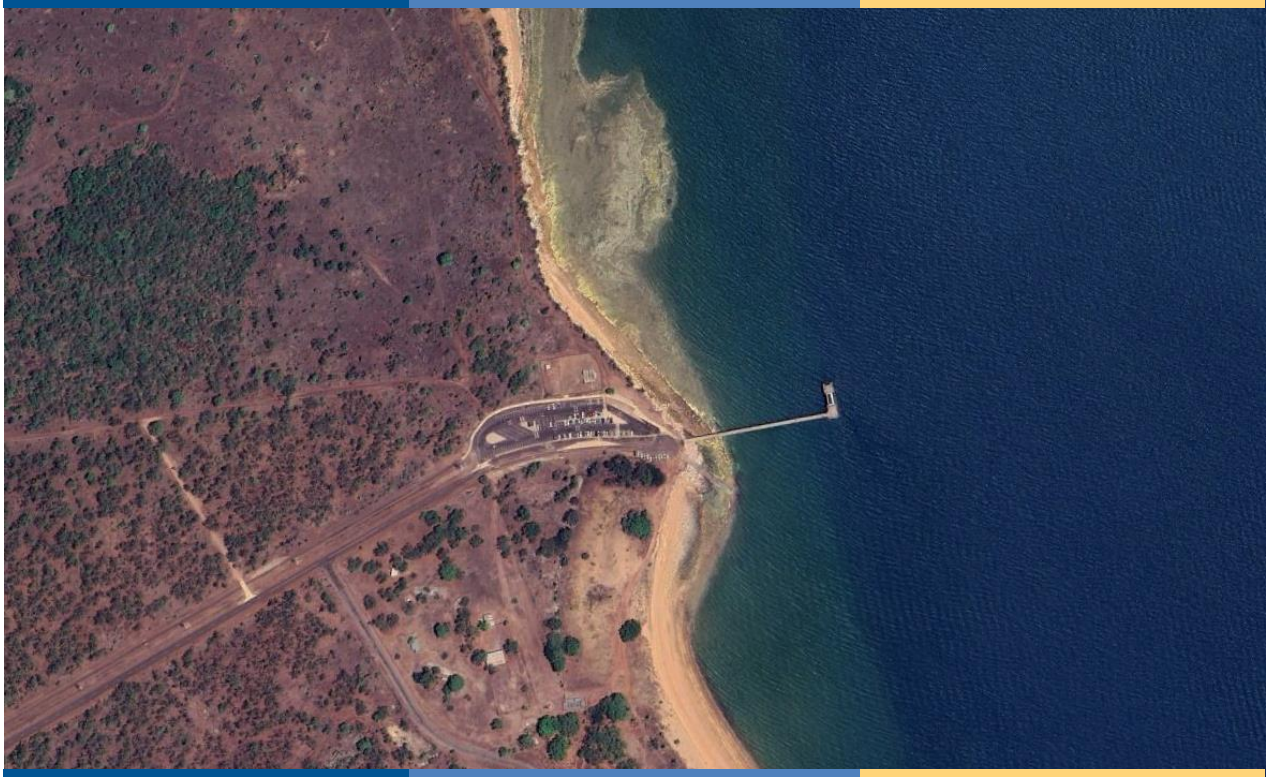
Coastal Processes Monitoring and Management Plan

New Marine Facilities to Service Mandorah and Cox Peninsula



Prepared for: SMC Marine on behalf of the Department of Infrastructure, Planning and Logistics

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1 ABBREVIATIONS

Abbreviation	Full Name
AAPA	Aboriginal Areas Protection Authority
BCH	Benthic communities and habitats
CEMP	Construction Environmental Management Plan
CPMMP	Coastal Processes Monitoring and Management Plan
DSDMP	Dredging and Spoil Disposal Management Plan
EMP	Environmental Management Plan
MSL	Mean sea level
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NTG	Northern Territory Government
RWA	Restricted Work Area
SER	Supplementary Environmental Report
TSS	Total suspended solids

2 CONTEXT, PURPOSE, AND SCOPE

2.1 Project Background

The Northern Territory Government (NTG) has identified the need to develop safe, compliant and more weather-resistant ferry berthing facilities at Mandorah ('the proposed project'). The proposed project will also improve transport connectivity between Cox Peninsula and Darwin City and improve boat ramp facilities for recreational users at the site. Mandorah is located near the eastern tip of the Cox Peninsula in the Northern Territory, approximately six kilometres to the west of Darwin (**Figure 2-1**). Access to Mandorah from Darwin is via the regular ferry service, or by driving approximately 120 km along the road network. The proposed project includes the construction of two large breakwaters that form a safe harbour around new ferry berthing and passenger boarding infrastructure, as well as a public boat ramp (**Figure 2-1**).

2.2 Environmental Approvals Context

The proposed project was referred to the Northern Territory Environmental Protection Authority (NT EPA) in March of 2022, accompanied by the *Environmental Referral Report* (Cardno, 2022) and various supporting technical reports. On 10 June 2022 the NT EPA decided that the proposed project required standard environmental impact assessment by Supplementary Environmental Report (SER) method. An SER (Stantec, 2023a) has been prepared to respond to the Direction to Provide Additional Information received from the NT EPA on 13 July 2022.

