Environmental Referral Report

New Marine Facilities to Service Mandorah and Cox Peninsula

ZMD01890

Prepared for

Department of Infrastructure, Planning and Logistics

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Executive Summary

Proposed Project

The Northern Territory Government (NTG) has identified the need to develop a safer, *Disability Discrimination Act 1992* (Cwth) compliant and more weather-resistant ferry berthing facility at Mandorah, to improve transport connectivity between Cox Peninsula and Darwin. The proposed facility uses two large breakwaters to form a safe harbour around new ferry berthing and passenger boarding infrastructure. The project is located adjacent the existing Mandorah Jetty, which currently services the transfer of ferry passengers, but does not comply with access requirements for the mobility impaired. Key components of the proposed facilities are:

- A safe harbour formed by rock armoured breakwaters – large northern breakwater and smaller southern breakwater;
- Capital dredging of an access channel, turning basin and berthing areas for the ferry, as well as safe navigation of recreational vessels to and from the boat ramp;
- A new single lane boat ramp within the harbour, connecting to the existing carpark at the site;
- A new floating pontoon, gangway, jetty (to be confirmed as a design option) and rock armoured causeway inside the harbour to allow passengers to access the ferry from land;
- A ferry terminal building established by repurposing an existing building at the site (Lot 50) and new carpark with a short road connecting it to the existing carpark, as well as pedestrian paths and minor onshore amenities; and
- Minor modification to the existing carpark to incorporate access and manoeuvring for the new boat ramp, as well as allow additional trailer parking.

The Department of Infrastructure, Planning and Logistics (DIPL) are the proponent for the proposed project, referring it to the Northern Territory Environment Protection Authority (NT EPA) for assessment.

Legislative and Regulatory Context

The NT *Environment Protection Act 2019* (EP Act) aims to protect the environment through sustainable development and manage significant disturbances through an environmental approval process. Under the act, the NT EPA regulates the environmental impact assessment process to identify potential environmental impacts of development proposals. The proposed project is being referred to the NT EPA for assessment under the EP Act, based on the information contained in this *Environmental Referral Report* and associated chapter reports.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage sites, referred to as Matters of National Environmental Significance (MNES). Developments likely to have significant impact on MNES require referral under provisions of the Department of Environment and Energy's *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance*. The first step is to 'self-assess' the project with respect to MNES and the EPBC Act, to determine whether referral is required, as has been undertaken in this report.

Existing Environment

Climate

Mandorah lies on the eastern side of Cox Peninsula, within Darwin Harbour. 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 relatively tranquil wave conditions within Darwin Harbour, disrupted by intermittent periods of persistent winds/seas and, less frequently, tropical storms and cyclones.

Topography and Bathymetry

Detailed topographical and bathymetric surveys were completed to inform the project's design and environmental impact assessment. The onshore area of the project is relatively flat with substantial high relief landward of the cliff features at the shoreline. No significant terrestrial landforms exist at the site. 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 are within the shallow, nearshore zone of Darwin Harbour. Whilst Darwin Harbour is greater than 20 m below mean sea level (MSL) in the main channel at low tide, the footprint of the main breakwater extends to approximately 4 m below MSL, with the dredged access channel extending to approximately 7 m below MSL.

Geology

Dredging and minor excavation for the project is expected to occur predominantly in rock described as a Phyllite, because of the grade of metamorphism and the high degree of micas present. Marine geology was confirmed onsite during geotechnical field investigations, with the primary material retrieved comprising fine to coarse grained, cohesive alluvial/residual sandy-clay, overlying rock varying in weathering and strength.

The marine footprint of the project includes:

- A thin Porcelanite 'shelf' at the surface of the site's nearshore area, extending offshore to where the seabed bathymetry is around 3 m below MSL;
- Underlying this shelf is weathered rock that should be relatively easy to dredge and will also be suitable for reuse as core fill;
- A small portion of the site that may contain high strength rock to depth; and
- Directly offshore of the edge of the Porcelanite shelf is a deep layer of soft muds / marine deposits, extending from the seabed surface to depths between 6 m and 9 m below MSL.

Hydrology

There are no significant surface water features at the project site and 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 south of Mandorah.

