location. Observations during this survey showed filter feeders, occasional hard corals and macroalgae communities present to the west of Catalina Island with the seabed typically bare sediment to the east. Benthic communities in the vicinity of South Shell Island were observed as being dominated by hard corals in shallower reef areas with filter feeder habitats dominating further from shore on the western side of the island. To the east of South Shell Island, a mix of filter feeder and macroalgae communities were dominant with areas of bare sand. Cover of all communities was typically moderate to sparse with smaller patches of dense benthic cover observed. Habitat observations generally align well with the modelled benthic habitat distribution developed by AIMS (2021) (AECOM, 2022c).

3.3.1.1 Hard coral communities

Hard coral communities occur in Darwin Harbour where the substrate is rocky in the lower intertidal and shallow subtidal zones and where hydrodynamic conditions permit. A total of 123 species of corals have been recorded in Darwin Harbour (Wolstenholme, Dinesen & Alderslade 1997). Hard coral communities are typically dominated by colonies with massive (e.g. Faviidae, Porites spp.), foliose (e.g. Turbinaria spp.) or encrusting (e.g. Faviidae) growth forms (INPEX 2010). Habitat modelling undertaken by AIMS (2021) (Figure 6) predicted potential hard coral habitat in East Arm to occur at a small number of locations, with previous surveys also identifying hard coral communities in the vicinity of South Shell Island and Catalina Island. Hard corals are dominant within some of the benthic communities around South Shell Island, mainly on the western side of the island. A reduction in hard coral cover was recorded at one South Shell Island monitoring site during the INPEX capital dredging campaign conducted between 2012 and 2014; this was concluded to be as a result of a combination of elevated turbidity and increased sedimentation (Cardno 2014a).

Reductions in hard coral cover at South Shell Island monitoring sites were also detected during the MSB capital dredging campaign that was undertaken within the same period as the much larger INPEX campaign (Macmahon 2013, Department of Infrastructure [DoI] 2014). Sediment plume modelling for the dredging works covered in this Plan (Section 5.0) predicts that the South Shell Island coral community is sufficiently distant from the works to not be at risk of detectable impact.

Other well-known hard coral communities in Darwin Harbour include the following:

- Off the north-east shore of Wickham Point.
- Weed Reef, Plater Rock and Kurumba Shoal, on the western side of the harbour, and Dudley Point at the northern end of Fannie Bay.
- Channel Island coral community in Middle Arm, on the intertidal platform between Channel Island and the mainland. This is listed on the Register of the National Estate and is a declared Heritage Place under the NT Heritage Act 2011.

All of these communities are sufficiently remote from the dredging, reclamation and tailwater discharge locations that there is no credible risk of impact to them.

3.3.1.2 Filter feeder communities

Filter feeder communities are those that primarily comprise sponges, gorgonians (sea fans and sea whips) and other soft corals. They primarily occur on intertidal or subtidal hard substrates and may co- occur with hard corals, giving rise to “mixed species” communities. However, they also occur at depths shallower than, and deeper than, those at which hard corals thrive and can be the dominant component of the benthic community in some areas.

Habitat modelling undertaken by AIMS (2021) identified areas of potential filter feeder habitat in the vicinity of the Project footprint and across much of the northern side of East Arm (Figure 6) Sponge habitat was modelled separately by AIMS (2021), though it is noted that sponges are also filter feeders and are typically mapped together with them.

It is recognised that filter feeder communities around South Shell Island may contain species that could be of importance to bio-prospecting. However, it is also recognised that large areas of filter feeder communities are present both within East Arm and across the broader harbour (Geo Oceans 2011, 2012a,b; Siwabessy et al 2015, Galaiduk et al 2019).

Benthic habitat monitoring during the MSB capital dredging campaign (undertaken in 2012 and 2013) found no statistically significant changes in filter feeder communities across the three surveys (Macmahon 2013, DoI 2014). This is somewhat unsurprising as these communities are generally less sensitive than corals to the physiological pressures of reduced benthic light availability and sedimentation associated with dredging activities or natural environmental conditions. Filter feeder communities were not monitored as part of the INPEX dredging campaign that was conducted within the same period as the MSB dredging (INPEX 2013).

3.3.2 Protected marine species

3.3.2.1 Cetaceans

Three species of coastal dolphin are the most commonly recorded cetaceans in Darwin Harbour: the Australian humpback (*Sousa sahulensis*; formerly known as the Indo-Pacific humpback), Indo-Pacific bottlenose (*Tursiops aduncus*) and Australian snubfin (*Orcaella heinsohni*) dolphins (Palmer 2008). INPEX (2011) details knowledge of the taxonomy, distribution, microhabitats, residency and site fidelity of the three species of coastal dolphins, while Brooks and Pollock (2014), Brooks et al (2017) and Griffiths et al (2020) present data from the extensive surveys undertaken for the INPEX Ichthys LNG project. In addition, the conservation status of coastal dolphins in the NT has been assessed by Palmer et al (2017).

Other species of dolphin that may be present in Darwin Harbour include common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), spotted dolphin (*Stenella attenuata*) and bottlenose dolphin (*Tursiops truncatus*). Pods of false killer whales (*Pseudorca crassidens*) are considered by Palmer et al (2009) to be regular visitors to the harbour. It is notable that all cetaceans are protected under the EPBC Act.

Griffiths et al (2020) summarise the outcomes of studies of the abundance, movements and habitat use of coastal dolphins (Australian humpback, Indo-Pacific bottlenose and Australian snubfin) in the Darwin region (Darwin Harbour, Bynoe Harbour and Shoal Bay). On the basis of data from surveys undertaken between 2011 and 2019, and model outputs based upon capture-recapture data from these surveys, Griffiths et al (2020) concluded the following:

- All three species typically occurred at low densities, exhibited substantial emigration and had fluctuating population size.
- Humpback dolphins were the most commonly observed of the three species and there was demonstrable movement of this species between the three monitoring areas. Over the course of the monitoring program, there was a significant decrease in estimated abundance in Darwin Harbour a non-significant increase in Bynoe Harbour and a non-significant decrease at Shoal Bay.
- The snubfin dolphin population was small, and was considered to have the greatest variability in population size and the greatest degree of temporary emigration (i.e. temporarily leaving the study area). Modelling indicated a significant negative trend in estimated abundance over the course of the monitoring program.
- The bottlenose dolphin population was the smallest, with an apparently high degree of temporary emigration and a significant overall decrease in estimated abundance.
- The reasons for the significant declines were considered to be unclear, but were thought to potentially be related to population dynamics, environmental or anthropogenic factors.
- The estimated population density of each species appeared to be similar to average densities in NT coastal waters.
- The estimated population densities of humpback and snubfin dolphins appeared to be within the ranges of densities recorded in Western Australia and Queensland, while the estimated densities of bottlenose dolphins in the Darwin Harbour region and the NT appeared to be lower than in similar northern Australian locations.
- The estimated temporary emigration rates were considered to be similar to those in coastal dolphin populations elsewhere in Australia and overseas.

- Apparent survival rates were considered to be similar to, or lower than, those reported elsewhere for the same species, though the difficulty in accurately assessing survival rates was recognised. It was considered that emigration probably had a greater influence on population growth than deaths.

It is noted that there are no known areas of critical feeding or breeding habitat for dolphins within the zone of potential effects from the development and operation of the Project. The Indo-Pacific humpback and the Australian snubfin dolphin appear to be opportunistic generalist feeders, eating a wide variety of fish both on the seabed and within the water column (Parra 2006). No calving areas have been identified in Australian waters for either species and little is known of their reproductive biology or population structure (Ross 2006, Parra et al 2006).

The EPBC protected matters database also lists the following as "species or species habitat [that] may occur within area", though the species are not known to occur within Darwin Harbour:

- Blue whale (*Balaenoptera musculus*).
- Bryde's whale (*Balaenoptera edeni*).
- Humpback whale (*Megaptera novaeangliae*).
- Killer whale (*Orcinus orca*).

3.3.2.2 Dugongs

Dugongs (*Dugong dugon*) are known to occur in Darwin Harbour waters, although in relatively low numbers. Dugongs have been recorded in higher densities at Gunn Point and the Vernon Islands, some 30–50 km to the north-east of the mouth of the harbour. Dugongs have also been observed in relatively high numbers at Bare Sand Island and Dundee Beach in Fog Bay, 60 km south-west of Darwin Harbour, and are known to travel long distances (Whiting 2008).

Cardno (2014b) compared the results of baseline surveys with four surveys undertaken throughout the dredging phases of the *Turtle and Dugong Monitoring Program* associated with the INPEX Ichthys project. This study revealed that dugongs were observed in varying numbers between surveys; however, no trends (including seasonal variations) were evident. There was a higher number of dugong observed in shallower waters (6 – 10m), generally in foraging areas where seagrass was present.

Variation in dugong observed between surveys within sites was concluded to most likely be a result of short term movement of dugongs to visit optimum foraging areas of seagrass.

During baseline surveys (June to October 2012) most sightings in Darwin Harbour were around Weed Reef, West Arm and near Bladin Point, as well as in the shallow regions of Shoal Bay. During later baseline surveys, most dugong sightings were around outer Darwin Harbour, with aggregations around mapped seagrass near Casuarina Beach (Cardno, 2014b).

During the first of the Dredging Phase surveys (May 2013), dugongs were predominantly sighted in outer Darwin Harbour, with only one dugong sighted near Weed Reef and another in the shallow areas in West Arm. During the Dredging Phase surveys in July/August and October 2013, no dugongs were sighted in the inner Darwin Harbour, while during the end of dredging survey (May 2014) three dugongs were sighted near Weed Reef (Cardno, 2014b).

During the two surveys undertaken in October 2013, sightings were concentrated around Casuarina Beach and were associated with areas of seagrass (Halodule sp.). Lower numbers were observed in this area in Wet season surveys and it was considered that the reduced seagrass coverage in this season was likely to have been a contributing factor (Cardno 2014b).

In general, it is considered that dugongs could occur anywhere in the harbour that could support seagrasses or macroalgae. Within Darwin Harbour, dugongs have been observed at Channel Island in Middle Arm, where they were thought to be feeding on macroalgae (Whiting 2002). However, there are anecdotal records of seagrass occurrence in the vicinity of the Channel Island boat ramp and this may have been a contributory factor to their presence.

While some macroalgal communities may be present in the vicinity of the Project area, substantially greater areas of potential foraging habitat for dugong exist elsewhere in the harbour (INPEX 2011).

3.3.2.3 Turtles

Six species of marine turtles are known to occur in NT waters. Of these, four (green [*Chelonia mydas*], hawksbill [*Eretmochelys imbricata*], olive Ridley [*Lepidochelys olivacea*] and flatback [*Natator depressus*]) are considered to occur in the Darwin region, though olive Ridleys are thought to occur only occasionally within the harbour (Cardno 2014b). Loggerhead turtles (*Caretta caretta*) are suspected to be infrequent users of the harbour and the leatherback turtle (*Dermochelys coriacea*) is considered to be an oceanic species which is unlikely to occur in Darwin Harbour (Whiting 2003).

The shoreline throughout Darwin Harbour, and particularly in East Arm, consists largely of mangrove forests and mudflats and does not provide suitable nesting habitat for any species of turtle (INPEX 2010). The nearest nesting beach (used by the flatback turtle) is located in the Casuarina Coastal Reserve near Lee Point on the north-eastern shore of the harbour. Turtles visiting the harbour are more likely to be foraging for food. Flatback and hawksbill turtles forage on the filter feeder communities which are extensive in the harbour. The hawksbill turtle also forages on seagrass and macroalgal communities in addition to filter feeders. Green turtles forage amongst seagrass and macroalgal communities (INPEX 2011).

Cardno (2014b) implemented the *Turtle and Dugong Monitoring Program* for the INPEX Ichthys project; this included aerial and land survey techniques to monitor the abundance and distribution of turtles around Darwin Harbour. They concluded that:

- Statistical analysis of population and density estimates formed in this study did not indicate that the distribution or abundance of these animals had changed since the baseline phase.
- During survey D4 (during dredging) 813 turtles were sighted, which was higher than the average number of turtles sighted per survey during the baseline phase (634 turtles), but approximately 17% lower than the number of turtles recorded during baseline survey B3 (984 turtles), undertaken at the same time of year (October 2012).
- Statistical analyses of turtle population densities did not detect any significant difference between the impact and control treatments in either phase, or between baseline and dredging phases, for either treatment. In contrast, estimates of turtle density based on raw observations were significantly higher at the control blocks compared with the impact block during the baseline phase, but not during the dredging phase. The observed temporal and spatial variation in turtle distribution and abundance was considered possibly to be a result of short-term movements in and out of specific areas, possibly due to avoidance behaviour and/or the pursuit of more optimal foraging areas.
- Turtle sightings were most frequently recorded within relatively shallow water habitat, most commonly in waters less than 5 m in depth; however, a small number were sighted in the deep water channels near the Vernon Island (outside of Darwin Harbour) in waters greater than 30m depth.
- Where benthic habitat type had been identified and mapped, turtles were primarily sighted in association with gravel, sand and reef. Only 3% of turtle sightings were associated with mud habitat, the predominant habitat within, and around, the Project area.

3.3.2.4 Sawfish

The EPBC protected matters database indicates that dwarf sawfish (*Pristis clavata*), green sawfish (*Pristis zijsron*), freshwater sawfish (*Pristis microdon*) and narrow sawfish (*Anoxypristis cuspidata*) may potentially inhabit Darwin Harbour, or that their habitats may be present in the harbour. While these species are widely distributed throughout Australian tropical waters, within the Atlas of Living Australia (ALA 2021), in Darwin Harbour the following are recorded:

- One record of a dwarf sawfish caught in a gill net in the creek leading to the Gardens Golf Course. This species inhabits shallow (2-3 m) coastal waters and estuarine habitats (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2009) and is not known to move into freshwater areas (Thorburn et al 2007). Estuarine habitats in north-western Australia are used as nursery areas, with immature juveniles remaining in those areas up until three years of age (Thorburn et al 2007). Adults have been found to seasonally migrate back into inshore waters (Peverell 2007).
- One record of a green sawfish caught on a line and released off Lee Point, in the outer harbour. This record was made by a 'citizen scientist' and the identification verification status on the ALA database is deemed to be 'uncertain'. However, elsewhere in northern Australia most records of the species have been from marine and estuarine areas (Thorburn et al 2003, Peverell et al 2004) and they have been noted to move into estuarine or more fresh waters to breed during the Wet season and subsequently move into marine waters after the Wet season (Peverell 2005).
- There are no records of freshwater sawfish within harbour waters. Elsewhere in northern Australia, it has been reported that their first three to four years of life are spent in freshwater (Larson et al 2006, Thorburn et al 2007) before moving into marine waters. They are thought to breed either in freshwater (Peverell 2005) or in marine waters (Thorburn et al 2007).
- There are no records of narrow sawfish within harbour waters.

Although there is a limited number of records of the four sawfish species within harbour waters, studies elsewhere in northern Australia indicate that there is the potential for them to occur in the vicinity of the Project area during parts of their lifecycles; this may only be transitory as they move between freshwater and marine habitats before and after the Wet season.

3.3.3 Migratory bird species

Migratory bird species recorded around the East Arm area have been predominantly within the mangroves, the saline wetlands and beside the water in the settling ponds. Although historical counts suggest that migratory shorebird numbers within Darwin Harbour are modest (Chatto [2003] survey Block 4), EAW does seasonally support nationally significant numbers of some migratory shorebirds.

Since November 2009, shorebird monitoring has been undertaken at EAW and the settling ponds through the program developed in accordance with EPBC Approval 2010/5304 for the EAW Expansion project.

Field assessments identified that the Project area is not a known or potential roost site for threatened or migratory shorebirds (Lilleyman, Lawes & Garnett 2013). These studies noted that during high tides small numbers of birds were observed to be roosting on saline flats and in mangrove areas along other areas of the East Arm Peninsula; however, no large aggregations (>30 birds) of roosting birds were detected anywhere other than the EAW settling ponds, with very few birds observed foraging or roosting on the foreshore areas within the Project area.

The criteria for determining the importance of habitat for migratory shorebirds in Australia (EPBC Act policy statement 3.21) rates a site as nationally important habitat if:

- the site is identified as internationally important under Ramsar: or
- the site supports:
  - at least 0.1% of the fly away population of a single migratory shorebird species; or
  - at least 2000 migratory birds; or
  - at least 15 shorebird species.

The EAW area meets the criteria for supporting nationally important migratory shorebird habitat in that:

- Five migratory shorebird species (lesser sand plover, greater sand plover, far eastern curlew, terek sandpiper and sharp-tailed sandpiper) have been recorded within the EAW area at numbers greater than 0.1% of the fly away population by Chatto (2003).
- Six migratory shorebird species (whimbrel, far eastern curlew, common greenshank, sharp-tailed sandpiper, lesser sand plover and greater sand plover) have been recorded within Pond D at numbers greater than 0.1% of the fly away population by Lilleyman, Lawes and Garnett (2013).
- At least 2000 migratory birds have been recorded
- Twenty-two migratory shorebird species have been recorded within the study area (EMS 2011).