Included in stakeholder feedback on the original referral and the Direction to Provide Additional Information were specific queries regarding the environmental risk associated with alterations to the local coastal processes regime once the facilities are installed. Further investigations have been undertaken to better understand and quantify the changes to coastal processes once the infrastructure is established and subsequently, better understand associated environmental risk. These detailed investigations were predominantly documented in an updated version of the proposed project's *Sediment Transport Report* (Stantec, 2023b) and summarized in the SER.

An assessment and Environmental Approval (EP 2022/014-001) has been issued by the NT EPA, however this evaluation was based on a facility arrangement historically prepared by Cardno/Stantec (**Approved design**) that has now been superseded. The Northern Territory Government subsequently awarded the Design and Construction works for the new facility to SMC Marine Pty Ltd. The new facility arrangement (**Alternative Design**), whilst very similar in location and composition provides several benefits over the previous arrangement:

1. Significant reduction in capital cost for the construction works;
2. Substantial improvement in sea-state at both basin and berth;
3. Reduction in erosion and accretion to adjoining landmass;
4. Substantial reduction in unconsolidated marine sediment dredge and disposal volume;
5. De-coupling of dredge and breakwater construction;
6. Reductions in breakwater volumes and exclusive use of clean granite rock; and
7. Beneficial re-use of backhoe dredge excavated rock/soil on the Darwin Shiplift project works.

Pursuant to the requirements of the EP Act (1969) an amendment to the existing Environmental Approval (EP 2022/014-001) to capture the Alternative Design is currently under application.

Detailed coastal processes investigations for the Alternative design have been undertaken to better understand and quantify the changes to coastal processes once the infrastructure is established and subsequently, to better understand associated environmental risk. These detailed investigations are detailed in the project's *Stage 1: Metocean Modelling* report (PCS, 2024).

Appendix A includes selected figures showing the key findings of the detailed coastal processes investigations for the Alternative design (pre-development and post development modelling figures) that demonstrate an equal or reduced impact to coastal processes for the Alternative design compared to the previous Approved design.

This *Coastal Processes Monitoring and Management Plan* (CPMMP) has been prepared to guide ongoing management of risk associated with changes to coastal processes once the facilities have been constructed.

2.3 Environmental Setting

2.3.1 Climate

Mandorah lies on the eastern side of Cox Peninsula, within Darwin Harbour (**Figure 2-1**). The tropical Darwin Area exhibits distinct wet and dry season rainfall conditions, and relatively consistent, warm temperatures throughout the year. The metocean climate includes very high tidal range and the relatively tranquil wave conditions found within Darwin Harbour, that are disrupted by intermittent periods of persistent winds/seas and, less frequently, tropical storms and cyclones.

2.3.2 Topography and Bathymetry

The onshore area of the project site is relatively flat with substantial high relief landward of the cliff features at the shoreline. The nearshore area of the site is relatively flat and shallow for approximately 150 m offshore. Beyond this intertidal area the seabed drops off steeply into deeper water. The proposed marine facilities lie within the shallow, nearshore zone, extending offshore to approximately -10 m below mean sea level (MSL). Surveyed bathymetry contours are shown in later **Figure 3-1** including associated monitoring.

2.3.3 Geology

Dredging and minor excavation for the project is expected to occur predominantly in rock described as a Phyllite (siltstone), with limited deposits of unconsolidated marine sediments in the project area. Marine geology was assessed during geotechnical and geophysical field investigations, with the primary material retrieved comprising fine to coarse grained, cohesive alluvial/residual sandy-clay, overlying rock varying in weathering and strength.