Historical investigations on Cox Peninsula indicate that depth to groundwater is between 10 and 15 m. The data suggests that there is a slight gradient, with groundwater migrating in a general easterly direction towards Darwin Harbour.

Marine Environment

A combination of desktop studies, database searches and field investigations were undertaken to characterise the site's marine environment. A benthic communities and habitats (BCH) map has been developed for the project area and surrounds, identifying the following important habitats:

- An assemblage of very low-density seagrass within the direct project footprint;
- An assemblage of low-density seagrass in close proximity, directly to the north of the project footprint;
- Significant coral coverage to the north, north east of the project footprint; and
- Assemblages of sponges and mixed filter feeders in the vicinity of the project footprint.

Database searches and review have indicated that the following important marine fauna may be present in the project area:

- Several species of migratory and threatened marine bird;
- Sawfish;

- Dugong;
- Migratory species of dolphin; and
- Migratory and threatened species of turtle.

Terrestrial Environment

Terrestrial habitats at the project site have been characterise by assessment of available digital mapping, complimented by site survey. The habitats present at the site include:

- *Terminalia* Woodland (mid-open) as the abundant native vegetation type. Field surveys did not record tree hollows, consistent leaf litter or stags within the habitat unit. One bird's nest was observed; however, no birds were observed during the survey. The lack of debris which provides habitat for ground dwelling animals may be explained by fires which can regularly occur in the area;
- High densities of *cenchrus spp*, commonly known as mission grass, present throughout the site. The weed infestation is categorised as high density, consisting of 15% seedlings, 20% juveniles and 65% adults;
- Coastal low-lying cliffs, which run from the existing boat ramp and jetty past the northern point of the proposed carpark and breakwater. *Cenchrus spp* infestation prevailed close to the edge of the cliff where few *casuarina*, *eucalypt* and *terminalia* species were observed. No signs of nesting or foraging were observed during the site visit;
- The intertidal zone, consisting of coastal sandflats, fringing reef and saline claypans. The intertidal zone does not contain mangroves; and
- Cleared land, including the Radio Australia fenced property north of the existing carpark and a dirt track running parallel to the coastal cliff.

Database searches and review have indicated that the following important terrestrial fauna may be present in the project area:

- Several species of migratory and threatened bird species; and
- Several threatened mammal species.

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.

The Mandorah Ferry, operated by Sealink, services the area with at least a dozen ferry services per day, with more frequent servicing in the morning and afternoon for patrons to get to and from work and school. The service is essential for many Cox Peninsula residents to complete everyday activities in Darwin.

Aboriginal sacred sites exist directly to the south of the project site which 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 works associated with the Project. The certificate identifies two Restricted Works Areas (RWA's) that protect known Aboriginal Sacred Sites.

Project / Site Alternatives

Planning and development of the project has included investigation of alternative sites to minimise environmental impact. The key feature of the existing Mandorah marine facilities site, that makes it favourable for sea to land connectivity at Cox Peninsula, is the close proximity between land and deep water. This proximity is closest at the existing jetty location. This has allowed ferry service access to date without any capital or ongoing dredging. The new facilities would also benefit from this proximity, minimising the dredging required, and consequent impact to the marine environment, to create and maintain an access channel. It also minimises disturbance to the terrestrial environment, by integrating with existing landside access infrastructure.

The proposed facilities have, therefore, been placed adjacent the existing Jetty. Further constraints for siting the proposed facilities included:

- Avoiding the area to the south of the jetty due to Aboriginal sacred sites;
- Maintaining a certain distance from the jetty so that the ferry service could continue uninterrupted during construction;
- Achieving the shortest possible walking distance to the ferry from parking at the existing carpark; and
- Minimising the terrestrial footprint required to connect new landside facilities to the existing (e.g. roads/paths).

Stakeholder Engagement

The importance of community involvement in the environmental impact assessment process, particularly of Aboriginal people and communities, is expressly recognised in the objectives of the EP Act.

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

Throughout the project's planning and development, extensive ongoing consultation has been undertaken with the local community and relevant stakeholders. Formal consultation has occurred and been documented at several key project stages, including the:

- Project Development Stage: Siting and scoping of facility upgrades to inform concept optioneering and project funding;
- Concept Optioneering Stage: Development of engineering options for comparison and selection of a preferred option to progress; and
- Design Development Stage: Refinement of the preferred concept option to meet available budget.