Nationally significant numbers of some migratory birds listed under the EPBC Act roost on Pond D at EAW. Recent survey data indicates that the total abundance of roosting shorebirds has increased at EAW since 2010 (Lilleyman et al 2020). Previous survey work in Darwin Harbour has shown that the EAW roost site is the only available roost site for shorebirds when the tide is greater than 7.6 m as available roosting space at all other survey sites is greatly reduced (Lilleyman et al. 2018). Further preliminary tagging studies have indicated that separate shorebird sub-populations roost at EAW to those tagged at other known natural roosting sites within Darwin Harbour (Lilleyman et al 2020).

Surveys have not identified any use of the intertidal area within the Project area as being utilised by EPBC listed bird species for roosting.

Based on a literature review and three field observation periods in 2022 (during which two common sandpipers [*Actitis hypoleucos*] were the only migratory shorebirds observed within the Project area), AECOM (2022) noted that, while migratory shorebirds may occasionally forage within the Project area, this appears to be uncommon and is unlikely to contribute to EAW's status as important habitat, which is derived from the populations utilising habitat at the EAW ponds. The Project area provides feeding habitat only during spring low tides, during which time such habitat would be plentiful throughout the Darwin Harbour shoreline.

3.3.4 Other EPBC listed species

The EPBC protected matters database indicates that the following threatened "species or species habitat may occur within [the] area", though there are no records (in the Atlas of Living Australia) of these species occurring within Darwin Harbour:

- Great white shark (Carcharodon carcharias)
- Northern river shark (*Glyphis garricki*)
- Whale shark (*Rhincodon typus*).

The database also indicates that the following migratory marine "species or species habitat may occur within [the] area":

- Estuarine crocodile (*Crocodylus porosus*) – this is known to occur within Darwin Harbour but is likely to typically avoid areas of high vessel activity, such as the dredging location. Because only limited nesting sites for the estuarine crocodile are available inside Darwin Harbour, the area is not considered critical habitat for crocodile survival in the NT (Whiting, 2003).
- Coastal manta ray (*Manta alfredi*) and oceanic manta ray (*Manta birostris*) – manta rays are known (from anecdotal accounts) to occur in the harbour, though there are no records (in the Atlas of Living Australia) from which to determine which particular species have been present.

3.4 Historical site use

The Project site appears to have been vegetated by natural scrub and mangrove until 1927, when the Commonwealth of Australia acquired East Arm properties for the purpose of establishing a quarantine station, with associated facilities located to the north of the Project site (KBR 2020).

The Project site and its surrounds were used during World War II for a range of activities, with a flying boat base and the lugger maintenance section located within the area. The flying boat base comprised a number of components, including a large tarmac hardstand, hangar, workshop and stores with associated maritime infrastructure. The latter included a large concrete ramp enabling Catalinas to be taken in and out of the water (the RAAF Catalina Ramp) and a concrete slipway with iron rails to serve the Marine Section vessels. Some of this infrastructure falls outside of the Project site, such as the timber jetty located to the east of the flying boat base site (Cosmos 2015).

The flying boat base also included a range of offshore marine infrastructure, including permanent Catalina and vessel moorings comprised of at least 22 seaplane moorings, nine marine craft buoys, five lugger buoys, three warping and steadying buoys, three marker buoys, and one submarine buoy (Cosmos 2015).

Maintenance and repair activities, including refuelling, were largely conducted on the hardstand area at the base; however, some maintenance works such as engine tuning, minor repairs and supply activities were carried out on the Catalinas whilst they were on their moorings, under tow or taxiing (Cosmos 2015).

In the 1980s, the former RAAF Catalina Ramp was opened to the public by the NTG for use as a recreational boat ramp. The boat ramp became one of the most popular ramps in Darwin Harbour due to its length, which enabled small craft to easily access the harbour waters during most tidal phases. However, in 2005 the boat ramp was no longer required to support recreational boating as a new recreational boat ramp was constructed at East Arm, north of Catalina Island (KBR 2020).

At present, the site is currently used for a marine services business. It has a car park, site office and hardstand areas which are used to conduct marine services activities (including marine equipment and material hardstand/laydown), a works depot and marine workshop.

During the FEED stage of the Project a geophysical survey was undertaken for the identification of potential unexploded ordnance (UXO) (G-Tek 2017). Prior to dredging commencing, a geotechnical investigation will be conducted, which will also include a diver survey to investigate and remove any potential targets identified in that survey.

3.5 Cultural heritage

3.5.1 Indigenous cultural heritage

Advice sought from the NT Heritage Branch in April 2018 confirmed that there are no existing registered Aboriginal archaeological sites within the proposed Project area. The AAPA certificate issued for the Project (RA2018/46, dated 18 January, 2019) indicates that there are no sacred sites within the Stage 1 dredging footprint, while two registered sacred sites are within 1km of the Project area:

- 5073-66 - Yirra (also known as Catalina Island), including the sand bar that extends in a north-westerly direction form the northern tip of the island; approximately 650 m to the east.
- 5073-90 – described on the AAPA certificate as ‘a rock in the harbour at East Arm’; this is known locally as Old Man Rock; approximately 900 m to the south-east.

3.5.2 European heritage

A number of cultural heritage surveys and archaeological assessments have been completed for the East Arm area as part of the EAW expansion and MUBRF projects. These assessments included field investigations and review of both cultural and indigenous heritage within portions of the proposed Project footprint, including:

- East Arm Multi-User Barge Ramp Facility, Recovered Cultural Objects, Maritime Archaeological Analysis Report (Cosmos 2015).
- Multi-User Barge Ramp Facility – Archaeological Report (Aurecon 2015).
- Archaeological Survey of the EAW Expansion and Surrounding Area, Darwin NT (Earth Sea Heritage Surveys 2011).

While a search of the NT Heritage Register indicated that no nominated or declared heritage places are located within the immediate Project area, the East Arm Flying Boat Base (described in Section 3.4) included a range of offshore marine infrastructure, including permanent Catalina and vessel moorings comprised of at least twenty-two seaplane moorings, nine marine craft buoys, five lugger buoys, three warping and steadying buoys, three marker buoys, and one submarine buoy (Cosmos, 2015); some remnants of this infrastructure may be within the dredging footprint.

An archaeological assessment was undertaken for the adjacent MUBRF in 2014/2015 (Cosmos 2015). This investigation noted that the seabed within and surrounding the footprint of the MUBRF had served as a 'rubbish dump' from the early to middle years of the 20th century, and up to the present day. The majority of artefacts recovered during the survey represented discards into the harbour associated with various land-based and water-based activities, primarily relating to World War II use of the area. Similar material may be present within the Project dredging footprint.

A search of the Australian National Shipwreck Database noted that there are no registered shipwrecks within the dredging footprint. The search identified, within the general East Arm area, four registered shipwrecks including two Vietnamese refugee boats (ID3429 and ID3430), a two-part barge (ID3428) and HMAS Kelat. None of these registered shipwrecks have been placed on a heritage register.

The database search also identified a number of aircraft wreck sites within the general East Arm area. The Catalina 2 (RAAF Catalina A24-69) site was located within the database search area, but approximately 500 m to the south of the dredging footprint. It is charted as rising to 4 m below LAT. The Catalina 3 (RAAF Catalina A24-206) site is located to the south of Catalina Island, over 1 km from the Project site. Neither of the Catalinas are a registered heritage site.

3.6 Sediment Transport Modelling and Impact Assessment

3.6.1 Synthesis of assessment approach

Sediment transport modelling was undertaken by AIMS to assess the potential impact of dredging for the Project on local water quality, and potential sedimentation impacts in the local area (Simão & Tonin 2020; Appendix I to the Project Draft EIS).

It is noted that the modelling was conducted on a preliminary Project layout, using indicative estimates of dredging volumes; these differ in some respects to the layout and volumes presented in the Project EIS. However, the modelling is considered to be sufficiently representative of the extents and magnitudes of potential changes in water quality that could occur in the vicinity of the dredging works to be of value for informing the environmental management framework presented in Section 6 of this Plan.

The following assessment of potential environmental impacts from the dredging works at the Project site was informed by:

- three-dimensional hydrodynamic models that incorporated water levels, wind, currents and waves
- sediment transport models that determined suspended sediment dispersion and sediment accumulation
- GIS analyses to quantify and depict potential impacts on habitats on the basis of tolerance limits.

Details of the hydrodynamic and sediment transport models applied are presented in Simão and Tonin (2020) and are not repeated here. The outcomes of this modelling are discussed in Sections 3.9.1

Modelling of elevated SSC associated with tailwater discharge from the settling ponds at EAW has not been repeated for this Project. Modelling of tailwater discharge from the same location (Pond E [South]), meeting the same water quality criteria, was completed for the MUBRF dredging program and has therefore been applied to assess potential impacts associated with tailwater discharge for the Project dredging program.

3.7 Tolerance limits for biological communities

3.7.1 Suspended sediment concentrations

Tolerance limits applied to the assessment of potential impacts from the MSB and MUBRF dredging campaigns are adopted for this Project. These tolerance limits were derived from turbidity data collected by URS (2011) in a long-term water quality study conducted in Darwin Harbour. The URS data were collected every 15 minutes at two sites in East Arm (South Shell Island and North-east Wickham Point) over a year-long program. Data were grouped and averaged based on tidal cycle and seasonal variation, allowing seasonal means, medians, and percentiles to be calculated. This gave a robust body of data to compare background levels of turbidity with potential increases associated with various natural and artificial turbidity-generating events in the harbour.

This dataset is considered to be relevant in the context of the current Project as the South Shell Island monitoring location is in the vicinity of the benthic communities of value that are closest to the Project site and it provides the longest continuous water quality dataset for this region. Further, as reported in the Project EIS a study was undertaken to review TSS concentrations in the region using remote sensing methods (EnSTaR 2021). It is noted that turbid plume dispersion modelling, and dredging monitoring and management measures, utilise measures of SSC. However, satellite imagery interpretation provides data in terms of TSS as the contribution of suspended sediments to the total amount of suspended solids in the water column cannot be determined in isolation from other (non-sediment) suspended solids.

This assessment applied the semi-analytic sediment model from Dorji et al (2016) to estimate TSS concentrations in surface waters, based on reflectance from MODIS satellite imagery. Using this methodology, TSS concentrations in East Arm were derived for the period February 1, 2010 – January 31, 2011; the period that data were collected by URS (2011), and then again for the period January 1, 2016 – October 30, 2020. While TSS derived through remote sensing methods and in situ turbidity measurements are not directly comparable, EnSTaR (2021) showed that, generally, based on the satellite-derived TSS results, TSS in Darwin Harbour during the period that the URS (2011) turbidity dataset was collected (median TSS = 4.72 mg/L, 95th percentile = 14.89 mg/L), was lower than that estimated for the period between 2016 – 2020 (median TSS = 5.4 mg/L, 95th percentile = 20.6 mg/L). Hence, it is evident that the tolerance limits derived for the INPEX dredging campaign, and adopted for the Project, are conservatively low relative to those that would be calculated from contemporary (2016-2020) data.

As there may be a need to dredge during either or both of the Dry and Wet seasons, tolerance limits for these seasons will be adopted from the appropriate (Dry or Wet season) subset of the one-year baseline dataset of water quality (URS 2011), on the presumption that biological communities in East Arm are adapted to local conditions but will be stressed if exposed to conditions that regularly exceed the 95th percentile of normally prevailing background concentrations (calculated from URS 2011).

As the sediment transport model calculates excess (above background) SSC caused by the dredging the median of the background concentrations was subtracted from the 95th percentile of the background concentrations to provide a comparable tolerance limit. This yielded a tolerance limit for Dry season dredging of 10 mg/L and a Wet season tolerance limit of 25 mg/L.

3.7.2 Sedimentation

Tolerance limits for sediment deposition on mangroves were derived by INPEX (2010, 2011) from a review of the outcomes of habitat-specific dose-response experiments and field observations reported in the scientific literature. These tolerance limits were adopted for the MSB and MUBRF dredging programs and will also be applied to the Project dredging program. The tolerance limits are based on the literature suggesting that 50 mm accretion may lead to reduced health or mortality; above 100 mm accretion, mortality of trees was considered “likely”.

For corals and filter feeder communities, INPEX (2011) contended that a meaningful sedimentation threshold could not be derived from the literature due to factors such as wide variations in tolerances between species, and between morphologies within species. Notwithstanding this, a sedimentation tolerance limit of 15 mm was included in the approved Dredging and Spoil Disposal Management Plans for both the Ichthys capital dredging campaign (INPEX 2013) and for the Ichthys maintenance dredging campaigns (INPEX 2018). It is noted by INPEX (2018) that “*the tolerance limit values were extensively discussed with and endorsed by the Ichthys Project Dredging Expert Panel*”.

3.8 Zones of impact and influence

For the assessment of potential dredging-related impacts upon benthic communities, definitions of Zones of Impact and Influence consistent with the WA EPA (2016) *Technical Guidance for the Environmental Impact Assessment of Dredging Proposals* were adopted:

- **Zone of High Impact**: this zone constitutes the direct footprint of the dredged area and a 20 m wide annulus around the footprint to account for smothering from coarse sediments liberated from the cutter head during dredging. Impacts in these areas are predicted to be severe and often irreversible.
- **Zone of Moderate Impact**: within this zone, damage to benthic habitats and mortality of benthic biota may occur, primarily as a result of the indirect impacts from increased turbidity and sedimentation that may occur at times over areas within the zone. Impacts within this zone are predicted to occur, but the disturbed areas may recover (after completion of the dredging operations). It is expected that there will be no long-term (beyond a period of five years) modification of the benthic habitats in this zone. The outer edge of the Zone of Moderate Impact is delineated by the 90th percentile contour plot for SSC, as defined by dredge plume modelling. This delineates the areas where, for 90% of the time, the predicted SSC is below the calculated tolerance for benthic communities (dredging-related SSC of 10 mg/L for East Arm communities during the Dry season, 25 mg/L during the Wet season, refer Section 3.7.1). The 10% of time during which the SSC threshold is predicted to be met or exceeded is likely to represent periods of mid-flow tidal states (particularly during spring tides) and any one exceedance event is not likely to exceed two hours.
- **Zone of Influence**: this zone includes the areas in which, at some time during the dredging works, benthic communities may experience (detectable) changes in sediment-related environmental quality outside the natural ranges that are normally expected. However, the intensity, duration and frequency of these changes is such that any damage to benthic habitats is likely to be reversible, and no mortality of benthic biota is expected to occur.

The outer boundary of this zone is delineated by the 95th percentile contour plot for SSC, as defined by dredge plume modelling. This reflects the area where, for 95% of the time, excess SSC from the dredging will be below the calculated tolerance for benthic communities (10 mg/L in the Dry season, 25 mg/L in the Wet season, refer Section 3.7.1).

3.9 Modelling results

Model outputs are presented as:

- 90th percentile plot of modelled SSC (mg/L) (**Figure 4**)
- 95th percentile plot of modelled SSC (mg/L) (**Figure 5**)
- Sediment deposition (mm) following the completion of dredging and the 30-day post dredge period (**Figure 6**).