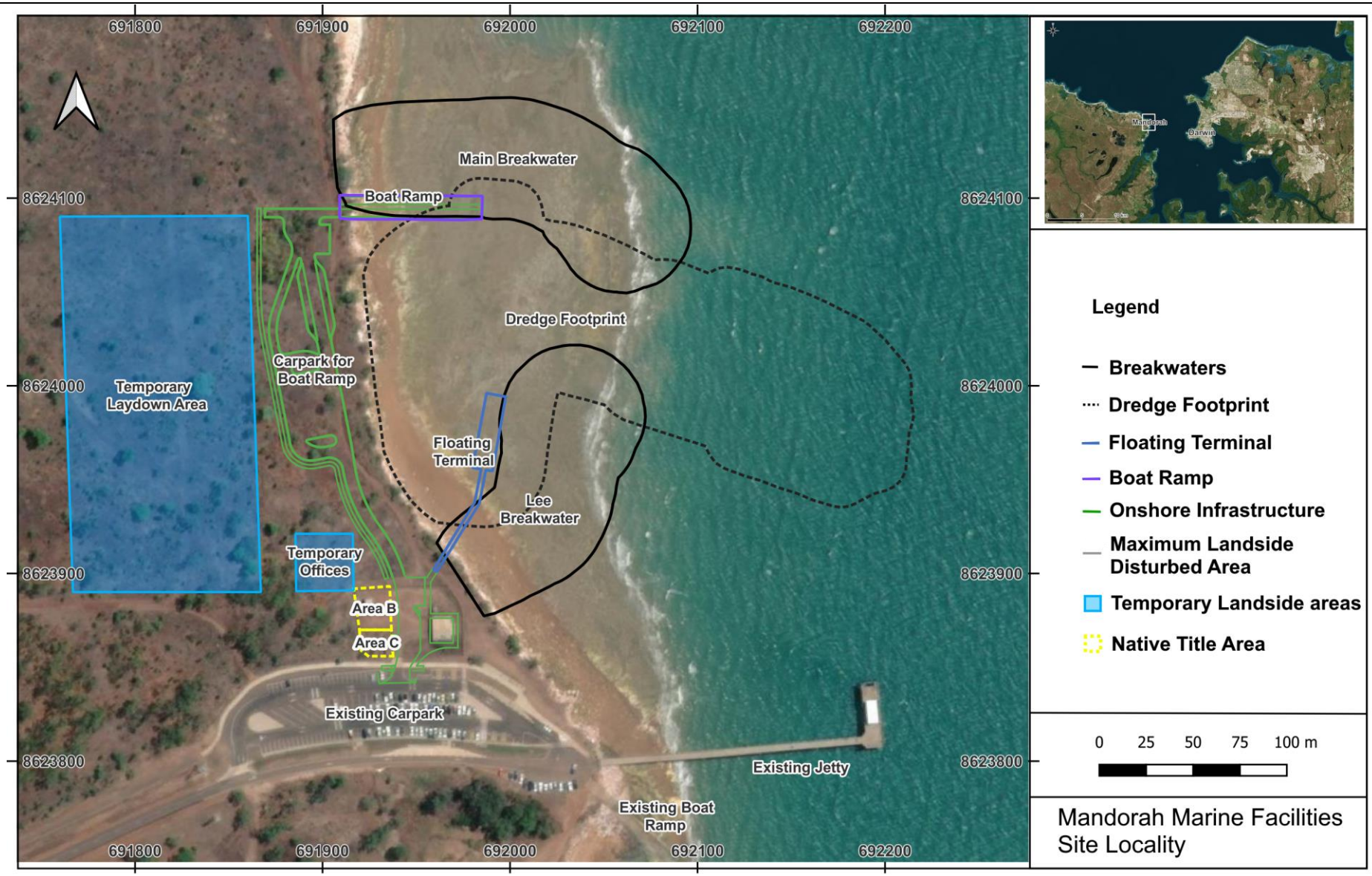

Figure 2-1: Site locality and proposed project layout

2.3.4 Hydrology

There are no significant surface water features at the project site and localized rainfall runoff is understood to flow directly to the ocean, with geology preventing significant infiltration. Coastal wetlands are present approximately 500m to the west, north-west of the project site, connecting to the ocean at the southern end of Wagait Beach. Woods Inlet is a major tributary of Cox Peninsula, with its entrance approximately 2 km to the south of Mandorah.

2.3.5 Marine and Coastal Environment

A combination of desktop studies, database searches and field investigations were undertaken as part of environmental investigations to characterise the site's marine environment, including benthic communities and habitats (BCH). The project area features a range of physical habitats from sand and low to high relief reef features. Seagrass and macroalgal communities are prominent on the low relief reef and sandy habitats in the western regions of the project area. Extending to the deeper waters east of the project footprint, the complexity of habitats increases on a bathymetric and biological scale. Benthic habitats northeast of the project area consists of a network of filter feeder habitats, comprising coral and mixed filter feeder communities. Seagrass is present within the project footprint, with additional communities to the south and north of the project area.

The coastal environment includes low-lying cliffs, which run from approximately 400m south of the existing boat ramp and exiting Mandorah jetty to approximately 400m north of the proposed main northern breakwater. The intertidal zone is described as coastal sandflats, fringing reef and saline claypans (see Figure 2-2). The intertidal zone does not contain mangroves, with the nearest assemblages located in Woods Inlet, approximately 500m NW of the proposed development site.

Figure 2-2: Claystone cliffs along the Mandorah shoreline (Cardno, 2022)

2.3.6 Social and Cultural Environment

There are two communities in proximity to the project site, Wagait and Belyuen, with small commercial operations including the Wagait Beach Supermarket and Cox Country Club. The resident population of Cox Peninsula is estimated at around 600 people.

Aboriginal sacred sites exist directly to the south of the project site (on land) and to the north where the coastal wetlands sit (including in the nearshore zone). These sites are protected under the *Northern Territory Sacred Sites Act 1989*. An Authority Certificate from the Aboriginal Areas Protection Authority (AAPA) is in place for the construction works associated with the Project. The certificate identifies two Restricted Works Areas (RWA's) that protect known Aboriginal Sacred Sites.

2.4 Key Environmental Factors

2.4.1 Overview

The EPA defines 14 environmental factors, under five themes, that underpin the environmental impact assessment process (NT EPA, 2022). Four environmental factors have been identified as potentially at risk due to the changes in coastal processes (which is a factor in its own right) that the new marine infrastructure is expected to induce. These are summarized in **Table 2-1** and further discussed in the sub-sections **2.4.2** to **2.4.5**.