The feedback of engagement has generally been positive towards the project intent overall, with varying opinions on priorities for the functional requirements of the facilities. Ongoing consultation has managed concerns regarding impacts to the environment and nearby Aboriginal sacred sites which, as outlined in this report, are not anticipated to occur, or be significant, with appropriate management and mitigation.

Environmental Factors, Impact and Risk Assessment

The NT EPA's pre-referral checklist was applied to undertake a self-assessment of the proposal's potential impact on each of the NT EPA's environmental factors. Eleven of the 14 environmental factors were deemed to have potential significant impacts associated with the proposed project, leading to further impact and risk assessment, as described below.

Landforms

The potential significant impacts associated with the environmental factor 'Landforms' that were identified and assessed were:

- The breakwaters, and to a lesser extent the reclaimed causeway and boat ramp, are large civil structures that will be installed in the nearshore environment. These structures can be considered landforms in their own right and constitute a significant change to the existing nearshore morphology at the project site. The establishment of the breakwaters is a key objective of the project and, therefore, not considered an impact to be mitigated. The design process has sought to minimise the scale of the breakwaters while achieving the functional requirements of the facility; and
- The installation of the breakwaters in the nearshore zone will alter wave and hydrodynamic patterns, and the sediment transport associated with these processes. This will lead to gradual changes to coastal landforms (beaches) adjacent the harbour. The beaches directly adjacent the proposed harbour are not considered to be 'significant' landforms in their own right, as they do not hold significant cultural or ecological value.

Changes to coastal landforms that are expected to be induced by the project may impact on other environmental values, such as those under the 'Marine Ecosystems' and 'Culture & Heritage' factors. Environmental impact and risk have, therefore, been assessed for the expected coastal landform changes under these factors, where appropriate.

Terrestrial Environmental Quality

The potential significant impacts associated with the environmental factor 'Terrestrial Environmental Quality' that were identified and assessed were:

- Earthworks and project construction activities that may release contaminants already present at the site. Landside earthworks for the project are expected to be minor and the areas to be disturbed are not considered a high contamination risk. Asbestos has been identified in the surface soil surrounding an existing building on the site, and this will require investigation, classification and removal before undertaking construction works.
- Construction activities may lead to the discharge of waste and pollution, impacting terrestrial environmental quality. The risk of pollution and waste associated with construction is typical of a civil works project. It is expected that risk can be mitigated through appropriate waste controls, planning and spill response, defined in the project's Construction Environmental Management Plan (CEMP).
- Degradation of soil quality may occur due to clearing associated within the project's construction and subsequent to the works. These risks are not considered significant, as the project predominantly works with the natural surface contours. Appropriate erosion control will need to be implemented during construction, with ongoing and final rehabilitation of areas disturbed. Appropriate design of runoff and drainage for landside facilities will mitigate the risk of ongoing soil erosion and quality issues.
- Operation of the new facilities will produce waste with the potential to impact terrestrial environmental quality. Production of waste from the facility is anticipated to increase with respect to production at existing facilities. This is due to the installation of ablutions and potential for increased patronage. Appropriate design of waste management and ongoing waste management practices for the facilities are expected to mitigate the risk of reduction in terrestrial environmental quality associated with this.

Terrestrial Ecosystems

The potential significant impacts associated with the environmental factor 'Terrestrial Ecosystems' that were identified and assessed were:

- Clearing of land and terrestrial habitat to install infrastructure (carpark, roads, paths). The increase in terrestrial footprint with respect to existing facilities is relatively small, and impacts a portion of land that is already partly cleared and degraded. Clearing associated with the infrastructure footprint is unavoidable, but is considered to impact an insignificant and low biodiversity value portion of the native vegetation present on Cox Peninsula.
- Temporary construction and laydown (cleared) will degrade or destroy habitat. Use of temporary works areas will result in clearing and degradation of the existing environment. The project will seek to minimise the destruction of important habitat (e.g. large native trees) associated with these activities and rehabilitate the areas disturbed once works are complete. As with the direct footprint, the areas to be affected are not considered to be a significant or particularly biodiverse portion of the natural habitat present in the region.
- Movement of machinery and light vehicles and the importation of fill may promote the introduction and/or dispersion of weeds. This risk is considered relatively low, as the site is not remote (disconnected) from the broader Darwin area and is already exposed to invasive flora species. Appropriate inspection and washdown of equipment and plant, stipulated in the CEMP is expected to mitigate this risk.
- Construction activities will generate noise, vibrations, dust and possible pollution that may directly impact native flora and fauna or result in behavioural changes. These impacts are considered to be low risk when managed by the controls outlined in the CEMP, such as dust suppression, waste management and work hour restrictions, which are also required to mitigate risk to people.