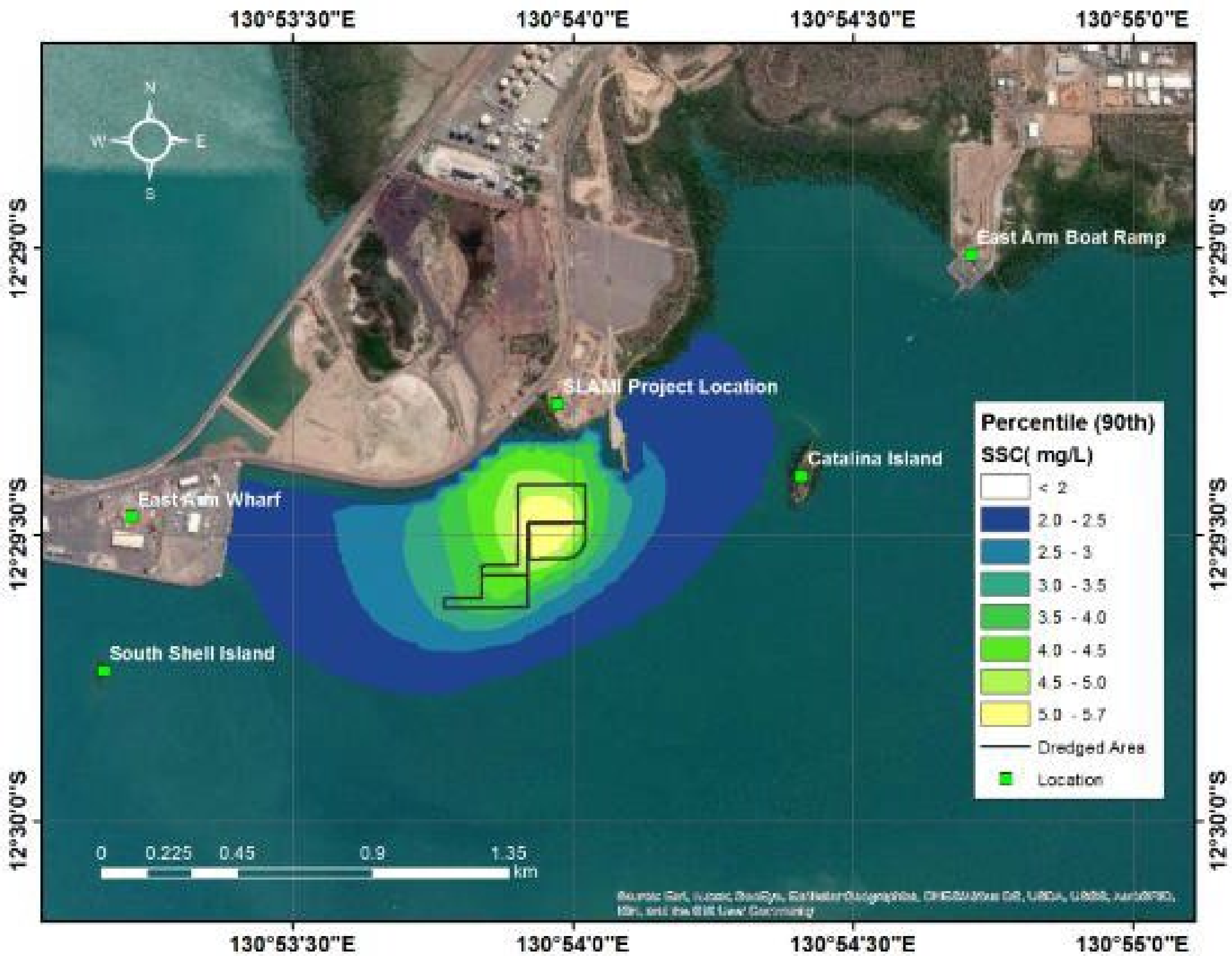

Figure 5 90th Percentile modelled SCC (above background level) (mg/L)

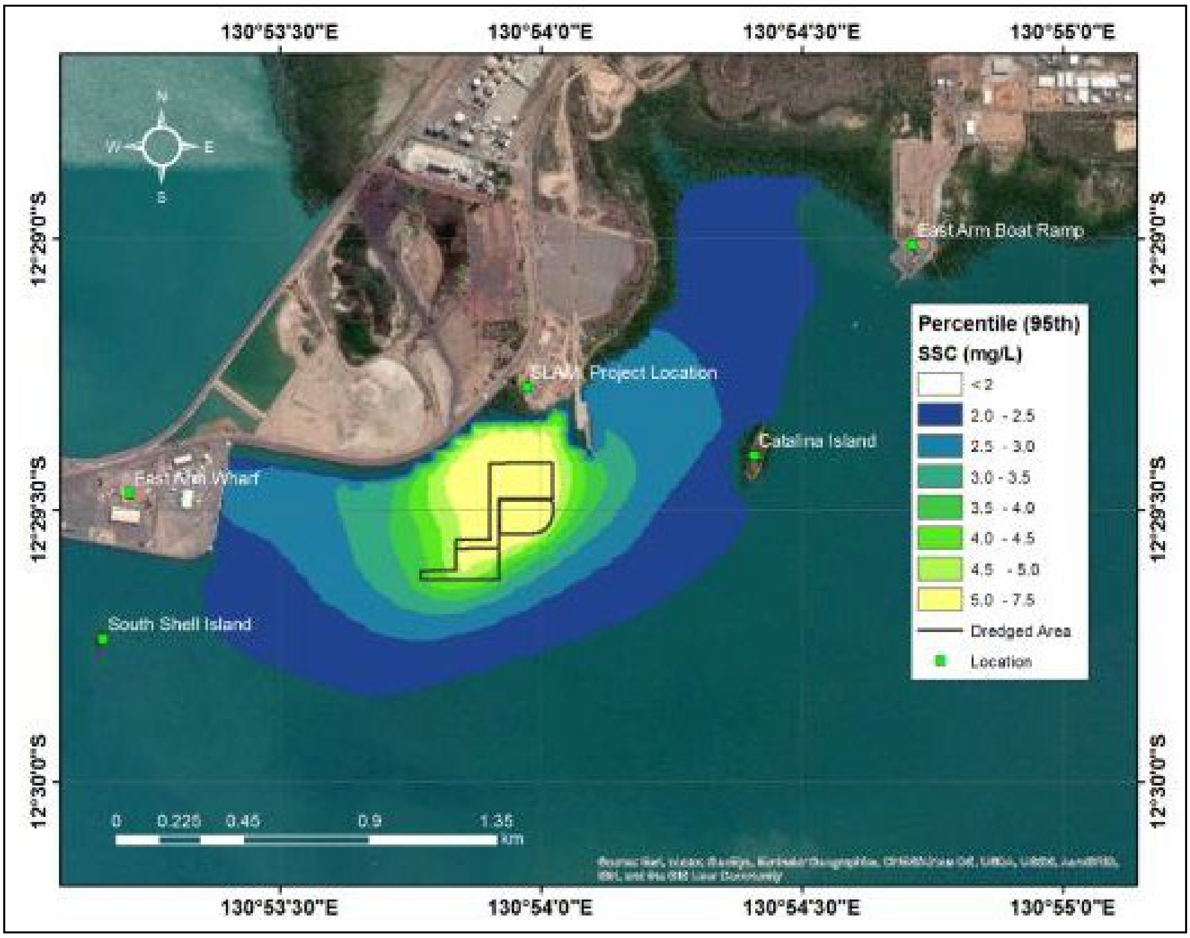

Figure 6 95th Percentile modelled SCC (above background level) (mg/L)

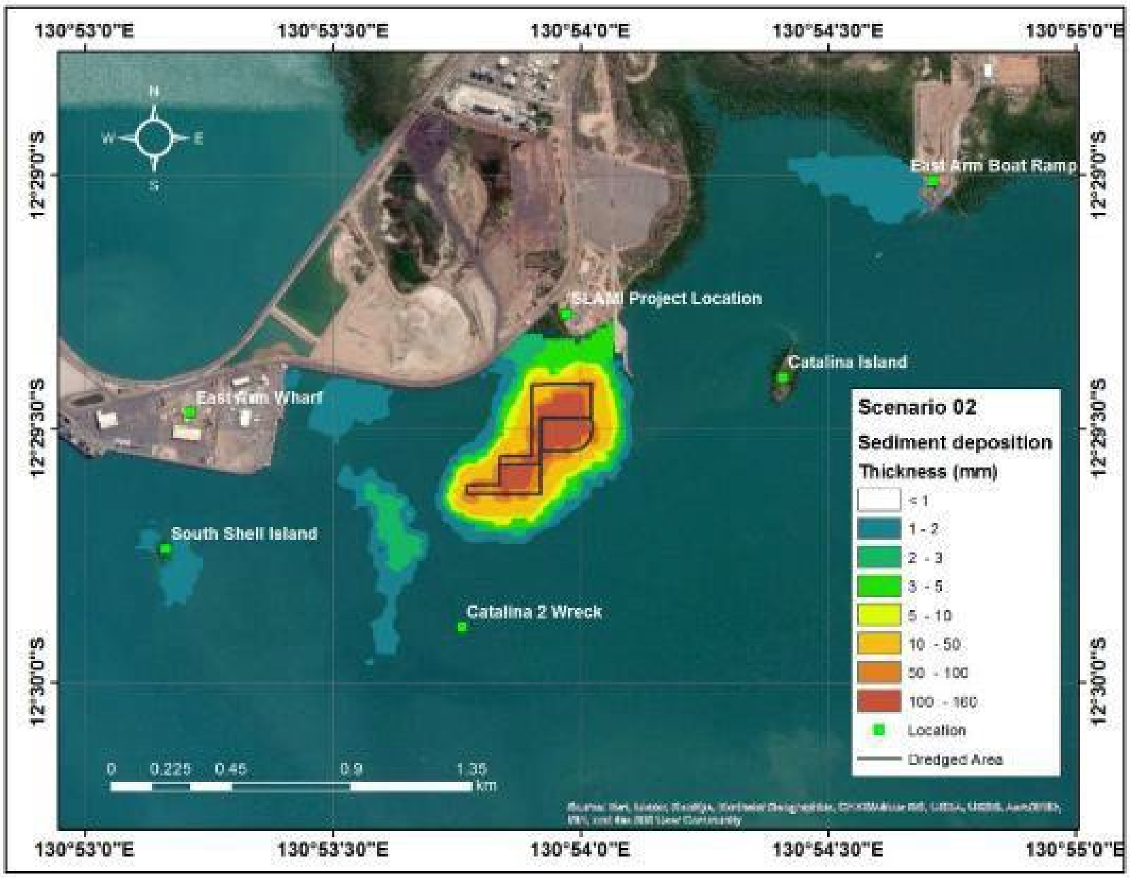

Figure 7 Sediment deposition at the completion of dredging and the 30-day post dredge period (in mm)

3.9.1 Suspended sediments

3.9.1.1 Dredging

Sediment modelling predicts a 90th percentile SSC of up to only 5.7 mg/L (**Figure 5**), which is less than the Dry season and Wet season tolerance limits of 10 mg/L and 25 mg/L respectively. Hence, the Zone of Moderate Impact falls completely within the Zone of High Impact. Similarly, a 95th percentile SSC of 7.5 mg/L is predicted at the cutter head (**Figure 6**) meaning that the Zone of Influence also falls entirely within the Zone of High Impact (i.e. within 20 m of the proposed dredging footprint boundary). As a result, suspended sediments mobilised from the dredge are not predicted to extend beyond the dredging area at concentrations that could result in detectable changes to environmental quality.

3.9.1.2 Tailwater discharge

Boundaries of the Zones of Moderate Impact and Influence at the tailwater discharge point at the permeable section of the railway bund wall (based upon a tailwater SSC criterion of 100mg/L; refer Section 6.2.2) were also defined by the 90th and 95th percentile plots produced by the modelling as follows:

- The outer edge of the Zone of Moderate Impact is delineated by the 90th percentile contour plot for SSC. On **Figure 8**, the outer edge of the Zone of Moderate Impact for the Dry season is shown as the purple contour, extending a maximum of approximately 100m from the railway bund wall. For the Wet season, there are no areas seawards of the railway bund wall where an SSC of 25 mg/L is exceeded more than 90% of the time; hence the Zone of Moderate Impact does not extend seaward of the railway bund wall.
- The outer boundary of the Zone of Influence is delineated by the 95th percentile contour plot for SSC. On **Figure 8**, the outer edge of the Zone of Influence for the Dry season is

shown as the red contour, extending a maximum of approximately 120m from the railway bund wall. For the Wet season, there are no areas seawards of the railway bund wall where an SSC of 25 mg/L is exceeded more than 95% of the time; hence the Zone of Influence does not extend seaward of the railway bund wall.

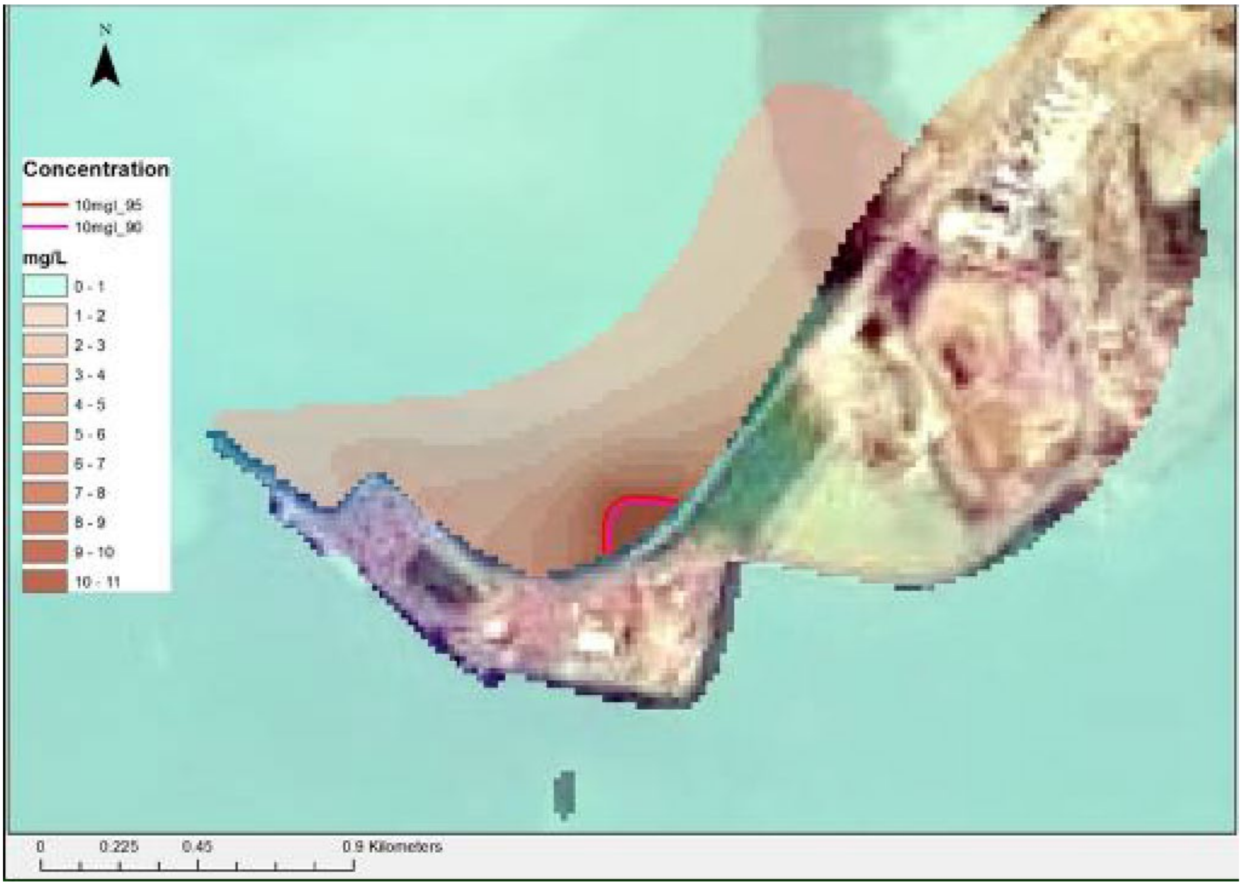

Figure 8 Predicted Dry season zones of Impact and Influence (SSC) at the tailwater discharge location

Suspended sediments may potentially impact a small area of benthic habitat up to 120 m from the Pond E (South) discharge point. While the habitat within this small area has not been mapped in detail, observations from low tide aerial imagery indicate that it is an intertidal mud/sandflat which would support benthic invertebrates living on and in the surface sediments. The suspended sediments could impact upon these organisms through clogging of feeding or respiratory structures, though any impacted areas would be expected to be recolonised by similar fauna once tailwater discharge has ceased. It should also be noted that no exceedance of suspended sediment limits set during the MSB or MUBRF dredging were observed at the outflow point from the pond system.

3.9.2 Sedimentation

3.9.2.1 Dredging

Sedimentation after 30 days of completion of dredging was modelled to identify any potential areas for concern for the exceedance of the sedimentation tolerance limits in mangrove areas. **Figure 7** shows that sediment deposition above 50mm is predicted to remain within the dredging footprint and does not extend beyond the Zone of High Impact defined for SSC (i.e. within 20 m of the dredging footprint). As such, no mangrove stands are predicted to be exposed to sediment accumulation beyond the tolerance levels proposed for mangroves (50 mm and 100 mm for reduced mangrove health, and likely mangrove mortality respectively). Hence sediment accumulation is not expected to impact on mangrove communities in areas such as upper reaches of East Arm, Blessers Creek and Charles Darwin National Park. It would be reasonably expected that Wet season wave activity under normal conditions would have a greater impact in these areas than sedimentation associated with the dredging and tailwater discharge (D Williams, AIMS, pers. comm. 2015).

A pocket of sediment deposition of between 1-2 mm (well below the 15 mm tolerance limit in the approved INPEX [2013, 2018] dredging management plans) is predicted to occur near South Shell Island (**Figure 6**). However, the modelling does not account for:

- The ability of hard corals to actively remove sediment from their surfaces (e.g. through the production of mucus) or for the influence of colony morphology in aiding sediment removal (e.g. Jones et al 2019).
- The active removal of sediments from the water column by filter feeders (e.g. Strehlow et al 2017, Abdul Wahab et al 2018) which may reduce the amount of sediment settling upon their surfaces, reducing the potential for impacts from smothering.

The wreck of Catalina 2 is located offshore from the proposed dredging footprint. It can be seen that sediment transport and sedimentation modelling does not predict sedimentation to occur in this area (**Figure 6**). Similarly, there is no net sedimentation predicted at either of the registered sacred sites (Catalina Island and Old Man Rock) that are present within 1 km of the dredging footprint.