Table 2-1: Environmental factors (EPA, 2022) relevant to this CPMMP

Theme	Factor	Environmental values	Potential impact to key environmental factor
Land	**Landforms**	Natural beach and nearshore morphology (Mandorah Beach).	Existing coastal morphology is altered by the installation of coastal infrastructure, due to alteration of the local coastal processes regime (see relevant environmental factor below).
Water	**Hydrological processes**	Function and quality of intertidal creek/wetland to the north of project site.	Changes to the local coastal processes regime, caused by installation of coastal infrastructure, affect the morphology of the creek entrance and, subsequently, its natural hydrological regime.
Sea	**Coastal processes**	Natural local coastal processes regime.	Local coastal processes regime (currents, waves, and sediment transport).is impeded and altered by the installation of coastal infrastructure.
People	**Culture and heritage**	Coastal sites of cultural significance including aboriginal sacred sites.	Cultural heritage sites are adversely impacted by the changes associated with an altered coastal processes regime.

2.4.2 Coastal Processes

The objective of the environmental factor 'coastal processes' is to:

- *Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained (NT EPA, 2022).*

The installation of the breakwaters and dredged basin in the nearshore zone will alter wave and hydrodynamic patterns, and the sediment transport associated with these physical processes. The proposed facilities are primarily expected to interrupt longshore currents and associated littoral drift. They will also change the physical patterns of current speeds and waves, making some areas lower energy ('calmer') and some areas more energetic than at present. Changes to metocean conditions themselves are not considered a direct environmental risk, but coastal processes are linked to several other key environmental factors. Risks for these specific factors discussed in the sub-sections below.

Pre- and post-construction coastal processes, for a range of site conditions, have been predicted using detailed numerical modelling, which is presented in the project's *Stage 1: Metocean Modelling* report (PCS, 2024).

2.4.3 Landforms

The objective of the environmental factor 'landforms' is to:

- *Conserve the variety and integrity of distinctive physical landforms (NT EPA, 2022).*

In addition to the immediate landform changes associated with construction of the marine facilities (i.e., breakwaters and dredged basin), changes to coastal processes are expected to induce gradual (in the order of years to decades) changes to the local coastline and nearshore area. It is important to note that the coastal zone is a dynamic environment that naturally experiences changes at seasonal and interannual timescales. Linked environmental factors, such as those discussed below, will be relatively tolerant of this natural

(ambient) variability. Environmental risk may arise if the proposed project induces changes outside the range of this natural variability. Such changes are expected to coastal landforms (beaches) directly adjacent the harbour. These changes may include seasonal patterns of increased erosion and accretion either side of the harbour, dependent on the seasonal direction of littoral drift.

Due to a predicted net (and predominant) annual movement of littoral drift southwards, there is expected be a gradual long-term accretion of the beach directly to the north of the proposed facility and potential erosion to its south (detailed assessment of these sediment transport processes is presented in the project's *Stage 1: Metocean Modelling* report (PCS, 2024).

2.4.4 Hydrological Processes

The objective of the environmental factor 'hydrological processes' is to:

- *Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained (NT EPA, 2022).*

Coastal wetlands are present approximately 500m to the west, north-west of the project site, connecting to the ocean at the southern end of Wagait Beach. Modelling has demonstrated that the distance of these wetlands from the facilities will prevent noticeable impact to their existing morphology and functionality (i.e., their connection with the ocean). However, due to the high environmental and cultural value of the wetlands and the inherent uncertainty in sediment transport modelling, this CPMMP has included monitoring of the system to detect any impact.

2.4.5 Culture and Heritage

The objective of the environmental factor 'culture and heritage' is to:

- *Protect culture and heritage (NT EPA, 2022).*

Restricted work areas (RWAs) exist near the shoreline directly to the south of the existing Mandorah carpark. Both Woods Inlet and Wagait Beach are areas of cultural significance, including the nearshore area adjacent coastal wetlands to the north of the proposed project area. Presence of the proposed structures could induce changes to coastal morphology near these sites, reducing their integrity. Although sediment transport modelling has suggested this will not be the case, a key aim of this CPMMP is to monitor changes and enact management to avoid such changes.

2.5 Scope of this CPMMP

This CPMMP is designed to identify and quantify the physical impacts associated with coastal processes, during the operational phase of the new facilities at Mandorah. Potential impacts during construction are to be managed via the project's *Construction Environmental Management Plan* (CEMP) (Stantec, 2023b) and *Dredging and Spoil Disposal Management Plan* (DSDMP) (Stantec, 2023c). The purpose of monitoring coastal processes and their indicators is to monitor and mitigate risk to associated environmental factors in the area, discussed above in **Section 2.4**. Risk assessment for these impacts and environmental factors has been undertaken in the project's *Environmental Referral Report* (Cardno, 2022) and subsequent SER (Stantec, 2023a).

Preparation of the CPMMP has been informed by review and analysis of relevant coastal and metocean data for the project area. This data has been applied to calibrate and validate physical process models for pre-

and post-development scenarios for the project. The purpose of data analysis and modelling is to gain an in-depth understanding of the natural coastal processes regime currently at the site (baseline) and to forecast as best possible how the coastal processes regime will adjust to the installation of the facilities. The CPMMP aims to first improve understanding of baseline conditions, then monitor and manage the predicted changes. Specific monitoring activities are underpinned by trigger criteria which will activate a management response to ensure associated environmental risk does not become unacceptable.

In accordance with Environmental Approval (EP2022/014-001) conditions 3-2 and in line with conditions 3-3 (1) and (3) to (10), the CPMMP needs to be implemented prior to substantial implementation (as defined in Environmental Approval (EP2022/014-001)).