- Potential for construction activities to directly impact native fauna. The disturbance site was not found to have abundant habitat for native fauna. However, the presence of such fauna, including migratory and threatened species, is possible and will require management. Ongoing monitoring and inspection prior to clearing is expected to significantly reduce the risk of impact to terrestrial fauna.
- Potential creation of wildfire by construction activities. This is a risk inherent in remote construction projects and requires appropriate management, via the CEMP, particularly if operating in dry season when fuel loads are high. Appropriate management measures are expected to lower this risk to an acceptable level.
- Ongoing operation of the new facilities may reduce the presence of native fauna in the project area (due to removed habitat, noise, lighting etc.). The new facilities are expected to have a slightly increased light output. The environmental risk of this, however, is considered low and can be further reduced through observation of restricted lighting periods during construction and operations.

Coastal Processes

The potential significant impacts associated with the environmental factor 'Coastal Processes' that were identified and assessed were:

- Installation of the breakwaters will interrupt nearshore hydrodynamics, waves and sediment transport, altering erosion and accretion patterns either side of the facility. This may impact local marine ecosystems and has, therefore, been assessed under the environment factor 'Marine Ecosystems'.
- Localised changes to nearshore hydrodynamic and wave climate are expected due to the installation of the harbour. This is anticipated, as the purpose of constructing a harbour is to divert coastal energy and create a calm marine environment. The harbour's profile with respect to the surrounding shoreline will be very small, and the impacts to the local tidal and metocean regime, beyond the immediate vicinity of the facility, will be negligible in terms of noticeable impact to the environment.

Marine Environmental Quality

The potential significant impacts associated with the environmental factor 'Marine Environmental Quality' that were identified and assessed were:

- Dredging has the potential to release contaminants from seabed sediments into the marine environment. This risk was investigated by characterising the material to be dredged, in accordance with the *National Assessment Guidelines for Dredging 2009* (NAGD). The assessment found that unconsolidated material at the site is suitable for open ocean disposal, presenting a low risk of impact to marine environmental quality in terms of its chemistry.
- Potential water quality (turbidity) issues due to sediment plumes generated by dredging actions. A relatively small volume (≈ 15,000 m^3) of unconsolidated sediment will generate temporary turbid plumes at the extraction and deposition locations during dredging. These effects have been modelled to predict suspended sediment concentrations and sedimentation thickness. The predictions have been impact assessed with respect to the 'Marine Ecosystems' environmental factor.
- Dredging and construction activities may release waste and pollutants to the marine environment. This is typical of marine construction works and will be managed by strict survey standards, waste management and spill response, stipulated in the project's Dredging and Spoil Disposal Management Plan (DSDMP).
- Surface water runoff from the proposed facilities may pick up litter and chemicals (e.g. hydrocarbons) from landside areas and flow into the marine environment. Design of the landside facilities will mitigate this risk through the incorporation of appropriate runoff filtration, typical of any construction adjacent the coastline.
- Siltation of the proposed marine facilities is likely to occur due to the tranquil harbour basin allowing the settlement of suspended particles (maintenance dredging). The facility is expected to require ongoing maintenance dredging of a similar nature to the capital dredging of unconsolidated sediments. The implementation of this and associated environmental risk and management will be in line with that for initial dredging.