3.9.2.2 Tailwater discharge

Previous modelling of sediment accumulation associated with the discharge of tailwater with SSC up to 100 mg/L (modelled for the MUBRF dredging) indicated sedimentation up to 2.88 mm may occur in close proximity to the outfall, well below the tolerance limits proposed for mangroves.

If the rate of sediment deposition adjacent to the settling pond discharge point is sufficiently high, then some of the benthic fauna may be smothered. However, any impacted areas would be expected to be recolonised by similar fauna once tailwater discharge has ceased.

It is concluded that potential sedimentation effects need not be given further detailed consideration in this Plan and that monitoring and management of suspended sediment levels within the pond system will provide an appropriate level of mitigation against the risk of impacts upon the receiving environment.

4 Dredging Program and Methodology

4.1 Dredging and Dredge Spoil Placement

Dredging will be carried out using a CSD to remove the unconsolidated material to the existing East Arm Wharf settling ponds, then a BHD to remove the consolidated material for land reclamation.

The location of the works within a tidal zone, sediment characteristics, limited available draught for vessels, and the method of placement of the dredged material were the determining factors for the selection of the preferred dredging methodology. Dredging shall not exceed more than 11ha of seabed disturbance within the approved extent, as per condition 1-1 condition of EP approval (EP2023/028-001). The land disturbance area (including infrastructure, hardstand and revetments)must not exceed 22.2 ha.

The current seabed surface levels within the proposed dredging footprint range from +1.0 m LAT to -3.0 m LAT. The typical geotechnical profile of the unconsolidated surface materials to be dredged consists of sand and gravel surface sediments (with gravel potentially comprising shell fragments) with silt and clay content generally increasing with depth. During sediment sampling undertaken at the site sample recovery of between 0.2 and 1.5 m was achieved before encountering consolidated material (AECOM, 2020). These unconsolidated sediments are underlaid by a thin layer of ‘stiffer’ consolidated residual soils, typically silty sand / sandy silt, which are overlaying shallow rock material. Side casting of excavated material may occur within the project extent (e.g., during early works for access to the ship lift pocket or dredging of ship lift).

Dredging of unconsolidated material will be undertaken using a small CSD. Dredged material will be transported via a temporary pipeline to the settling ponds at EAW. The final pipeline route would be determined by the Dredging Contractor in conjunction with CBJV and the Harbour Master.

The EAW ponds have previously been used for the disposal of capital dredging material from the initial development of EAW and from two developments undertaken as part of the EAW expansion project (Marine Supply Base [MSB] and Multi-User Barge Ramp Facility [MUBRF]), as well as from the Darwin City Waterfront Redevelopment. The existing EAW pond external pond revetment walls have been designed and constructed to wholly contain all material placed within the reclaimed area and to prevent the release of sediment to tidal waters during Project construction. This is in accordance with Environmental Approval (EP2023/028-001) condition 2-2(1),

It is expected that tailwater flow rates into the pond system would be approximately 500 L/s at a water to sediment ratio of 9:1. A sediment loss rate of 5% at the CSD cutter head could be expected and a dry bulk density of 857 kg/m^3 is considered to be likely; these are in line with those characteristics assumed for the MUBRF dredging campaign (URS, 2015).

The material placement scenario is shown in **Figure 9**:

- The dredged material will initially be pumped into the ponds at a location in Pond K, in which the larger particles (sands and silts) will settle out. If necessary, internal bunds may be constructed within Pond K to enhance the settlement process, or tailwater held within Pond K for a longer settling period.
- The supernatant tailwater will then flow into Pond E (North), in which retention will be managed such that there is sufficient time for finer particles to settle out, using the weir box into Pond E south to control the level in Pond E north. Silt curtains may be installed in Pond E (North) to assist in this process.
- Pond E (South) will provide a final settlement stage before the tailwater, under tidal influence, enters Frances Bay (Darwin Harbour) via a permeable section of the bund wall.

The primary method of control over tailwater quality discharged from the pond system would be through the use of silt curtains, internal diversion walls (bunds), control of the dredging regime and through the management of weir boxes. The flow direction and flow rate of tailwater into the ponds would be controlled so that sufficient residence time is achieved to result in suspended sediment concentrations (SSCs) within allowable limits at the point of entry of the tailwater to Pond E (South).

The reclamation area would be bunded as required and then progressively filled with consolidated material until the extent of the proposed reclamation is reached. Consolidated material would be removed by a BHD, placed into hopper barges and transferred into the reclamation area within the Project footprint. Sediment control measures such as silt curtains would be used to further minimise the release of sediments into the receiving environment from the reclamation area.

Figure 9 Indicative settling pond configuration

4.2 Pond levels (water only)

The maximum water height in Pond K will be 6.0 m AHD or a minimum of 0.5 m freeboard (whichever is higher).

Pond E (North) will operate with a water level of between 3.5 and 5.0 AHD and be controlled by a reclamation box with an adjustable weir.

The water level in Pond E (South) will be controlled to ensure at least 0.5 m freeboard at all times. During the dredging works, tailwater will pass through the permeable section of the railway bund (at the south-west corner of Pond E) at a rate which matches or exceeds the dredge output; hence the water level will in the pond will not vary significantly and is mainly influenced by tidal variation. As a backup there will be a pump discharge outlet located in the south-east corner of Pond E (South) where a pump system capable of pumping 600 L/s, if required, will return the tailwater to Pond K or Pond E (North).

Each pond will operate with a minimum 0.5 m freeboard. While it is not anticipated to be required given the relatively low flow rates into the ponds, pumps may be used to supplement gravity flows to ensure transfer flows equivalent to the dredge output are maintained between ponds.

During dredging the daily water levels of each pond will be recorded and provided in the weekly reports. Where transfer pipes are fitted, the flow between ponds can be stopped by blocking the pipework between these ponds with steel plates and/or inserting rubber expanding plugs, with both options available on site.

Where a reclamation box is fitted the flow can be stopped by adding drop boards and raising the height of the weir. In both instances flow can be stopped within an hour as a corrective action if required.

4.3 Stormwater flow paths

Stormwater from the pond network and adjacent Darwin Port land ultimately flows into Pond E (South) for return to the harbour via the permeable section of the railway bund wall (refer **Figure 9**). During dredging operations, particularly where dredging is undertaken over the Wet season, consideration will be given to possible storm events and ensuring a flow path is always available for stormwater to find its way through the ponds.

Stormwater from the Pond K road bund and a catchment area near the gatehouse, estimated to be 20,000 m^2, is diverted into a stormwater channel in place along the boundary between Pond K and the former Pond C area, into Pond D, instead of flowing into Pond K (refer **Figure 10**). Stormwater from the highpoint on the road to the south of Pond K flows along a stormwater channel and through a culvert into Pond E (North).

The runoff from Darwin Port land to the north of the ponds passes through both Pond D and into Pond E (North). Importantly, stormwater does not flow into Pond K, allowing greater control over water exiting from this disposal pond.

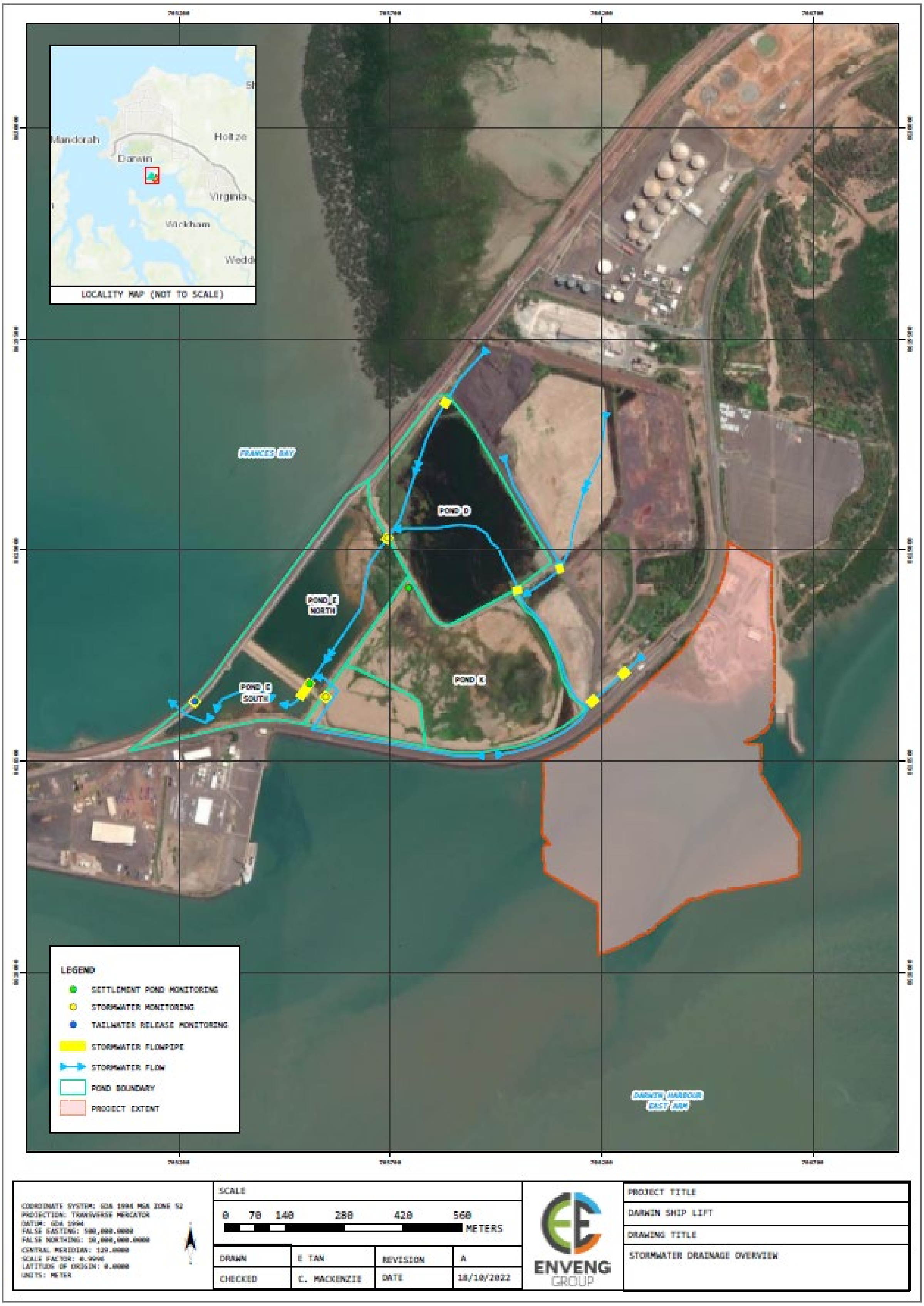

Figure 10 Stormwater flow paths through the EAW pond system

5 Environmental Factors and Objectives

Environmental factors are those features of the environment that may be impacted by an aspect or activity of a proposal. The NT EPA has identified 14 environmental factors, categorised under five themes: Land, Water, Sea, Air and People and Communities (NT EPA 2018).

Each environmental factor has an associated environmental objective against which the Project can be assessed, and which guides the development of impact mitigation and management measures set out within this Plan.

Table 4 lists the environmental factors that have been identified in the Project EIS Terms of Reference (NT EPA 2019) as those that may potentially be impacted by the Project activities set out in this Plan (i.e. the dredging and reclamation activities), the EPA objective for each and the potential impact pathway associated with the Project.

The Environmental Performance Objectives, management targets and measures for each environmental factor are defined in the Environmental Management Frameworks in Section 6.

Table 4 Environmental factors, objectives and potential impact pathways

Theme	Environmental Factor	Objective	Potential Impact Pathway
Sea	Marine flora and fauna	Protect marine flora and fauna so that biological diversity and ecological integrity are maintained.	Direct impact to or loss of marine habitats within or in close proximity to the dredge footprint due to dredging.
			Indirect impacts to marine ecosystems due to increased turbidity and subsequently reduced benthic light availability as a result of dredging and tailwater discharge.
			Underwater noise and vibration associated with dredging and other Project-related vessel movements.
			Smothering of benthic flora, fauna and infauna as a result of sedimentation during and following dredging.
			Interaction between vessels and marine fauna including entrainment in dredge and collisions with Project-related vessels.
			Introduced invasive marine pest (IMP) species may compete with, or prey on, local marine fauna.
			Potential impacts to coral spawning due to increased turbidity associated with dredging during or around the time of coral spawning events
			Introduction of IMP species from Project- related vessels may impact benthic communities through competition for food and resources.
	Marine environmental quality	Protect the quality and productivity of water, sediment, and biota so that environmental values are maintained.	Impacts to water quality resulting from suspended sediment loads created by dredging potentially impacting marine ecosystem values.
			Potential hydrocarbon release associated with vessel operations, equipment operation (hydraulic fluids), bunkering or vessel collision.

			Changes to the physico-chemical properties of the water column resulting from dredging and tailwater discharge.
			Introduction of IMP species may impact local environment by altering population dynamics of local species through competition and predation.
People and communities	Social, economic and cultural surroundings	Protect the rich social, economic, cultural and heritage values of the NT.	Suspended sediments generated by dredging activities settling upon cultural heritage sites.
			Physical impacts upon cultural heritage sites by Project vessels.

6 Environmental Management

This section describes the Environmental Management Frameworks (EMFs) that have been developed for the risks associated with the dredging works, as identified through the environmental risk assessment process (AECOM, 2022b). The EMFs are instrumental to effectively manage and mitigate environmental risks to sensitive receptors identified in Section 3.3, and to achieving the objectives set by the NT EPA for each of the Environmental Factors identified in Section 5 of this Plan.

EMFs have been developed for the following receptors:

- water quality – Darwin Harbour
- water quality – EAW settling ponds
- protected marine species – physical interaction
- protected marine species – underwater noise.

Each EMF states the relevant Project commitments made and objectives to be met, and contains specific, measurable targets to achieve the objective for each of the applicable Environmental Factors. It also summarises the management actions required to meet these targets, the relevant KPIs and the monitoring activities to be employed to measure success in meeting the requirements and to identify the need for corrective actions.

It should be noted that:

- catalmanagement actions are routine tasks that will be undertaken to meet the objectives of each EMF
- corrective actions are those tasks that are possible to be undertaken if monitoring indicates that trigger levels have been exceeded.

Where trigger levels are proposed, it should be noted that these are triggers for further investigation and are set well below levels at which significant adverse ecological effects could be anticipated. Monitoring is described in greater detail in Section 7. Each EMF also indicates the relevant reporting requirements (detailed further in Section 8) and the responsibilities of Project personnel.

6.1 Water quality – Darwin Harbour

6.1.1 Potential impacts

6.1.1.1 Suspended sediments

Plumes of suspended sediments (‘turbid plumes’) may impact upon marine organisms through clogging of feeding or respiratory structures or through a reduction in light penetration through the water column.

Turbid plumes containing elevated levels of suspended sediments will be generated:

- At the cutter head of the CSD.
- From any improperly sealed joints within the pipeline leading from the dredge to the EAW settling ponds.
- As the BHD bucket interacts with the seabed and lifts the dredged material through the water column.
- At the seaward face of the reclamation area, as a result of the return of entrained water from the dredged material.

As discussed in Section 3.9, sediment modelling predicts the Zone of Moderate Impact falls completely within the Zone of High Impact, i.e. within 20m of the dredging footprint boundary. Tidal currents will rapidly disperse the suspended sediments, and SSC’s will rapidly return to background levels upon the completion of dredging. As a result, suspended sediments mobilised from the dredge are not predicted to extend beyond the dredging area at concentrations that could result in detectable changes to environmental quality. As such, and consistent with the *Darwin Port Long Term Dredging Management Plan* (AECOM 2018), monitoring of benthic communities is not considered necessary.

The risk assessment (AECOM, 2022b) has assessed the risk of increased SSC in the water column from dredging activities as Small magnitude, and Moderate sensitivity, equating to a Minor overall risk.

AECOM (2022) assessed the risk of reduction on incident light levels to benthic biota, potentially leading to reduced growth or to mortality; and clogging of fauna feeding or respiratory structures, potentially leading to reduced growth or to mortality, as Small magnitude, and Moderate sensitivity, equating to a Minor overall risk. Benthic biota within the area over which reduced light levels may occur are well represented within the harbour. No benthic communities of conservation significance are known to occur in the vicinity of the dredging and reclamation activities. In the past, a degree of research importance has been ascribed to the filter feeder communities around South Shell Island. However, it is predicted from modelling that elevations in SSC will not reach the predicted tolerance limits (Section 3.7) over these communities.

Given that dredging-related SSC is not predicted to approach these receptors, a precautionary monitoring program (detailed in Section 7.2) will be implemented to determine whether SSCs in the vicinity of the operating dredge are sufficiently low as to pose a negligible risk of exceedance of tolerance limits at the nearest sensitive receptor sites. In addition, monitoring of benthic communities will occur at selected locations around South Shell Island (refer Section 7.3).