2.6 Rationale and Approach

2.6.1 Study Area

The study area (see later **Figure 3-1**) for the coastal processes monitoring program has been defined based on the outcomes of sediment transport modelling, understanding of the assumptions and uncertainty associated with such modelling and consideration of key environmental values in the vicinity of the proposed project.

The extent of monitoring is approximately 500 m to the south of the project area, where a prominent shoreline feature (groyne) and change in shoreline orientation compartmentalises littoral drift to the north. The area extends approximately 700 m to the north, beyond the facilities predicted influence based on physical processes modelling. This extension has been made to capture the entrance of the coastal wetlands at the south of Wagait Beach. The study area extends shoreward to the top of the primary vegetated dune (noting this may be a dynamic feature) or coastal cliff. Offshore the study area extends to a maximum depth of -10m AHD. The study area also captures the harbour basin and approach channel/area, as survey of these areas will also be conducted to inform operational maintenance (e.g., dredging) of the facility. The nearshore is defined as the subtidal area adjacent to the shoreline. The coastal zone is defined as the beach and intertidal area.

This CPMMP acknowledges that initial and ongoing monitoring results may justify adjustment of the study area for the monitoring. This may include expansion of the area monitored or reduction upon review of the data collected.

2.6.2 Key Assumptions

The CPMMP acknowledges that coastal processes in the region and project area are dynamic and variable, over multiple timescales. This is due to the combined influence of estuarine sediment inflows, varying offshore sediment supply, variable metocean conditions, and the sporadic influence of storms – including tropical cyclones. Consequently, determination of monitoring regime and trigger criteria has required appreciation of the existing sediment loads and availability for transport, rates of sediment transport, environmental/cultural thresholds and distinction between natural variability and impacts due to the proposed facilities (i.e., disturbance to the natural coastal system). It is expected that any trigger criteria, and the efficacy of the monitoring program itself, will be refined and improved as data is collected.

The underlying assumption of this CPMMP is that the installation of the marine facilities is likely to alter short-term (intra-annual) and long-term (interannual) coastal processes and associated sediment transport

processes, with respect to the existing ambient conditions. These predicted changes have been assessed qualitatively and quantitatively by data analysis and physical processes modelling.

This analysis and its inputs and assumptions are documented in detail in the project's *Stage 1: Metocean Modelling report* (PCS, 2024). Key inputs and assumptions are summarised as follows:

- Underlying metocean conditions (winds, waves and currents) for the project area have been established by application of historical and hindcast data for the region and project area. The modelling has been validated at the project site and throughout the harbour by data collected specifically for this project and from previous projects,
- Existing sediment availability and composition within the project area has been estimated based on detailed geotechnical borehole investigations, geophysical survey and targeted sediment grab samples,
- Sediment loads entering the project area have been estimated based on sedimentation rates of fine-grained sediment in other dredged channels and berths in Darwin Harbour, these were calculated from repeat bathymetry surveys, and
- Validation of model performance for sediment transport processes has involved comparison to historical patterns of change, assessed through comparison of historical aerial shoreline imagery.

2.6.3 Management Approach

In accordance with Environmental Approval (EP2022/014-001) condition 3-3(1), the CPMMP is to be prepared as an adaptive management plan in consideration of the Northern Territory Environment Protection Authority Guidance on Adaptive Management (EPA NT, 2018). Successful implementation of adaptive management requires careful initial design for each of these steps:

1. Define the management problem
2. Establish clear management objectives
3. Identify uncertainties and hypotheses
4. Establish performance indicators or triggers
5. Identify, select and implement management actions
6. Monitor ecosystem response
7. Evaluate effectiveness
8. Adjust management actions

This CPMMP has been designed to manage risk associated with changes to coastal processes, as identified in the *Environmental Referral Report* (Cardno, 2022) and SER (Stantec, 2023a). The risk assessment for environmental factors relevant to this CPMMP is summarised in **Table 2-2**. Coastal processes modelling has demonstrated that two primary physical processes require monitoring:

- Long-term shoreline adjustment that could degrade the quality of beaches beyond naturally occurring variability and, if unmanaged, potentially impact sites of cultural significance and the coastal wetlands to the north. This is predicted to manifest as accumulation on beaches directly to the north and south of the harbour and erosion along the length of the beach to the south (of the accretion area), and
- Relatively rapid reorganisation of sediment deposition and accumulation in the nearshore area, in areas where the harbour creates a less energetic hydrodynamic regime. Small areas of scour are also anticipated where the structures lead to increased hydrodynamic energy.

The management approach for these impacts would be to intervene and artificially enable existing sediment transport processes, if the environmental risk associated with the facility becomes too high. This would involve sand bypassing for accumulation and erosion of beaches. For nearshore areas, sediment would need to be reorganised by removal and relocation if deemed necessary.