Marine Ecosystems

The potential significant impacts associated with the environmental factor 'Marine Ecosystems' that were identified and assessed were:

- Direct destruction of marine ecosystems within the project's construction footprint. Benthic communities and habitats (BCH) mapping identified that the project footprint will impact a combination of bare ground and sparse seagrass assemblage (*halodule* and *halophila*). While the removal of seagrass will be irreversible, the assemblage is considered to be of low density and a very low portion of the seagrass present along the eastern side of Cox Peninsula. Appropriate controls of plant movement and dredging will be applied to constrain the impact to the direct project footprint and its close proximity.
- Indirect impacts of dredging actions, associated with sediment transport and sedimentation, to nearby marine ecosystems. Modelling of suspended sediment plumes and sediment deposition thickness have been compared to background concentrations and assessed against tolerance thresholds for sensitive receptors such a seagrass and corals. The results demonstrate various zones of impact at the dredging and disposal site. Managed environmental risk is considered to be low, due to the limited extent of the plumes, the tolerance of BCH to be impacted and the short duration of the dredging and offshore disposal phase.
- Interaction/impact of construction activities with marine fauna. Impact to marine fauna from marine construction plan and activities is a risk for the project, including to priority migratory and threatened species. Appropriate marina fauna observation and avoidance techniques, as well as controls on construction methods (e.g. 'soft-start'), stipulated in the DSDMP, are expected to reduce this risk to a tolerable level.
- Long-term changes to coastal processes and morphology impacting marine flora and fauna. Long-term changes to coastal processes and morphology, described for the factors 'Landforms' and 'Coastal Processes', are not expected to pose a significant risk to marine ecosystems due to their gradual effect and the lack of biodiversity in the intertidal areas where they would cause impact. They can also be mitigated with ongoing bypassing.

Air Quality

The potential significant impacts associated with the environmental factor 'Air Quality' that were identified and assessed were:

- Dust production impacting vegetation, diversity of ecosystems and human health. The project has the potential to generate dust as with any civil works project. Nearby ecosystems are not expected to be highly susceptible, but human health must be considered given the proximity to ferry operations and patrons. Management of dust will be required as stipulated in the CEMP, such that levels do not exceed environmental and human health thresholds.
- Exhaust emissions during construction and operation of the facility. These will be typical of a construction project, not presenting a high risk given the remote nature of the site. Appropriate management via plant and equipment standards and maintenance will minimise this risk.

Atmospheric Processes

The potential significant impacts associated with the environmental factor 'Atmospheric Processes' that were identified and assessed were:

- Construction of the facilities will contribute to NT emissions overall. These emissions cannot be avoided, but will be minimised through careful construction planning and have been calculated as minimal with respect to existing NT emissions.
- Operation of the facilities will contribute to overall NT emissions, given a potential small increase in electricity use compared to existing. This impact will be mitigated through the design process with the incorporation of low power use components and solar power, where practicable.

Community and the Economy

The potential significant impacts associated with the environmental factor 'Community and the Economy' that were identified and assessed were:

- Interruption and inconvenience to the community during construction. Construction staging and management will need to carefully consider the local community and avoid interruption to the ferry service.
- Economic stimulation from the project's construction. The construction project is expected to benefit the NT by creating temporary jobs and stimulating the associated economy.
- It is expected that this project will improve accessibility to the area and increase economic opportunities for residents and visitors to the area. Long-term, improved accessibility to Cox Peninsula is expected to have a positive impact to the community.
- Increase in accessibility for residents of the Cox Peninsula to jobs, businesses, education and healthcare services.

Cultural Heritage

The potential significant impacts associated with the environmental factor 'Cultural Heritage' that were identified and assessed were:

- Impact to known or unknown Aboriginal sacred sites during construction. There are several known sites in the vicinity of the project that are not anticipated to be impacted due to restriction of access. There is a risk that new sites or artefacts will be encountered. The CEMP will minimise this risk by ensuring appropriate protocols are followed should such sites or items be encountered during construction.
- Impact to unknown heritage objects or sites (e.g. WWII) during construction. It is not expected that such heritage will be encountered, but protocols in the CEMP will ensure proper response if they are.

Human Health

The potential significant impacts associated with the environmental factor 'Human Health' that were identified and assessed were:

- Contaminants and dust released during construction could impact nearby users of the area, such as ferry passengers. Dust suppression, stipulated in the CEMP, will be implemented to ensure that dust generated by the project will remain below human health thresholds. The dust is not expected to be contaminated, with small areas of the site that contain asbestos to be identified and removed prior to construction. Proper construction and site layout planning will also minimise unnecessary ground disturbance and dust production.
- Emissions from construction plant acting as an irritant to humans. This is considered a low risk due to the remote, open nature of the site.
- Dredging activities releasing contaminants that could enter the food chain. As discussed with respect to the environmental factor 'Marine Environmental Quality', the material to be dredged is considered 'clean' and suitable for open ocean disposal as per NAGD.