6.1.1.2 Toxicants

The potential for toxicants to be released from the porewater within the unconsolidated seabed materials to be dredged is recognised. However, on the basis of the results from the sediment geochemical assessment undertaken by AECOM (2020) it is considered that there is negligible risk of these being released at sufficient concentrations to significantly impact upon the beneficial uses, water quality objectives or identified environmental values of Darwin Harbour.

The following aspects of the dredge operation will further mitigate the potential for changes in toxicant concentrations to occur in the water column beyond the dredging footprint:

- CSDs utilise powerful suction to transport the dredged material to the disposal location. This entrains the majority of porewater (within the dredged material) into the dredge, then into the pipeline to the disposal location.
- While there is typically some release of fine sediment particles from CSD cutter heads (conservatively estimated as 5% of the volume of dredged material), these are only carried away from the cutter head if currents are sufficiently strong. These currents will have the effect of rapidly diluting any porewater (and any toxicants therein) that may become entrained in the flow away from the cutter head.
- It is anticipated that the loss at the cutter head will be considerably lower than 5% when dredging unconsolidated materials as the CSD would primarily operate in 'suction-only' mode. The release of sediments from a cutter head typically occurs when it is activated in order to fracture consolidated material, within which there is limited porewater.
- During BHD operations, much of the sediment porewater will be retained within the dredged material as it is raised through the water column. While this will be released as the material is deposited into the reclamation area, it is reiterated that the toxicant concentrations within the sediments to be dredged have been determined (by AECOM 2020) to be sufficiently low as to not pose a risk of significant impacts upon the receiving environment.

It is considered that the monitoring of turbidity levels, as an indication of the veracity of the plume dispersion modelling, is an appropriate strategy to also mitigate the risk of impacts from nutrients and toxicants.

6.1.2 Trigger levels

A turbidity **trigger level** of 100 mg/L (140 NTU) has been set at a distance of 150 m down current from the operating dredge, the pipeline, or the seaward edge of the reclamation area; this is based on the need to retain SSCs at sensitive receptor sites (e.g. South Shell Island) below the tolerance limits for those communities (10 mg/L for Dry season and 25 mg/L for Wet season).

Given the distance between the proposed dredging location and the nearest significant sensitive receptor site at South Shell Island, this trigger level is considered suitable to provide an early warning that SSCs are elevated above those predicted and that management measures may be required to reduce the risk of the relevant SSC tolerance limit being exceeded at South Shell Island.

Seasonal turbidity **limit values** of 21.2 NTU (Wet season) and 3.5 NTU (Dry season) (AECOM 2018) have been set at the benthic communities at South Shell Island monitoring site and Catalina Island monitoring site.

6.1.3 Response to trigger exceedance

Where a **trigger level** (140 NTU) at a distance of 150m from the operating dredge, from its associated pipeline, or from the seaward edge of the reclamation area is exceeded, a drone will be employed to capture aerial imagery of the plume.

Additional turbidity monitoring will then be carried out at the South Shell Island and Catalina monitoring sites, to determine if the limit value has been exceeded.

If a **trigger value** and/or seasonal turbidity **limit value** is exceeded, then this will be reported to the Territory within 24 hours and corrective actions (see **Table 5**) will be implemented in a manner aimed at determining which of them have the greatest potential to reduce the dispersion of plumes from the dredging and reclamation activities towards South Shell Island and / or Catalina Island.

Concurrently, an attributability assessment will be initiated and submitted to the Territory to determine whether or not the exceedance was likely to have been caused by dredging or reclamation activities. This assessment will be completed within three business days of the exceedance occurring and will include consideration of information such as:

- Changes in TSS levels within East Arm that are due to natural factors such as storm activity, or to other anthropogenic sources.
- Observations of turbid plumes emanating from other sources within East Arm.
- Wind, wave, current direction and tidal data.

If it is deemed that the exceedance is potentially due to the dredging or reclamation activities, then those corrective actions (**Table 5**) that are most effective in adequately reducing turbidity emanating from these sources will continue to be implemented until such time as the turbidity levels fall to below the **trigger level** and/or **limit value**.

Where the turbidity **trigger value** (140 NTU) at a distance of 150m from the operating dredger, associated pipeline or the seaward edge of the reclamation area is exceeded, this will be reported by the Contractor to the Territory within 24 hours. Also within 24 hours, additional monitoring and corrective actions (see **Table 5**) will be implemented in a manner aimed at determining which of them have the greatest potential to reduce the dispersion of plumes from the dredging and reclamation activities towards South Shell Island and Catalina Island.

If attributability report determines CBJV dredging is the cause of the exceedance tolerance at benthic communities, the following actions should be undertaken:

Monitor the turbidity at nominated monitoring sites (South Shell Island and/ or Catalina Island), a minimum of once per day for a period of 7 days. Where the seasonal turbidity **limit values** of 21.2 NTU (wet season) and 3.5 NTU (dry season) at the benthic communities at South Shell Island or Catalina Island monitoring sites is exceeded for a period of greater than 7 days, the immediate response is to cease dredging, implement corrective actions (see **Table 5**) and report in accordance with the trigger level exceedance.

6.1.4 Management measures

The following inherent characteristics of the dredging operation are anticipated to minimise the generation of turbid plumes:

- Dredging and reclamation activities are situated close to shore, at locations which are afforded some protection from the effects of tidal currents.
- During CSD operations, the feed of sediments into the suction pipe is maximised by its location directly behind the cutter head. This minimises the release of sediment into the water column surrounding the dredge. When dredging unconsolidated materials the cutter will be disengaged for much of the time, while dredge pumps will operate at the maximum speed possible.
- During BHD operations, the bucket will be raised through the water column at a speed that minimises the loss of material from the bucket. The dredged material will be placed into barges from which there will be no overflow of entrained water or porewater. Silt curtains will be deployed along the seaward edge of the reclamation area and runoff from the area will be managed to minimise the entry of sediments into the marine environment.

Monitoring of the turbid plume from the dredge will allow for detection of exceedances of the trigger value. Where the turbidity exceeds the **trigger value** 140 NTU 150m down current of any sources of turbid plumes from the dredging, dredge pipeline and reclamation activities, the following management measures will be implemented (**Table 5**):

- Cutter head and pump speeds adjusted to minimise dispersion of fine sediments from the cutter head.
- Immediate action to repair pipeline to ensure integrity maintained to reduce the potential for spoil leakage from joints between sections.
- Speed of BHD bucket movement through water column adjusted to minimise loss of sediments into the water column.
- Installation of additional silt curtains along seaward edge of reclamation area.

An exceedance of the **trigger value** will cause additional turbidity monitoring at the South Shell Island monitoring site or the Catalina Island Monitoring Site.

Where turbidity exceeds the seasonal **limit value** (21.2 NTU Wet season and 3.5 NTU Dry season) at the South Shell or Catalina Island monitoring site, the following management measures will be implemented (**Table 5**):

- Cease dredging activities.
- Depending on the tidal cycle, relocation of the dredge can be scheduled to coincide with those times when the tide will not move sediments towards benthic habitats.
- Implement corrective actions as for exceedance of trigger level.

Table 5 Water Quality Management Framework – Darwin Harbour

Element	Maintenance of water quality in East Arm
Commitments	EP Approval conditions 2-1 and 2-2.
Objective	To minimise the potential for impacts upon the hard coral and filter feeder communities at South Shell and Catalina Islands from turbid plumes emanating from dredging and reclamation activities.
Target	1. No instances of exceedance of turbidity **trigger levels** at a distance of 150m down- current of the operating dredge or its associated pipeline or the seaward face of the reclamation. 2. No instances of exceedance of turbidity **limit value** at the South Shell Island or Catalina Island monitoring site
Key Performance Indicators	Number of instances of exceedance of **trigger level** at the sampling locations 150m down current from the sources that require corrective actions to be implemented to return water quality in East Arm to an acceptable level. Number of instances of exceedance of seasonal **limit value** at the South Shell Island or Catalina Island monitoring site(s) that require corrective actions to be implemented to return water quality to an acceptable level.
Management	CSD: • Cutter head and pump speeds managed to minimise dispersion of fine sediments from the cutter head. • Pipeline integrity maintained to reduce the potential for spoil leakage from joints between sections. BHD: • Speed of bucket movement through water column managed to minimise loss of sediments into the water column. • No overflow from barges. • Silt curtains along seaward edge of reclamation area. • Management of runoff from reclamation area.
Monitoring (Sections 6.1.2 and 6.1.3)	• Reactive water quality monitoring 150m down current of the operating dredge, the pipeline and the reclamation area, if a plume is emanating from it. • Where there is an exceedance of the trigger value at a distance of 150m from the dredge, pipeline or reclamation area, a drone will be employed to capture aerial imagery of the plume and additional turbidity monitoring will be carried out at the South Shell Island and / or Catalina Island monitoring sites

	• Baseline and post-dredging assessments of proportions of live hard corals and filter feeders within benthic communities at South Shell Island and Catalina Island monitoring sites.
Reporting (Section 12)	• Reporting of reactive monitoring data by Project Environmental Advisor to the Territory within 24 hours of an exceedance of **trigger level** or **limit value**. • Monitoring report to the NT EPA at the conclusion of dredging. • A report on attributability assessment and corrective actions implemented to address the cause of the exceedance will be submitted by Project Environmental Advisor to the Territory within three business days of the notification.
Corrective Actions	• Where turbidity exceeds the **trigger level** 150m down current of any sources of turbid plumes: - Cutter head and pump speeds adjusted to minimise dispersion of fine sediments from the cutter head. - Immediate action to repair pipeline to ensure integrity maintained to reduce the potential for spoil leakage from joints between sections. - Speed of BHD bucket movement through water column adjusted to minimise loss of sediments into the water column. - Installation of additional silt curtains along seaward edge of reclamation area. • Where turbidity exceeds the seasonal **limit value** at the South Shell Island and/or Catalina monitoring site: - Cease dredging activities. - Depending on the tidal cycle, relocation of the dredge can be scheduled to coincide with those times when the tide will not move sediments towards benthic habitats. - Implement corrective actions as for exceedance of trigger level.
Term	• For the duration of dredging and reclamation works.
Responsibility	• Project Environmental Advisor to ensure that works are undertaken in compliance with the approved WQMF. • Project HSSE Manager to ensure monitoring program and water quality management measures are implemented.

6.2 Water quality – East Arm Wharf settling ponds

6.2.1 Potential impacts

The tailwater discharge from the settling ponds will contribute suspended sediments to the receiving environment in the vicinity of the permeable railway bund wall at East Arm Port, though on occasions (e.g. during spring tides) the concentrations of suspended sediments in the tailwater may be less than those in the receiving environment.

AECOM (2022), assessed the risk to receiving waters of increased SCC from tailwater release as Negligible magnitude and Low sensitivity, equating to a Minor overall risk.

Monitoring during the MSB and MUBRF dredging provides a relevant comparison with which to compare likely suspended sediment dispersion and sedimentation resulting from the use of the pond system. No exceedances of SSC trigger levels occurred in the natural environment at the outflow point of the pond system, indicating that the ponds are capable, with effective management, of maintaining tailwater outflow to the environment within the set limits for dredge programs utilising similar dredging equipment. Based on this experience, it is expected that the use of the ponds as described in this Plan will result in outflow to the receiving environment at acceptable SSCs, with negligible risk of unacceptable degrees of sedimentation.

There will be two primary sources of potential impact upon the receiving environment in Frances Bay from tailwater discharge from the EAW settling ponds:

- Elevated concentrations of suspended sediments; these are addressed in Section 6.1.1.1.
- Increased acidity (i.e. reduced pH) and/or elevated toxicant concentrations due to the oxidation of potential acid sulfate soils. These could result in acute or chronic adverse impacts upon biota in the vicinity of the permeable section of the railway bund wall.

6.2.1.1 Acid sulfate soils

Potential impacts upon the water quality within the settling ponds (reduced pH) may occur as a result of generation of acid if dredged sediments that contain ASS are exposed to air within the ponds for extended periods. Synergistic impacts may arise if these sediments are subsequently re-wet (e.g. by water from the dredging process, or from rainfall); the water would be acidified and would potentially leach metals (including arsenic) from the dredged sediments, or from the existing sediments within the ponds.

If acidic tailwater is released from the Pond E (South) into Francis Bay, then impacts around the discharge location could include:

- injury to, or mortality of, protected marine species, fish, crustaceans, mangroves, etc.
- reduction of bicarbonates in the receiving water, potentially resulting in deformities in shellfish development.
- release of contaminants from sediment in the receiving environment.
- corrosion of metals and weakening of concrete structures, potentially impacting on infrastructure and/or engineering works.

Some indicators for the presence of acid leachate arising from oxidation of PASS are:

- green-blue water, sometimes cloudy but sometimes extremely clear due to the presence of metals that have leached from the soils (aluminium)
- rust coloured stains on soils, and rust coloured slime on water (due to iron oxidising bacteria)
- yellow patches on soils as they dry out (“jarosite”).

As discussed in Section 3.2.3.4, all samples reported ANC ranging between 1.57 %S and 18.5%S. The ANC ranged between 19 and 231 times greater than the sum of existing and potential acidity concentrations; well within the adopted criterion of ANC being greater than 15 times the total acidity of samples.

6.2.2 Water quality criteria for tailwater release

The key water quality guidelines that are relevant to the management of the dredging and dredged material placement activities are the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG) 2018 and the Darwin Harbour Region Water Quality Objectives (WQOs) (Fortune 2010, Cassilles Southgate & Fortune 2018). The Darwin Harbour Region Report Cards (e.g. DEPWS 2021) are also relevant as they contain data from ongoing NTG water quality monitoring in Darwin Harbour.

The National Water Quality Management Strategy recommends that "the guidelines for each indicator should be based on locally derived data to reflect local (ambient) conditions. Where derivation of guidelines based on local monitoring is not possible, it is recommended that the national ANZECC Guidelines are used instead (for tropical Australia)". Therefore, the most applicable guidelines for this Project are Darwin Harbour Region WQOs, and in the absence of guidelines for certain parameters, reference will be made to the national ANZG (2018) Guidelines.

The most stringent water quality criterion for Darwin Harbour was considered by NRETAS (2010) to be the environmental beneficial use category. This was because the intent of the environmental beneficial use was to maintain the health of aquatic ecosystems, and a water body that meets an environmental beneficial use will in almost all circumstances also meet the requirements for all other beneficial uses.

NRETAS (2010) adopted the ANZECC Guidelines approach for physico-chemical indicators for 'slightly to moderately disturbed' systems. The ANZECC (now ANZG) Guidelines have defined acceptable effect sizes for each level of protection for different indicator types.

NRETAS (2010) states that the Darwin Harbour Region WQOs can be used as a tool for monitoring water quality and supporting decision making on the management of activities affecting coastal marine waters in the Darwin Harbour catchment. They apply to ambient waters (i.e. the receiving waters) and should not be regarded as individual discharge criteria. The values include protection of aquatic ecosystems and recreational activities associated with the use of marine waters such as swimming, boating and fishing. Where the values are not being met, planning and management of these areas should move towards achieving the objectives over time.

The Darwin Harbour Region WQOs and the ANZG (2018) Guidelines can be used to provide guidance to those undertaking water quality monitoring programs by providing key water quality indicators that can be monitored over time. Measured water quality can be compared with the criteria to determine whether management goals are being achieved or where management action is required.

The ANZG (2018) Guidelines and Darwin Harbour Region WQOs apply to the receiving environment, rather than to the tailwater. However, if the tailwater meets the following criteria before discharge from the settling ponds then it will be considered suitable for continued release:

- The pH of the water samples collected during monitoring at the weir box between Pond E (North) and Pond E (South) (see Section 8.3.2) is greater than 6.0. This will meet the criterion for an Upper Estuary setting, as presented in the Darwin Harbour Region Water Quality Objectives.
- For toxicants (including arsenic) the Darwin Harbour Region WQOs defer to the ANZG (2018) default guideline values (DGVs). Hence concentrations of toxicants will be

compared against the ANZG (2018) DGVs for slightly to moderately disturbed ecosystems (i.e. for 95% species protection). For some toxicants (including arsenic) ANZG (2018) has no DGV for marine waters as there are considered to be insufficient data to derive reliable trigger levels. In these instances, the criteria levels for fresh water will be adopted. The list of metallic toxicants to be tested (**Table 10**) is based on the potential presence and toxicity of these metals in Darwin Harbour.

- The target SSC for the tailwater will be 100 mg/L (140 NTU). As SSC cannot be monitored directly in the environment, turbidity (in NTU) is used as a surrogate measure. A mathematical relationship between NTU and SSC was derived from water samples collected within the pond system and analysed for both SSC and turbidity as part of the MSB capital dredging monitoring program (DoI 2014). This relationship (100 mg/L = 140 NTU) will be applied during interpretation of water quality monitoring undertaken during the dredging campaign.