Table 2-2: Environmental impact and risk assessment summary relevant to coastal processes

Theme	Factor	Environmental values	Risk pathway	Potential impact	Inherent risk rating	Management / mitigation	Residual risk rating
Land	**Landforms**	Natural beach and nearshore morphology (Mandorah Beach).	Installation of coastal infrastructure leads to changed coastal processes and morphology.	Altered (eroded or accreted) coastal landforms (beaches).	High	Undertake mapping and a description of specific areas in the intertidal zone that require management and protection (in accordance with Environmental Approval (EP2022/014-001) condition 3-3(5)). Sediment redistribution (e.g., bypassing).	Low
Water	**Hydrological processes**	Function and quality of intertidal creek/wetland to the north of project site.	Changes to the local coastal processes regime affects the morphology of the creek entrance.	Natural hydrological regime and dependant ecosystems impacted.	Medium	Sediment redistribution (e.g., bypassing).	Low
Sea	**Coastal processes**	Natural local coastal processes regime.	Installation of proposed coastal infrastructure.	Local coastal processes regime (currents, waves, and sediment transport) is altered.	Medium	Gain detailed understanding of coastal processes during planning/design and minimisation of impacts through design. Preparation for ongoing management via this CPMMP.	Medium
People	**Culture and heritage**	Coastal sites of cultural significance including aboriginal sacred sites.	Changes to the local coastal processes regime affects the morphology of culturally significant sites.	Degradation due to excessive erosion or sedimentation.	Medium	Sediment redistribution (e.g., bypassing).	Low

3 MONITORING AND MANAGEMENT PROGRAM

3.1 Purpose

The purpose of the monitoring and management program is to ensure that the implementation, adaptive management and revising of the CPMMP will achieve the Environmental Approval (EP2022/014-001) condition 3-1 environmental objective:

- *The approval holder must implement the action to achieve the following environmental objective:*
  - *(1) maintain the beach within its natural extent under non-cyclonic conditions for a distance up to 400 m south from the existing Mandorah jetty.*

3.2 Monitoring

The survey monitoring areas are depicted in **Figure 3-1**. Survey focuses on identifying coastal morphology change. This monitors the physical effects of changes to the environmental factor coastal processes such as changes to landforms. These changes could impact on environmental factors hydrological processes and/or culture and heritage, so risk to these is also monitored via this program. Monitoring areas have been defined based on the outcomes of sediment transport modelling, understanding of the assumptions and uncertainty associated with such modelling and consideration of key environmental values in the vicinity of the proposed project (see **Section 2.6.1**).

In accordance with Environmental Approval (EP2022/014-001) condition 3-3(4), a field-validated assessment of the baseline conditions for the beach and adjacent areas should be undertaken prior to project disturbance in the marine environment. Once the field-validated assessment has been completed, the CPMMP should be amended to include the findings.

Full coverage survey will be collected within the defined monitoring areas, with a resolution of at least 1 m^2 and vertical accuracy of +/- 0.05 m. It is recommended that the majority of surveying is undertaken by aerial survey, during low spring tides, in calm conditions. The nearshore extents not covered by this should then be captured by overwater method (e.g., hydrographic survey) during high tides.

In accordance with Environmental Approval (EP2022/014-001) condition 3-3(6), control/reference sites should be included as part of the monitoring surveys (i.e. areas beyond the likely impact areas).

Surveying to be undertaken at the following intervals:

- Quarterly monitoring to be conducted for first 2 years.
- Followed by yearly monitoring up until year 5, subject to the outcomes of years 1 and 2.
- Monitoring may also be extended to 7 years if the previous 3 years of monitoring warrant it.

The outcomes of the monitoring will determine the need for coastal protection measures and effectively validate the outcomes of modelling. The collected data will become part of the wider Darwin Harbour database, to provide better historical inputs at this and many other harbour wide sites.

Yearly monitoring should be undertaken at a consistent time of year for comparability. Ideally this will be timed to occur during an interval between the seasonal wet and dry periods (approximately April or October/November).

Surveying will also be undertaken as soon as practicable following the effects of a tropical cyclone, as such an event could cause significant change in a short period. This should be triggered by a named tropical cyclone crossing the coast within 50 km of the project site. Discretion should be used to determine the necessity for post-storm monitoring following an event that doesn't meet this criterion.

Baseline data for this monitoring component will be derived from existing high-resolution survey of the study area, as well as post-construction survey for the project.

3.3 Management Actions

3.3.1 Triggers

Proposed monitoring and management actions and their triggers are presented in **Table 3-1**. The management approach is based on management of sediment accumulation and erosion, to avoid this impacting (or reaching a high risk of impacting) key environmental values. Proposed trigger quantities have been derived based on the outputs of sediment transport modelling and these may be revised once the monitoring program has commenced and collected data is analysed. The monitoring data collected should be analysed within 1-month of collection to compare results against trigger criteria, with the report, outcomes and any trigger breaches reported to key stakeholders. The monitoring and reporting should also analyse the efficacy of any bypassing or back-passing (if and when this occurs). This will help improve such sand management (placement and timing) for future campaigns.

3.3.2 Management

Bypassing and back-passing are methods of longshore redistribution of sediment along a coastline. Bypassing refers to the action of moving sediment from the 'updrift' side of a coastal feature or structure to the 'downdrift' side – enabling the longshore transport that was interrupted. Back-passing involves moving sediment from a location where it accumulates updrift of a coastline feature or structure in the opposite direction to longshore transport.

Sediment extraction is expected to be undertaken by excavator, loading the material to dump trucks. The excavator will extract sediment from the furthest offshore location first, working backwards towards the shore. The aim of a sand redistribution program will be to reinstate the shoreline position and beach form to (interpreted) baseline conditions. This will involve placement or removal of material, depending on the induced changes being experienced by specific areas. It is predicted that sediment will need to be removed from the beach directly north of the marina and transferred to the south (bypassing). Some build-up directly to the south may also need to be shifted further southwards (back-passing), if necessary to meet the eroded deficit.

Bypassing can also be undertaken using a floating (or on-land) pipeline and bypass the sand as a slurry mixture and rainbowed onto the beach. This would require a jet at the borrow area to agitate the sand first which could then be transported through a slurry pipe and discharged downdrift of the harbour. We understand this option is preferable to AAPA.

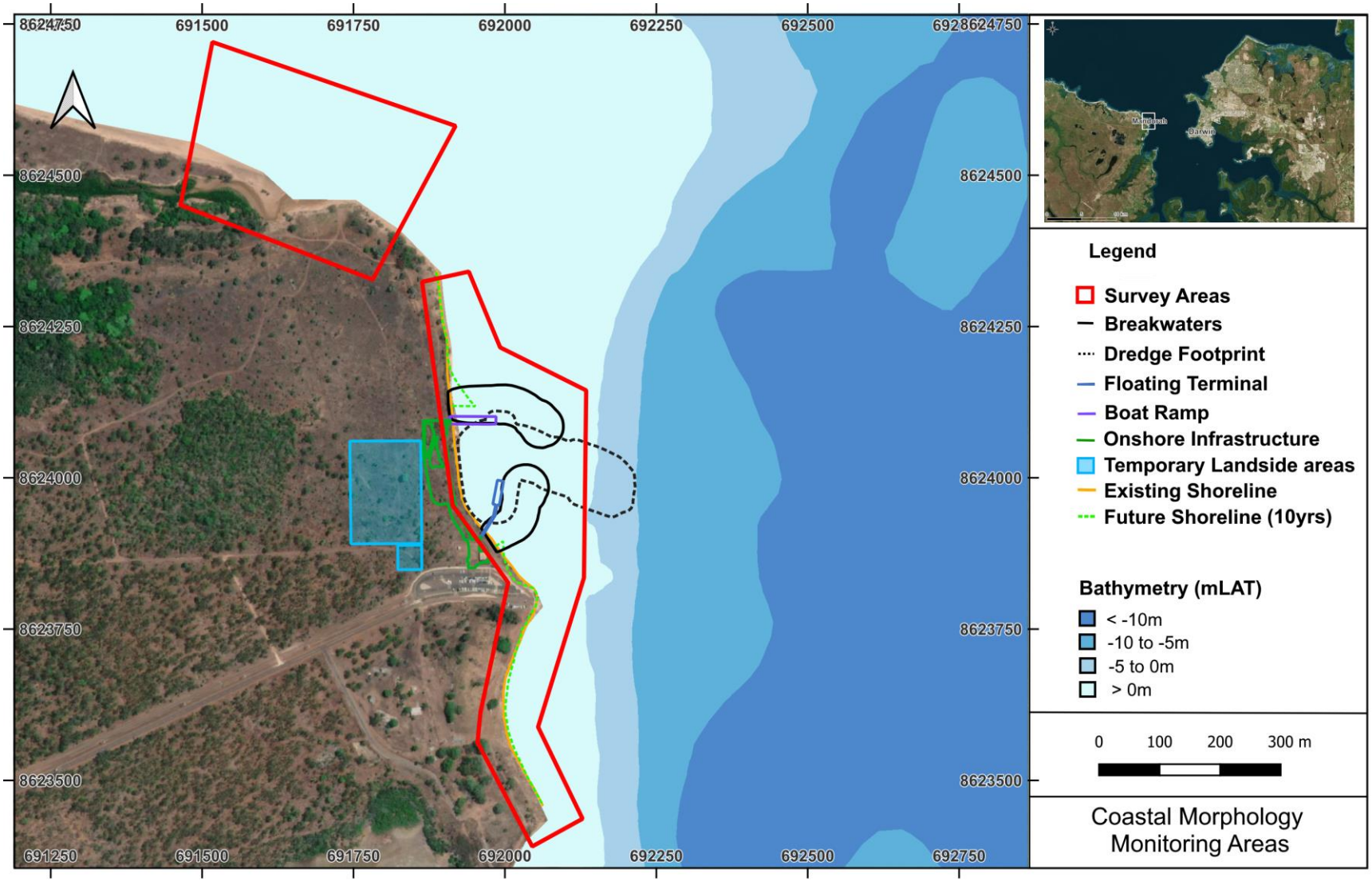

Figure 3-1: Coastal morphology monitoring - survey areas

Table 3-1: Monitoring and Management actions and triggers

Factor	Data	Assessment interval	Trigger	Proposed Management Response
Landforms	Survey	Quarterly monitoring to be conducted for first 2 years. Followed by yearly monitoring up until year 5, subject to the outcomes of years 1 and 2. Monitoring may also be extended to 7 years if the previous 3 years of monitoring warrant it.	Estimated accumulated volume to the north of facility = 10,000 m^3 greater than predicted baseline	Undertake bypassing to beach to south of facility
			Estimated lost volume to the south of facility = 10,000 m^3 less than predicted baseline	Bypass or back-pass excess accumulated sediment to replace
			Average shoreline position recedes by 5 m compared to baseline (see Note 1)	Bypass or back-pass excess accumulated sediment to restore shoreline position
Hydrological processes	Survey		Facility induced sedimentation is occurring beyond the modelled extent alongshore, encroaching on coastal wetlands to the north of the new infrastructure.	Remove sediment and place at areas of erosion
			Sedimentation is measured to be occurring at the entrance to coastal wetlands, at an increased rate attributable to the new marine infrastructure. Nominally, the entrance area (calculated from profile surveys) has reduced by 10 m^2 compared to its natural (pre-construction), long-term range. [This nominal cross-section can be revised during baseline data collection].	Remove sediment and place at areas of erosion
Culture and heritage	Survey		Erosion or sedimentation is occurring within 10m of registered/known sacred site, attributed to the influence of the new facilities	Remove sediment from areas of accretion and place at areas of erosion (in the vicinity of cultural heritage areas)
Note: **1**. Average 5m recession selected to account for intra-seasonal (annual) variations in shoreline position				

4 ADAPTIVE MANAGEMENT AND REVIEW

Following identification of potential impacts attributable to installation of the proposed facilities and associated risks described in this CPMMP, DIPL commits to:

- Implement management actions identified in **Section 3.3.2** and **Table 3-1** to mitigate risks to the environment and maintain the achievement of the environmental objective specified in the Environmental Approval (EP2022/014-001) condition 3-1 (as detailed in **Section 3.1**),
- Regularly monitor and evaluate environmental risk for the key environmental factors set out in **Table 2-2**,
- Undertake monitoring and implement management actions and triggers as set out in **Table 3-1**.
- Report the performance evaluation against the environmental objectives to key stakeholders including the NT EPA, in accordance with Environmental Approval (EP2022/014-001) condition 9-1, that being:
  - within 12 months after completion of construction of the action; and
  - after closure of the action; and