Table 6 Toxicant trigger levels for tailwater released to Darwin Harbour

Toxicant	Trigger Level
Arsenic (AsIII)	24 µg/l (freshwater)
Arsenic (AsV)	13 µg/l (freshwater)
Cadmium	5.5 µg/l
Chromium (CrIII)	27.4 µg/l
Chromium (CrVI)	4.4 µg/l
Copper	1.3 µg/l
Lead	4.4 µg/l
Mercury (inorganic)	0.4 µg/l
Nickel	70 µg/l
Selenium (total)	5 µg/l (freshwater)
Zinc	15 µg/l

6.2.3 Response to trigger exceedance

Prior to the release of tailwater from Pond E (South), if the laboratory analytical results indicate that the mean concentrations of any (dissolved) toxicants exceed ANZG DGVs, or if the pH is below 6.0, then further investigations and contingency measures (e.g. dilution of tailwater with seawater, refer **Table 7**) will be instigated and tailwater will be retained within Pond K and Pond E (North).

It is acknowledged that a period of time will elapse between the collection of water samples and receipt of the laboratory analytical results. Hence, if monitoring shows an increasing trend in any toxicant concentrations in Pond E (North) that may indicate a potential for trigger level exceedance, then tailwater will not be released into Pond E (South) until such time that the analytical results are received and it can be confirmed that no trigger levels are exceeded.

During tailwater discharge, if the mean turbidity level at the weir box between Pond E (North) and Pond E (South) exceeds the trigger level (140 NTU), then (subject to the need to keep the weir open under high stormwater flow conditions) the weir box will be closed until turbidity levels have fallen to below 140 NTU.

6.2.4 Management measures

The tailwater will be managed within the settling ponds such that the quality of the water discharging through the railway bund wall is within the guideline criteria discussed in Section 6.2.2. If trigger levels are exceeded within any of the ponds, then this will be reported to the Territory within 24 hours of the exceedance occurring. Should the exceedance occur at either of the two critical monitoring locations – where tailwater enters Pond E (North) or in Pond E (North) at the weir into Pond E (South), the Project Environmental Advisor will notify the Territory.

Exceedances occurring in Pond E (North) at the weir into Pond E (South) will trigger management actions requiring the cessation of flow from Pond E (North) into Pond E (South). Monitoring results approaching or exceeding the trigger levels at the point where water flows into Pond E (North) from Pond K will be used as an early indication that pre-emptive management actions should be considered to prevent an exceedance in Pond E (North) prior to the weir into Pond E (South). Where an exceedance requires the closing of the weir into Pond E (South), Pond E (South) will remain isolated from the tailwater management system until corrective actions (see **Table 7**) can be implemented to preserve the quality of the receiving waters. It will remain isolated until such time that it can be demonstrated that the pond can be reinstated into the tailwater management system without causing the water quality in Pond E (South) to exceed trigger levels.

The frequency of monitoring within the ponds (refer Section 7.3) limits the risk of trigger level exceedances within Pond E (South) arising from tailwater effects. Trends identified within the preceding ponds will enable corrective actions to be implemented before exceedances occur within Pond E (South). In this manner Pond E (South) is effectively considered to be the ‘receiving environment’, with the railway bund wall providing an additional buffer against impacts upon the environment of Frances Bay and Darwin Harbour.

Table 7 Water Quality Management Framework – EAW settling ponds

Element	Maintenance of water quality within the EAW settling ponds
Commitments	Conditions on the WDL for the Project
Objective	• Protection of receiving waters from impacts arising from the physico-chemical properties of discharged tailwater. • No increase in acidity within pond waters to the extent that the tailwater is unacceptable for discharge due to low pH or elevated toxicant concentrations.
Target	1. No increase in tailwater acidity within Pond E (North) to the extent that it is unacceptable for discharge into Pond E (South) and receiving waters due to low pH (<6.0). 2. No exceedances of ANZG DGVs for toxicants (refer Table 10) in tailwater within Pond E (North) prior to the commencement of transfer into Pond E (South). 3. All tailwater discharging from Pond E (North) into Pond E (South) has: a. SSC less than 100 mg/L (measured as turbidity [140 NTU]), and b. pH greater than 6.0 4. No occasions when tailwater discharging from Pond E (South): a. Contains floating oil or grease or petroleum hydrocarbon sheen or scum, or litter or other objectionable matter. b. Causes or generates odours which would adversely affect the use of surrounding waters c. Causes algal blooms d. Causes visible change in the behaviour of fish or other aquatic organisms e. Causes mortality of fish or other aquatic organisms f. Causes adverse impacts on plants
Key Performance Indicators	• Number of instances when pH or bioavailable toxicant concentrations are outside of acceptable guidelines (pH <6.0; bioavailable toxicant concentrations >ANZG DGVs) in Pond E (North), prior to discharge into Pond E (South). • Number of instances when SSC at the weir box between Pond E (North) and Pond E (South) is >100 mg/L (measured as turbidity). • Number of instances when target criteria 4 (a)-(d) are not met.
Management	• The dredged sediments are pumped via pipeline into Pond K, and tailwater residence time is managed to allow for settlement of suspended sediments within the ponds. • Internal pond system maintained with a minimum freeboard to ensure sufficient water to facilitate settlement of suspended sediments and to minimise mobilising existing sediments.

	• Ensure discharge of dredge spoil into EAW ponds is managed taking into account storm events and an increase in stormwater within the system. • Pond K maintained below 6.0m AHD with a minimum freeboard of 0.5 m to ensure sufficient water to facilitate settlement of suspended sediments and to minimise mobilising existing sediments.
Monitoring (Sections 7.2)	• Water quality monitoring within ponds – pH, toxicants, NTU as detailed in Section 7.2 • Visual monitoring of target criteria 4 (a)-(d) outside the permeable section of railway bund (during the water quality monitoring events).
Reporting (Section 12)	• Weekly reporting of water quality monitoring data to the Territory. • Monitoring report to the NT EPA at the conclusion of dredging • Should a trigger level exceedance occur in Pond E (North) at the weir into Pond E (South), this will be reported by the Project Environmental Advisor to the Territory within 24 hours of the exceedance occurring and a report on corrective actions implemented to address the cause of the exceedance provided within five business days of the notification.
Corrective Actions	• If pH falls below 6.0, toxicant concentrations exceed ANZG DGVs, or SSC exceeds 100 mg/L in Pond E (North) at the weir into Pond E (South), then tailwater flows out of Pond E (North) will be blocked at the weir within one hour of detection. • If pH is <6.0, tailwater will be recirculated until the pH at each point of tailwater transfer between ponds is >6.0. • If toxicant concentrations exceed ANZG DGVs, the water may be diluted using water with lower toxicant concentrations (either from within the pond system or from within the dredging footprint) until toxicant concentrations are returned to below ANZG DGV levels. • If SSC exceeds 100 mg/L, then tailwater will be retained within Pond E (North) until the SSC (measured as turbidity, 140 NTU) is reduced to below 100 mg/L due to settlement of sediments out of suspension. If deemed necessary, silt curtains may be installed within Pond E (North) to increase the flow path of tailwater through the pond; this will increase the settlement of suspended sediments from the tailwater.
Term	• For the duration of tailwater flow from Pond E (North) into Pond E (South).
Responsibility	• Project Environmental Advisor to ensure that works are undertaken in compliance with the approved WQMF.

	• Project HSSE Manager to ensure monitoring program and water quality management measures are implemented.

6.3 Protected Marine Species

Management of the impacts on protected marine species that may occur within the Project area (dolphins, turtles and dugongs) is provided in the Marine Megafauna Management Plan (41213-HSE-REP-D-1002).

6.4 Seabed Disturbance

Ensure the Project complies with the Environmental Approval (EP2023/028-001) condition 1-1 limitation that the disturbance of no more than 11 ha of seabed within the approved extent.

6.4.1 Management measures

Prior to dredging activities commencing marker buoys will be located at the dredge extent as a visual barrier to act as both a barrier for both the public and also as a visual barrier of the project extent. Regular surveys will be completed to assess dredge extents by the dredging contractor including dredge hydrographic surveys confirming dredge volumes and locations CBJV to compile report to be issued to Territory as discussed in Section 12.1.4.

6.5 Land Disturbance

The Environmental Approval (EP2023/028-001) action description that states: 'land disturbance area (including, infrastructure, hardstand and revetments) must not exceed 22.2 ha.'. Management measures to be employed on the project are outlined in Section 6.5.1.

6.5.1 Management measures

The project approved extent will be surveyed and the disturbance area is to be clearly demarcated prior to the commencement of works, in accordance with land clearing requirements and development permit. Temporary fencing is proposed to be used to delineate the project clearing boundary and extent. The project induction will outline the project boundaries and outline that disturbance outside the project is prohibited.

GPS will be used in machinery where available.

Project Environmental advisor to be present onsite to complete regular inspections of project boundaries. Clearing and Ground Disturbance to be managed in line with Project Construction Environmental Management Plan 41213-HSE-PL-G-1002.

7 Environmental Monitoring

The environmental monitoring program to be implemented as a part of this DDSPMP comprises the following:

- Monitoring of water quality surrounding the dredge and pipelines transporting spoil to the EAW settling pond system and reclamation (Section 7.1).
- Monitoring of water quality within the EAW settling ponds (Section 7.2).

Key aspects of each of the monitoring programs are summarised in Section 7.5.

During dredging and reclamation activities all monitoring data (including sensitive ecological data), surveys, maps, and other spatial and metadata required under the conditions the controlled action approval (EPBC2021-9068) are prepared in accordance with:

- the *Guidelines for biological survey and mapped data*, Commonwealth of Australia 2018, as required by controlled action approval [EPBC2021-9068, condition 16].

- *Guide to providing maps and boundary data for EPBC Act projects,* Commonwealth of Australia 2021, [EPBC2021-9068, condition 17].

Further guidance regarding monitoring data and compliance records refer to EPBC Controlled action approval (EPBC2021-9068).

7.1 Darwin Harbour water quality - dredge, pipeline and reclamation

7.1.1 Objectives

The objectives of monitoring water quality in the vicinity of the dredge, pipeline and reclamation are to:

- Determine if the maximum turbidity levels within observable plumes exceed the allowable SSC **trigger value** of 100 mg/L (measured as 140 NTU) at a distance of 150m from these sources, and the allowable SCC **limit values** (Wet season: 25 mg/L [measured as 21.2 NTU]; Dry season: 10 mg/L [measured as 3.5 NTU]) at the South Shell Island monitoring site.
- Provide a trigger for corrective actions to be implemented to reduce the dispersion of plumes from the dredging and reclamation activities towards South Shell Island and/or Catalina Island.
- Comply with the EP Approval.

7.1.2 South Shell and Catalina Island Monitoring Locations

The below monitoring sites have been selected to ensure compliance with Condition 2-1 of EP Approval (EP2023/028-001), to ensure that no dredging or reclamation activities cause any material environmental harm to water quality, or the condition or distribution of benthic communities beyond the approved extent.

The South Shell Island monitoring site is a putative impact site due to proximity to the dredging location, the model outcomes and the known presence of benthic communities that may be adversely affected by increased turbidity levels from dredging at the DSL. The monitoring site is located within filter-feeder communities known to occur in this location and is shown in **Figure 11**.

It is considered that the South Shell Island and Catalina Island benthic communities are sufficiently distant from the predicted Zones of Impact and Influence from the dredging and reclamation activities. Suitable hard coral habitat is predicted to occur surrounding the shallow waters west of Catalina Island and therefore, due to proximity to the project has been included as an additional monitoring site shown in **Figure 11.**

All access to Catalina Island and associated environmental monitoring must be undertaken in line with Aboriginal Areas Protection Authority (AAPA) Certificate (C2019/004) issued under the *Aboriginal Sacred Sites Act 1989* including all permit conditions.

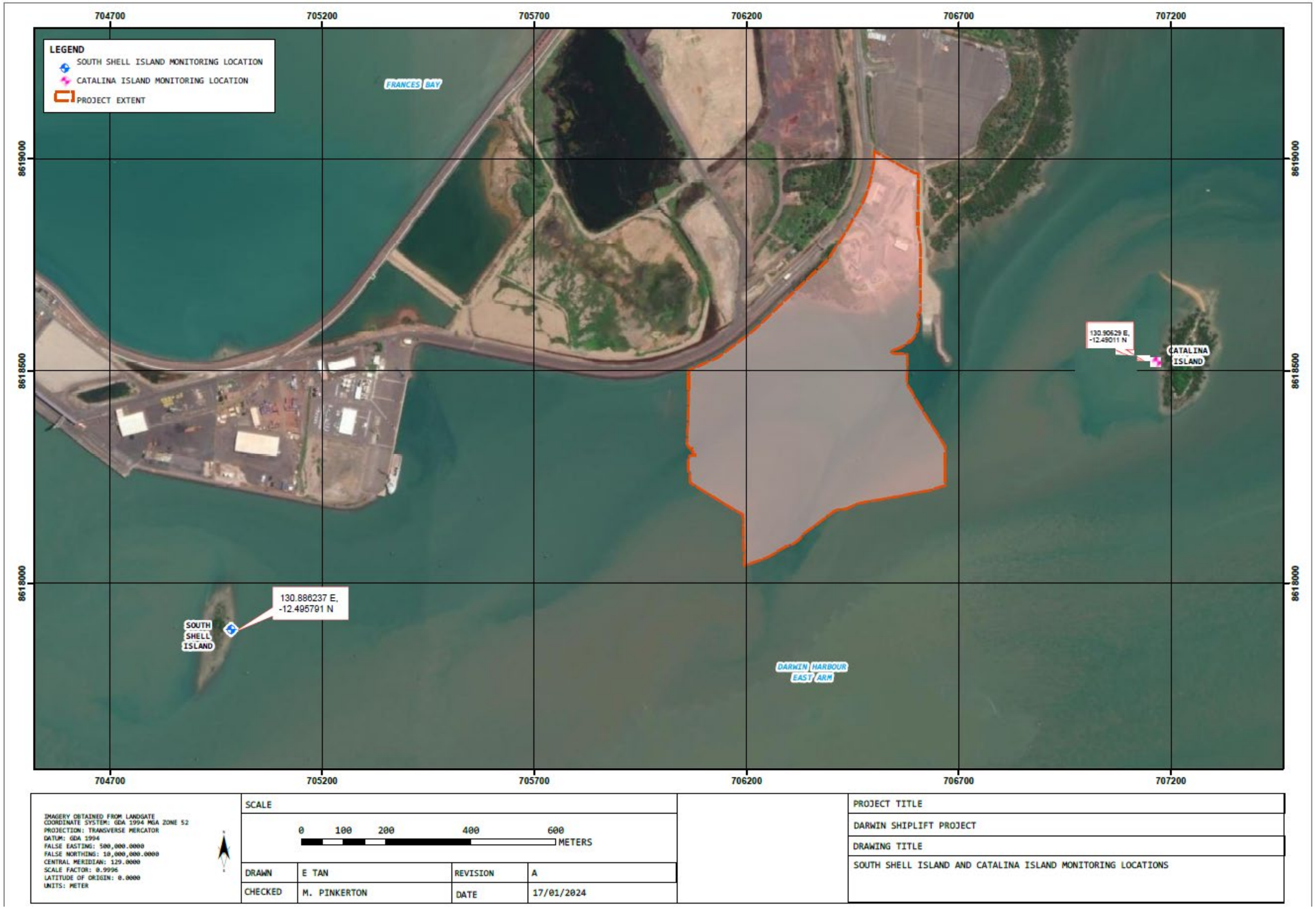

Figure 11 South Shell and Catalina Island Monitoring Locations

7.1.3 Methodology

A visual survey of the areas surrounding the sources of turbid plumes (dredge, pipeline and reclamation) will be undertaken continuously during daylight hours from the commencement and during Project dredging and reclamation activities to determine the extents of the plumes. Should the visual survey determine that a plume may be extending beyond 150m from its source, a small vessel or dredge tender will be used to inspect the distance from the source to the edge of the plume using a GPS. The GPS will be used to locate and record a point 150m from the source; at this point a turbidity measurement will be taken, using a handheld water quality probe to measure a profile through the entire water column. The maximum turbidity within the water column will be compared against the allowable **trigger value**.

Where the turbidity within the water column exceeds the trigger value of 140 NTU at a point 150m from the source, monitoring of turbidity will then be carried out at the South Shell Island and Catalina monitoring locations. The maximum turbidity within the water column at the South Shell Island and Catalina monitoring locations will be compared against the allowable limit value (21.2 NTU in the Wet season or 3.5 NTU in the Dry season).

Sampling will be carried out by the Project Environmental Advisor in accordance with the methods described in AS/NZS 5667.1:1998 *Water quality – Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.*

The calibrated turbidity meter should be kept in gentle motion through the water column while a reading is being taken and allow several minutes for the reading to stabilise. Measurements using probes must be made at least 1m below the water surface and deeper in clear waters to ensure that there is no influence from ambient light.

To assist with any attributability assessments that may be required during dredging (refer Section 6.1.3), where there is an exceedance of the trigger value at a distance of 150m from the dredge, pipeline or reclamation area, a drone will be employed to capture aerial imagery of the plume. This will assist in determining whether the turbidity level at 150m from the dredge and pipeline, or in the case of a plume extending to South Shell Island or Catalina Island, can be attributed to the dredging activity, or whether it is a result of broader regional influences (e.g. due to a period of high rainfall or elevated wave action, or to other turbidity-generating activities within the harbour). It is noted that the broadscale indications of turbidity presented in the drone imagery would provide a more reliable measure of potential impacts to benthic communities than turbidity measures made by submersed turbidity probes at discrete locations (at which turbidity levels may be either higher or lower than in the surrounding area and may therefore be un-representative of the risk of potential impacts to the benthic communities in the broader area).

During monitoring, quality assurance and quality control (QA/QC) methods will be implemented including ensuring equipment used is calibrated and water quality Monitoring is undertaken in accordance with AS/NZS 5667.1:1998 *Water quality – Sampling.* During collection of laboratory samples, field blanks and duplicates are examples of QA/QC measures that should be undertaken in line with project water quality monitoring programs.

7.1.4 Data Analysis

NTU levels measured in the field as required will be assessed against the **trigger value** and **limit values**.

A rolling average of measured turbidity over a seven-day period would be used to assess compliance with trigger levels.

If additional water quality monitoring is required, the results of the turbidity monitoring will be provided to the Territory one week after completion of monitoring, or when monitoring data is available.

7.1.5 Outcomes

Based on the SSC determined at 150m from the dredge or reclamation, management procedures will be initiated to reduce the maximum SSC to below the **trigger value** at distances greater than 150m from the source and below the limit value at the South Shell Island monitoring location and below the limit value at the Catalina Island monitoring location.

Management procedures may include ceasing dredging activities, modification of dredging and reclamation activities during certain tidal phases or other steps deemed appropriate by the Project Environmental Advisor. These management measures shall remain in place until the maximum SSC fall below the **trigger value** and **limit value**.

The data outputs from the monitoring will enable ongoing assessments to be made of the need to implement management measures within the dredging and reclamation operations, in order to reduce the potential for them to contribute to turbidity levels at sensitive receptor sites further afield (e.g. South Shell Island and/or Catalina Island).

7.2 East Arm Wharf settling ponds – water quality

7.2.1 Objectives

The objectives of monitoring water quality within the EAW settling ponds will be to:

- Detect trends in tailwater pH that may indicate the generation of acid from dredged PASS material pumped into the ponds.
- Detect trends in toxicant concentrations within the ponds that may indicate the mobilisation of toxicants from the dredged sediments, or from material placed in the ponds during past dredging programs (EAW development, Darwin City Waterfront Redevelopment, etc.).
- Confirm the physio-chemical properties (pH, toxicants and SSC) of the tailwater are suitable for discharge from the ponds to the harbour waters.
- Comply with the Waste Discharge Licence.

7.2.2 Monitoring locations

The water quality monitoring locations are shown in **Figure 12,** and **Table 8**. The pH, turbidity and toxicant concentrations of the tailwater will be monitored at any pond discharge point where tailwater is flowing and within Pond E (South) prior to discharge through the permeable bund wall.

In the event that stormwater enters Ponds E (North) from Pond D and/or Pond K road bund, then pH and toxicants will be monitored weekly at the point of stormwater entry to Pond E (North). This will inform the assessment of potential causes of any changes in pH and toxicant concentrations that may become evident in Ponds E (North) or (South) (i.e. it will determine if contaminants are present in the stormwater).

Table 8 East Arm Wharf Settling Pond Monitoring Locations

Monitoring Site Number	Monitoring Location Description	Latitude	Longitude
1	Tailwater release – Pond E (South)	130.888507	-12.489
2	Settlement pond – Pond E (North)	130.891	-12.488591
3	Settlement pond – Pond K	130.8931499	-12.48652585
4	Stormwater – Pond D	130.8926716	-12.48547552
5	Stormwater – Pond K road bund	130.8913588	-12.48887974

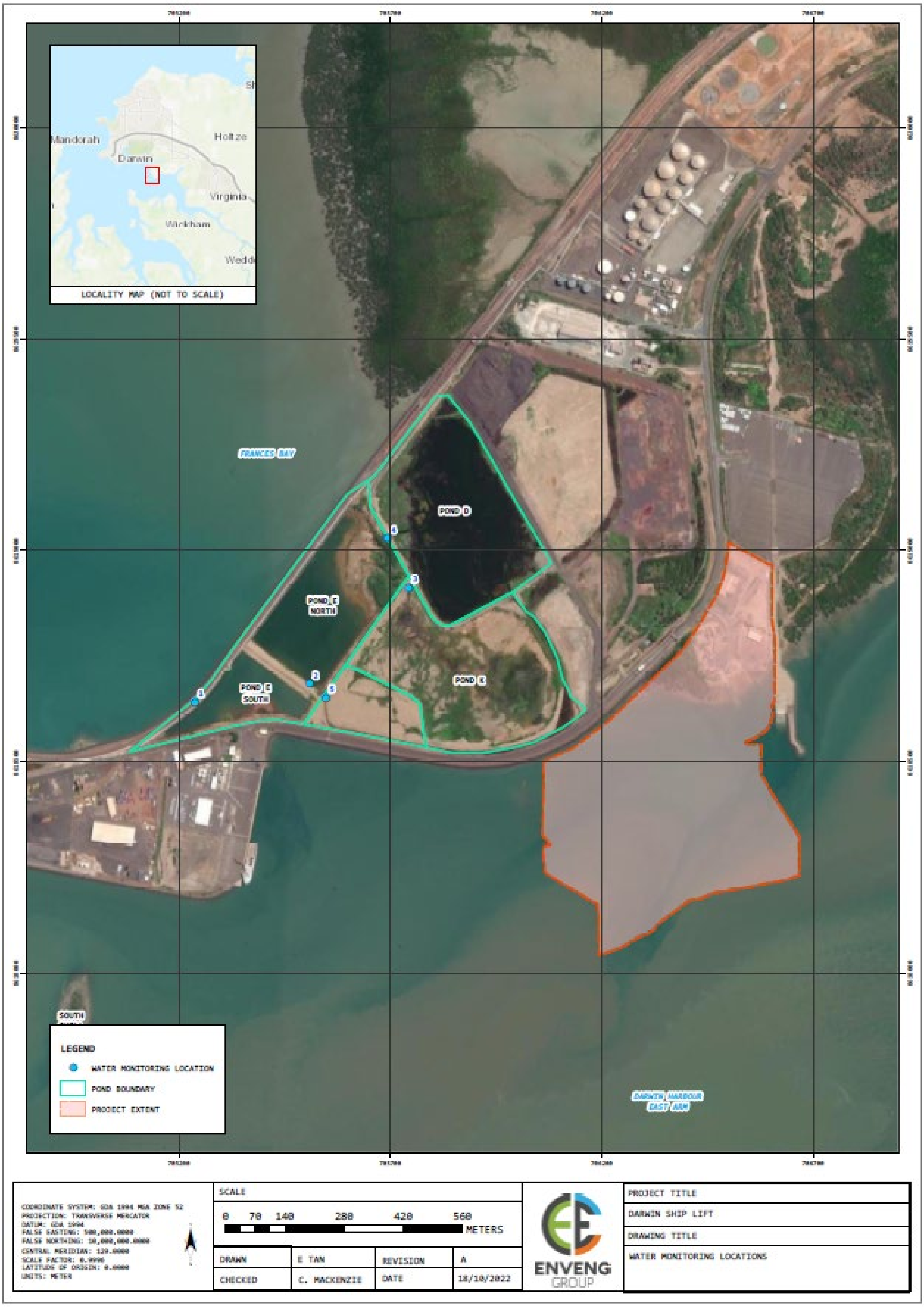

Figure 12 East Arm Wharf Settling Pond Monitoring Locations

7.2.3 Methodology

Over the course of discharge of tailwater from the pond system:

- Tailwater pH will be monitored in the field by extracting water samples daily from each monitoring location and testing the water with a hand-held pH meter.
- Turbidity will be monitored in the field daily at each monitoring location using a hand-held probe.
- One water sample per week will be collected from each of the monitoring locations and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis of toxicant concentrations. A rapid turnaround time for analysis will be specified, to minimise the time that elapses before any required corrective actions are able to be implemented.

Where stormwater is discharging into Pond E (North) from Pond E, and/or discharging sampling will be carried out by the Project Environmental Advisor in accordance with the methods described in AS/NZS 5667.1:1998 *Water quality – Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.*

Two samples are required, as the analysis includes filtered metals, and total (and speciation, if required) arsenic and chromium. Dissolved metals are determined by analysing those metals in a filtered sample that passes through a 0.45 μm membrane filter. Containers are to be pre-prepared plastic with caps that have a Teflon liner. Containers will not be pre-rinsed and will contain 2 mL acid. Samples will be refrigerated at 1-4°C or frozen.

Based on potential toxicity and presence within Darwin Harbour sediments, the metallic toxicants to be monitored through collection of water samples are presented in **Table 6**.

During monitoring, quality assurance and quality control (QA/QC) methods will be implemented including ensuring equipment used is calibrated and water quality Monitoring is undertaken in accordance with AS/NZS 5667.1:1998 *Water quality – Sampling.* During collection of laboratory samples, field blanks and duplicates are examples of QA/QC measures that should be undertaken.

7.2.4 Data analysis

Data for tailwater pH, turbidity and toxicants will be plotted and assessed for trends after each data collection period. Any trends towards allowable limits will be used as an early warning mechanism, and dredging operations and tailwater or stormwater management procedures will be assessed to ascertain whether corrective actions (such as those presented in **Table 7**) may need to be implemented to avoid exceedance of water quality limits.

The toxicant trigger levels are set at the 95% species protection level as per ANZG (2018). Where marine water quality triggers are not available due to insufficient data, freshwater trigger levels applicable to slightly–moderately disturbed systems are adopted. Speciated toxicants (arsenic and chromium) will be analysed for total concentrations, and if any total exceeds the trigger level of one of the species, then the samples will be reanalysed for the individual species.

The pH of the water samples collected during monitoring at the weir box between Pond E (North) and Pond E (South) is to be greater than 6.0. This will meet the criterion for an Upper Estuary setting, as presented in the Darwin Harbour Region Water Quality Objectives.

7.2.5 Outcomes

The data outputs from the monitoring enable ongoing assessments to be made of the need to implement further tailwater (or stormwater) management measures to maintain water quality parameters within the pond system below trigger levels and to render the water suitable for disposal from Pond E (South) through the permeable bund wall.

7.3 South Shell Island and Catalina Island benthic communities

As discussed in **Section 3.9**, sediment modelling predicts the Zone of Moderate Impact falls completely within the Zone of High Impact, i.e. within 20m of the dredging footprint boundary. Tidal currents will rapidly disperse the suspended sediments, and SSC's will rapidly return to background levels upon the completion of dredging. As a result, suspended sediments mobilised from the dredge are not predicted to extend beyond the dredging area at concentrations that could result in detectable changes to environmental quality. As such, and consistent with the *Darwin Port Long Term Dredging Management Plan* (AECOM 2018), monitoring of benthic communities is not considered necessary.

However, the NT EPA considers it necessary for the Territory to design an appropriate monitoring program that can reliably measure the response of these habitats to disturbance from dredging and landfill. The benthic monitoring program is not included in this DDSPMP.

7.3.1 Contingency Monitoring Program

While the CBJV does not anticipate any sedimentation impacts from dredging to occur outside the zone of Moderate/High Impact, a monitoring plan for aquatic water quality has been developed (outlined in **Section 6** and **Table 5**).

A benthic habitat monitoring strategy has not been developed, however, CBJV has prepared the following plan as a contingency. This monitoring plan shall be used to enable the measurement of the response of benthic community habitats to disturbance attributed to the CBJV dredging campaign, after the conclusion of the attributability review outlined in **Section 6.1.3.**

After consultation with Territory, the following or similar shall be incorporated into a revised version of the DDSPMP and the CEMP, as necessary:

7.3.2 Contingency Monitoring Program Draft Methodology

If exceedance of 3.5 NTU **(limit value)** for Dry Season or 21.2 NTU **(limit value)** for Wet Season for greater than 7 consecutive days is recorded (**Section 6.1.3)**:

- Conduct benthic monitoring to assess the impact upon the hard coral and filter communities at South Shell and Catalina Islands from turbid plumes emanating from dredging and reclamation activities.
- Benthic monitoring shall be carried out in accordance with the methodology outlined in Case et al. (2021). A Slow Towed Video (Slowvid) shall be used to record underwater video and stills imagery of the benthos.
- It is considered that it is only feasible to detect (with sufficient statistical confidence) a change of 10% in biota cover at the monitoring locations (Darwin Ship Lift Project: Draft Dredging and Dredge Spoil Placement Management Plan, AECOM, 2022).
- Analysis of 50 still images per transect will be required, with five points analysed per image.
- The results of the Geo Oceans study (Geo Oceans (2012). NT Department of Lands and Planning – East Arm Wharf Expansion Project. Baseline Marine Habitat Monitoring Survey. Report to URS Australia Pty Ltd, Document code DLPEAWMON.401) will be taken into account when assessing the biota cover.
- In addition to measurements of benthic cover of hard corals and filter feeders, the proportion of biota showing evidence of stress (e.g. bleaching or excessive mucus production) will also be recorded and comparisons made between the South Shell Island and/or Catalina Island sites.
- Fortnightly monitoring of the benthic communities at the South Shell Island and/or Catalina Island will be carried out. Monitoring will continue over four fortnightly periods following the positive attributability assessment. It is recognised that elevated turbidity levels at the South Shell Island and/or Catalina Island sites are unlikely to result in immediate changes to benthic community health, but that indications of reduced health may become evident over time (AECOM, 2022).

- If the monitoring does not indicate any trend in decreasing health of the benthic communities at the monitoring sites (as indicated by increasing stress or mortality of hard corals or filter feeders), and there have been no further positive attributability assessments over the monitoring period, then monitoring will be suspended.
- Post-dredging assessments of proportions of live hard corals and filter feeders within benthic communities at South Shell and Catalina Island monitoring sites shall be carried out, using the same methodology as provided by Case et al. (2021).

7.4 Protected Marine Species

Monitoring of protected marine species that may occur within the Project area is provided in the Marine Megafauna Management Plan (41213-HSE-REP-D-1002). Whilst this management plan was prepared for the management of megafauna (dolphins, turtles and dugongs), the same principles apply to the management of other protected marine species, including sawfish.

7.5 Summary of monitoring programs

Key aspects of each of the monitoring programs are summarised in **Table 9**.

Table 9 Summary of environmental monitoring programs

Locations	Parameter	Methods	Frequency	Triggers	EMF
TURBID PLUME (dredge, pipeline and reclamation)					
Daily visual survey of areas surrounding the sources of turbid plumes (dredge, pipeline and reclamation).	Turbidity	Visual	Continuously visual monitoring.during daylight hours	Any visual turbid plume	Water Quality Management – Darwin Harbour
TURBID PLUME UP TO AND GREATER THAN 150 m FROM DREDGE, PIPELINE OR RECLAMATION AREA					
Section 7.2 Throughout the water column where the turbid plume extends beyond 150m from the source. Monitoring locations: within the plume at a point 150m from source.	Turbidity	Visual Hand-held probe	As required by visual monitoring.	Maximum SSC >100 mg/L (measured as turbidity, 140 NTU) 150 m from source (**trigger level**).	Water Quality Management – Darwin Harbour
Section 7.2 Aerial imagery from dredge to South Shell Island and Catalina Island	Drone imagery	Drone	As required by exceedance of **trigger level** SSC >100 mg/L (measured as turbidity, 140 NTU) where the turbid plume extends beyond 150m from the source.	Visual confirmation of plume extending from dredge to South Shell Island and/or Catalina Island.	Water Quality Management – Darwin Harbour
Section 7.2 Throughout the water column where the turbid plume extends to South Shell Island and/or Catalina Island. Monitoring location: South Shell Island Monitoring Site. Catalina Island Monitoring Site	Turbidity	Visual Hand-held probe	As required by exceedance of **trigger level** SSC >100 mg/L (measured as turbidity, 140 NTU) where the turbid plume extends beyond 150 m from the source.	Maximum seasonal SSC >25 mg/L (Dry season, measured as turbidity, 21.2 NTU) or 10 mg/L (Wet season, measured as turbidity, 3.5 NTU) at South Shell Island (**limit value**) and Catalina Island **(limit value).**	Water Quality Management – Darwin Harbour

EAST ARM WHARF SETTLING PONDS					
Section 7.3 Pond E (South) at the railway bund – **Monitoring Site 1** Pond E (North) at the weir prior to flow into Pond E (South) – **Monitoring Site 2** Pond K at the weir prior to flow into Pond E (North) - **Monitoring Site 3**	pH	Hand-held probe	Daily while tailwater is flowing, from commencement of dredging until cessation of tailwater discharge	pH <6.0	Water Quality Management – EAW Settling Ponds
	Turbidity	Hand-held probe		Toxicant concentrations > ANZG DGVs for toxicants (refer **Table 6**).	
	Toxicants	Laboratory	Weekly from the commencement of dredging until cessation of tailwater discharge	SSC >100 mg/L (measured as turbidity, 140 NTU)	
Section 7.3 *Stormwater Monitoring* Pond E (North) where stormwater enters from Pond D - **Monitoring Site 4** Pond E (North) where stormwater enters from Pond K road bund – **Monitoring Site 5**	pH	Hand-held probe	Weekly when stormwater enters Pond E (North) from Pond D.	pH <6.0	Water Quality Management – EAW Settling Ponds
	Turbidity	Hand-held probe		SSC >100 mg/L (measured as turbidity, 140 NTU)	
	Toxicants	Laboratory		Toxicant concentrations > ANZG DGVs for toxicants (refer **Table 6**).	