  - within 6 months after any maintenance dredging activities; and/or
  - implementation of shoreline mitigation activities; and
- Make this CPMMP publicly available via DIPL's website.

DIPL is committed to conducting activities in an environmentally responsible manner and aims to implement reviews of its environmental management actions as part of a programme of continuous improvement. This commitment to continuous improvement means that DIPL may review the CPMMP to address matters such as the overall effectiveness, environmental performance, changes in environmental risks and changes in business conditions on an as needs basis (e.g., in response to new information or new coastal developments within the broader Darwin Harbour).

Any significant changes to this CPMMP will result in the document being resubmitted to the NT EPA for review and approval. A 'significant change' includes changes to monitoring (e.g., timing, location, duration) or trigger criteria.

During the life of this CPMMP, DIPL may investigate options associated with alternative methods of sand bypassing. This may include the installation of a range of permanent bypassing infrastructure to re-establish natural sand flows around the harbour, or the sustainable relocation of dredged material (from maintenance dredging) to nearshore areas with the aim of reintroducing this material into the littoral zone in downstream environments. Any change to the current practice of land-based sand bypassing will require a revision to this CPMMP and subsequent regulatory approval.

In accordance with Environmental Approval (EP2022/014-001) conditions 3-3(9) and 3-3(10), any permanent infrastructure (such as structures for shoreline impact mitigation) required to maintain the environmental objectives specified in conditions 3-1 and 4-1 includes the requirement that the layout and cross sectional drawings of such infrastructure (including certification from a registered engineer confirming the stability and integrity of any permanent infrastructure to be used) shall be amended in the CPMMP and sent to the NT EPA for review and approval.

Reporting to be undertaken as part of the implementation of the CPMMP, shall include:

- A report provided to DIPL detailing the finding of the field-validated assessment of the baseline conditions for the beach and adjacent areas undertaken prior to project disturbance in the marine environment (as mentioned in **Section 3.2** and required by Environmental Approval (EP2022/014-001) conditions 3-3 (4));
- Monitoring reports to DIPL as specified in **Section 3.2**; and
- Monitoring reports to include the requirements of Environmental Approval (EP2022/014-001) condition 9-2 (1) to (4), including:
  - provide all monitoring data (inclusive of any raw and processed data) and reportable incidents required by the conditions of this approval;
  - provide an analysis and interpretation of monitoring data to demonstrate whether compliance with the requirements of conditions 2-1 and 3-1 has been achieved;
  - provide a comparison between the actual and predicted impacts;
  - include an assessment of the effectiveness of monitoring, management and contingency measures implemented to comply with conditions 2-1 and 3-1 of the environmental approval.

The CPMMP will be routinely updated every five years to ensure it remains current and continues to reduce the impact of operations on the surrounding environment.

5 REFERENCES

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Appendix A Selection of Shoreline Evolution Figures (PCS, 2024)

Figure 40. **Present day shoreline (yellow line) and predicted future shoreline in 10 years time for the Existing Case (red line).**

Figure 41. Predicted future shoreline in 10 years time for the Existing Case (red line) and the Alternative design (green line).

Figure 42. Predicted future shoreline in 10 years time for the Existing Case (red line) and the Original design (blue line).

Figure 43. **Predicted future shoreline in 10 years time for the Alternative design (green line) and the Original design (blue line) along with locations of Sacred Sites to the north of the Facility.**