8 Performance Management

Performance management includes activities to ensure that goals are consistently being achieved in an effective and efficient manner. A key component of the environmental management process is the development and implementation of specific measures to ensure that the environmental risks arising from the dredging and dredged material placement activities are minimised. The success of these objectives is measured with key performance indicators (KPIs) defined for environmental management (see Section 6).

8.1 Performance criteria

The DDSPMP is the key reference document which identifies actions and commitments to be followed by the CBJV and Dredging Contractor and any subcontractor personnel throughout dredging operations. The broad performance criteria of the DDSPMP are as follows:

- Compliance with the DDSPMP by all Project personnel and activities.
- Adherence to discharge water quality parameters as identified in the water quality monitoring program outlined in Section 7 of this Plan.
- No net long-term adverse impacts on biota.
- No injuries to protected marine species.
- No complaints received in relation to dredging-related noise or vibration and no impacts on protected species from these sources.
- Response to all registered complaints and completion of Complaint Record and / or Incident Report; appropriate corrective actions taken within three working days.

Where performance criteria are not met, this will form a trigger for review of the DDSPMP, in addition to initiating corrective actions specific to the scenario.

8.2 Environmental management KPIs

In the environmental management frameworks detailed in Section 6 of this plan, specific objectives and targets, and KPIs related to these, are set for each significant environmental aspect.

General objectives and targets are:

- all personnel working on site have undergone an environmental induction
- CBJV and Dredging Contractor 100% compliance with the DDSPMP
- no activity in breach of the provisions of any environmental legislation and Project environmental approval conditions
- 100% investigation and reporting of any environmental incident at the site
- 100% compliance required for management measures relating to dredging and dredge spoil management.

9 Environmental Incidents, Non-conformances and Complaints

9.1 Environmental incidents

Environmental incidents will be investigated and reported on in accordance with the CBJV's Incident Investigation Operating Standard (CORP-GOV-OS-G-0001). Any environmental incidents will be immediately reported to the environmental representative or project manager, who will report the incident to the client / Territory as per project requirements.

In the event of serious or material environmental harm CBJV will notify the relevant regulatory authorities as per legislative requirements as outlined in the Incident Investigation Operating Standard. Where necessary, CBJV will also notify the respective property owners or occupiers within 24 hours of the incident occurring.

An incident will be reported if any of the following scenarios occur or have the potential to occur:

- serious environmental harm
- material environmental harm
- prosecution by a Regulatory Authority
- environmental approval condition breach
- environmental monitoring parameter breach.

Incidents will be reported both verbally and in writing. Details of any environmental incident will be investigated and entered into the CBJV's Incident and Accident Database/Register. Additionally, this information will be forwarded to the Client. Verbal notification will be provided immediately (where practicable), and written notification will be forwarded as per project requirements.

Complaints will be investigated by the Project Environmental Advisor and action taken to enable satisfactory closeout. Any incidents that have caused environmental harm, or that have the potential to cause environmental harm, will also be reported to the Project Environmental Advisor and to the NT EPA Pollution Hotline (1800-064-567) or, for marine fauna incidents, Marine Wildwatch line (1800-453-941) within 24 hours.

9.2 Environmental Non-Conformances

Non-conformances relating to product or services shall be managed in accordance with Contractor Non-conformance and Reporting Work Instruction 41213-QM-WI-G-0003. All non-conformances shall be reported to the Territory.

Further to this all non-conformances will be reported and investigated internally and to Client via the requirements of the 41213-HSE-WI-G-0063- HSSE Incident Notification, Investigation and Reporting Work Instruction.

9.3 Complaints

In the event of a complaint received as a result of dredging activities, they will be entered and tracked using the CBJV's incident management system. Details to be recorded include:

- date, time and method of complaints
- description of complaint
- complainant details
- cause, action and proposed action, including allocation of a person to action the complaint and an action date
- follow-up and close-out.

Corrective action in response to valid complaints is to occur within 48 hours following receipt of the complaint. Records will be made available to the Territory and authorities upon request, taking into account any privacy issues of the complainant as appropriate.

10 Inspections and Audits

10.1 Inspections / monitoring

Daily visual monitoring will be conducted by site supervisors. Any corrective actions resulting from inspections will be entered onto a 'Non-conformance and Corrective Action Register' and the progress tracked for completion.

10.2 Internal audits

An internal audit of this DDSPMP will be undertaken prior to commencement of dredging to assess the likely effectiveness of the Plan in the field and to identify any opportunities for improvement. A second internal audit will be undertaken three months after the commencement of dredging to assess the effectiveness of the implementation of the Plan, and of the monitoring and reporting procedures being applied. The intent of this audit is to identify any opportunities for improvement to ensure monitoring, reporting and record keeping are sufficient to support required reporting.

10.3 External audits

External audits can be conducted by CBJV or third parties, such as other government departments. The NTG may conduct an audit at any time when they believe there is an issue in relation to environmental compliance. The Project Environmental Advisor will assist with any external audit.

Results from any external audits will be reviewed by the Project HSSE Manager, with any necessary corrective actions assigned to Project personnel to ensure appropriate and timely closeout. Any corrective actions will be entered into a Project corrective action register and the progress tracked for completion.

10.4 Project Corrective Action Register

Any environmental non-conformance (e.g. incidents, audit-related non-conformance, complaints, government notices, etc.) will be recorded in project corrective actions register or similar to be developed by CBJV. The corrective actions register will detail the non-conformance, the corrective action required, the responsible person(s), the timeframes by which the action is to be completed, and the actual completion date. Each non-conformance will be reviewed and it will be established if there are any actions available to reduce the severity or likelihood of re-occurrence.

11 Communication

A program for formal internal correspondence will be implemented during project delivery. Regular project management and coordination meetings will be held to monitor progress, discuss issues and plan upcoming construction activities. Environmental management will be a mandatory agenda item at such meetings.

11.1 Meetings

Meetings where environmental issues are identified and discussed will include:

- Daily prestart meetings – a forum where all construction personnel have the opportunity to raise concerns, where specific environmental works can be discussed and delegated, and where general environmental issues can be relayed to the workforce. Items are to be recorded on the Prestart Talk and Site Attendance Record form.
- Weekly / fortnightly toolbox meetings – current project environmental issues are to be discussed on a regular basis. Additionally, specific toolbox meetings may be held following an environmental incident to ensure the team is aware of issues and

preventative measures are communicated. Items are to be recorded on the Toolbox Talk Record form.

- Weekly project management meeting – attended by key construction and management personnel, client and other relevant participants.

Minutes of all formal meetings will be recorded and distributed to relevant personnel.

11.2 Site Induction

Communication of the DDSPMP requirements will commence with the compulsory site induction. The site induction will ensure all project personnel, subcontractors, consultants and visitors become familiar with the environmental management obligations and requirements of the project. The environmental component of the induction has been developed for the project, targeting the relevant environmental aspects of the site.

The project site induction will outline the following:

- General environmental duty / duty to notify
- Legislation and permit / approval / licence / compliance obligations applicable to the project
- Site incident reporting requirements
- Sensitive or protected environmental areas on and surrounding site
- Significant project environmental risks and mitigation measures

12 Reporting

12.1 Routine reporting

12.1.1 Beginning of dredging

The CBJV will notify the Territory and the NT EPA at least seven days prior to the planned start of dredging. This notification will include confirmation that all of the necessary measures are in place to comply with this DDSPMP.

The Territory will provide details of the dredging works to the Regional Harbourmaster so that a Notice to Mariners can be issued. The Notice to Mariners will be the mechanism through which stakeholders, and other members of the general public, will receive notification of the intention to commence dredging.

12.1.2 Daily reporting

Brief daily reports will be provided by the CBJV to the Territory and will include:

- a summary of the dredging completed in the last 24 hours and status of dredging operations
- information relating to any exceedances detected through monitoring
- proposed schedule for dealing with exceedances reported and next steps to be followed
- dredge daily logs showing work area and availability.

12.1.3 Weekly monitoring report

Each week during the dredging, reclamation and tailwater discharge activities, a weekly summary report of monitoring data will be submitted by the CBJV to the Territory. The report will include:

- tailwater pH and turbidity (NTU) data within the EAW settling ponds, from the commencement of dredging and dredged material placement until the cessation of tailwater discharge into Pond E (South)
- toxicants data for tailwater, once available from the laboratory
- comments on any apparent trends in the tailwater data, both over time and between ponds
- summary of daily data reports
- discussion of any trigger level exceedances
- corrective actions taken to address exceedances
- South Shell Island and/or Catalina Island and Channel Island benthic community data (including analysis of trends), if any surveys triggered within the previous fortnight
- details of any injuries to, or mortalities of, turtles, dugongs, dolphins or migratory birds as a result of dredging or reclamation activities, or settling pond water management
- a summary of environmentally significant equipment failures or events and an outline of corrective actions taken, or proposed, to reduce environmental harm arising therefrom.
- Analysis and interpretation of monitoring data to demonstrate whether compliance with the requirements of Environmental Approval (EP2023/028-001) condition 2 has been achieved

12.1.4 Dredge operation records and reporting

The Dredging Contractor will advise the CBJV of areas dredged, the volumes of material removed and dredge availability daily. These records will be provided to the Territory weekly, and the findings from hydrographic surveys confirming dredge volumes and locations will be included in the CBJV's report to the Territory fortnightly and on completion of the dredging). Copies of daily environmental inspection checklists and other relevant environmental records will be provided by the Dredging Contractor to the CBJV for circulation as appropriate. All records will be provided in a format that allows auditing by relevant environmental regulators if required.

12.1.5 End of dredge phase reporting

Within one month of the conclusion of dredging, the CBJV will submit a monitoring report to the Territory, who will in turn provide this report to the NT EPA and DCCEEW. The report will include the outcomes of all monitoring activities, exceedances, management actions and any relevant trend analysis and interpretation of analytical data collected in accordance with environmental conditions.

The end of dredge phase reporting will also include a comparison of the predicted impacts of the action, including dredging and dredged material management activities as identified in baseline surveys, and the actual impacts of the action as verified by environmental monitoring data collected during dredging and dredged material placement activities, as required by Environmental Approval (EP2023/028-001) condition 7-4(2).

12.1.6 Compliance reporting

The Territory, as the holder of the NT EPA approvals, will report to the NT EPA in accordance with the pertinent approval. The CBJV will report to the NT EPA in accordance with Environmental Approval (EP2023/028-001) conditions. The CBJV will provide information to the Territory as required to facilitate this reporting requirement, including:

- summaries of all monitoring program outcomes
- summaries of any monitoring exceedances

- details of corrective actions (method and timing) implemented to dredging, reclamation and tailwater management in response to monitoring exceedances, as required by EPBC Act controlled action approval (EPBC2021-9068) condition 25 (c).
- analysis and interpretation of monitoring data to demonstrate whether compliance with the requirements of Environmental Approval (EP2023/028-001) condition 2 has been achieved.
- the potential impacts of the incident and/or non-compliance as required under the Darwin Ship Lift EPBC Act controlled action approval (EPBC2021-9068) condition 25 (b).
- CBJV compliance reporting to be consistent with DCCEEW's Annual Compliance Report Guidelines, Commonwealth of Australia 2014, or any subsequent official version, as required by Darwin Ship Lift EPBC Act controlled action approval (EPBC2021-9068) condition 20.
- one or more shapefile showing all clearing of protected matters (as defined under the Darwin Ship Lift EPBC Act controlled action approval (EPBC2021-9068)), and/or their habitat, undertaken within the Project dredging period from the commencement to 3 October 2024, and Project dredging period from 4 October 2024 to the completion of dredging. This is a requirement of the Darwin Ship Lift EPBC Act controlled action approval (EPBC2021-9068) condition 21(b).

During dredging, the Territory will notify DCCEEW within 12 business days of becoming aware of any incident and/or potential non-compliance and/or actual noncompliance, the details of that incident and/or potential non-compliance and/or actual noncompliance with the conditions or commitments made in the Construction EMP (CEMP), DDSPMP, MMMP and Erosion and Sediment Control Plan.

During dredging, the CBJV will notify the Territory and the NT EPA of any non-compliance with the WDL, as required by that licence.

12.2 Exceedance notification and reporting

The following notifications of exceedances will be made by the CBJV to the Territory within 24 hours of the exceedances occurring:

- Within the EAW settling ponds in Pond E (North) at the weir into Pond E (South), or in Pond E (South), exceedance of pH, toxicant or SSC (measured as NTU) trigger levels.
- At the location 150m down current of the dredge, pipeline or reclamation area, where management measures are implemented.
- At the South Shell Island and Catalina Island monitoring locations, exceedance of SCC (measured as NTU) limit values.

Exceedances will also be reported to the NT EPA in accordance with conditions of the WDL, and as required under the *Waste Management and Pollution Control Act 1998* and the *Water Act 1992*.

For each exceedance at Pond E (North) at the weir into Pond E (South), or in Pond E (South), the CBJV will provide the NT EPA (via the Territory) with a report on the corrective actions implemented to address the cause of the exceedance. This report will be submitted in accordance with the required timeframe stipulated in the WDL.

CBJV are to notify the Territory of the outcomes of investigative corrective action, adaptive management, stop work or recommencement actions within 24 hours of completing the three-day attributability review period.

12.3 Environmental incident notification and reporting

Environmental incidents (spills, etc.) will be recorded and reported in environmental monitoring reports to the Territory. If the incident is a notifiable incident under the *Waste Management and Pollution Control Act 1998*, then the NT EPA will be notified by the Territory within 24 hours.

All incidents will be investigated and recorded on a CBJV 'Incident Report Form' (41213-HSE-FO-G-0035) in accordance with the CBJV's Incident Investigation Operating Standard (CORP-GOV-OS-G-0001). Preventative and corrective actions will be established, and these will be recorded on the CBJV 'Non-conformance and Corrective Action Register', and the progress tracked for completion.

12.4 Complaints reporting

In the event of a complaint received as a result of dredging activities, they will be entered and tracked using the CBJV's incident management system. Details to be recorded include:

- date, time and method of complaints
- description of complaint
- complainant details
- cause, action and proposed action, including allocation of a person to action the complaint and an action date
- follow-up and close-out.

Corrective action in response to valid complaints is to occur within 48 hours following receipt of the complaint. Records will be made available to the Territory and authorities upon request, taking into account any privacy issues of the complainant as appropriate.

12.5 Reporting and notification summary

Reporting and notifications will be sent to the following Northern Territory Government (NTG) stakeholders, as per the requirements detailed within this section of the DDSPMP.

The Department of Infrastructure Planning and Logistics (DIPL): https://dipl.nt.gov.au/

NT EPA: https://ntepa.nt.gov.au/make-a-report

The reporting and notification requirements for the Project are summarised in **Table 10**.

Table 10 Reporting and notifications summary

Reporting Type	Time	Reporting to	Content/Comments
Routine reporting			
Commencement of dredging notification.	Seven days before intended commencement of dredging	Territory NT EPA Regional Harbourmaster	Notification of intent to commence dredging works and confirmation that all required measures are in place to comply with the requirements of this DDSPMP. This notification will include any other reporting requirements of the WDL.
Daily reports	Daily	Territory	Daily work completed, monitoring undertaken and any exceedances detected. If an exceedance is detected the report will include a summary of proposed corrective actions and timeframes for implementation.
Weekly monitoring reports	Weekly	Territory	Water quality data from tailwater monitoring within the EAW settling ponds and at 150 m down current from the dredge, pipeline and reclamation area, and South Shell Island and Catalina Island monitoring locations (if required due to exceedance of trigger levels or limit values). Benthic community monitoring data (if triggered due to exceedance of limit value at South Shell Island and/or Catalina Island monitoring locations). Summary of dredge operation records for the week.
End of dredging report	Within one month of conclusion of dredging.	Territory NT EPA	Monitoring report as per WDL conditions.
Exceedance reporting			
Water quality exceedance – initial notification	24 hours (from occurrence)	Territory	Location and value of exceedance.
Water quality exceedance – attributability review	24 hours (from end of three-day attributability review period)	Territory	Details of determination and logic used to support the conclusions.
Water quality exceedance – corrective actions	Five business days (from notification)	Territory NT EPA	As per WDL conditions.
Other reporting			

Incident Investigation and Corrective action	Within 24 hours of completing the three-day attributability review period	Territory	Outcomes of investigative corrective action, adaptive management, stop work or recommencement actions

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