EPBC Act Self-Assessment

A 'self-assessment' was undertaken for the proposed project actions, in accordance with the EPBC Act. This was based on MNES with potential to be impacted by the project. The project lies at the land/sea interface, with proposed project actions impacting both the terrestrial and marine environments. MNES identified that may be impacted by the project are both threatened (39) and migratory (70) species with potential to occur in the project area.

The project's terrestrial footprint is relatively small and the habitat to be modified is already in a degraded condition and not considered to represent high biodiversity or habitat value. There is substantial similar and better-quality habitat in the surrounding areas of Cox Peninsula.

Marine impacts are expected to be confined primarily to the direct project footprint (breakwaters and dredging) due to the majority of dredge volume being rock (i.e. not producing large turbid plumes). The impacted area consists of bare ground and a portion of relatively sparse seagrass assemblage. There is higher density and more abundant seagrass available throughout Darwin Harbour, which has been shown to be preferred habitat for migratory marine species such as turtles, dolphins and dugongs.

The project area has already been influenced by previous and ongoing anthropogenic activity (e.g. construction, fishing and ferry movements). There are frequent ferry movements and significant infrastructure and human activity on land. This activity has probably reduced the likelihood of many listed species residing at the site permanently or visiting for extended periods of time.

The project involves significant actions and will highly modify a small area of marine and terrestrial environment. However, based on the existing habitat at the proposed location, the nature of the migratory and threatened species with potential to occur there and the type of construction actions, it is considered unlikely that it will impact on MNES, as defined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

Application of the Principles of Environment Protection and Management

Section 43 of the EP Act sets out the general duty for proponents of proposed actions, under an environmental impact assessment process. DIPL has upheld these principles, as defined in Part 2 of the EP Act, through the project's planning, development and design.

Principles of Ecologically Sustainable Development

- The 'decision-making principle' has been applied through facilities long design life, providing benefit to multiple generations. It also aims to improve access for all existing generations, increasing accessibility and connectivity for its users. Significant community engagement has been undertaken to achieve this principle, including with the Aboriginal communities that may benefit from, or be impacted by, the project.
- The 'precautionary principle' has been applied extensively in environmental assessment of the project. Appropriate data gap analysis and subsequent field investigations have been undertaken to properly characterise the existing habitat at the site. Potential environmental impacts have been quantified through best-practice techniques and monitoring of the actions has been proposed to ensure risk can be mitigated in response to actual risk during construction.
- The 'principle of evidence-based decision-making' was demonstrated through assessment of existing data, filling of data gaps and application of data analysis and modelling to assess potential environmental impact and risk. Where risk remains with a level of uncertainty, best-practice field monitoring has been recommended to ensure intolerable risk or impacts do not develop during construction.
- The 'principle of intergenerational and intragenerational equity' is demonstrated in the project purpose and aim - to effectively create a permanent public access facility to be used by multiple generations of Territorians, with all range of abilities. The potential environmental impacts have been assessed as unlikely to be significant during construction (short-term), and the legacy of the facility (long-term) is not expected to degrade the surrounding environment.
- The 'principle of sustainable use' has limited relevance, with the project not expected to use natural resources on an ongoing basis, beyond its construction with primarily local, natural rock. The exception to this is the potential use of rainwater harvesting to service ablutions in the terminal building.
- The 'principle of conservation of biological diversity and ecological integrity' has been demonstrated through the extensive environmental investigations, risk assessment and EPBC Act self-assessment. The project has sought to minimise its environmental footprint throughout the planning and design process, while still achieving its functional aims.
- The 'principle of improved valuation, pricing and incentive mechanisms' will be upheld through DIPL taking on responsibility for the ongoing management, maintenance and operation of the facility. Other

beneficiaries, such as the ferry operator (currently Sealink) and Wagait community will be expected to be involved in general upkeep, security and waste management at the facility.

Management Hierarchies

- The 'environmental decision-making hierarchy' has been applied by minimising major project actions where possible, such as dredging and disposal volumes, nearshore construction footprints and terrestrial land clearing footprints. Management options have then been defined to effectively limit environmental impact to the direct construction footprint and its immediate vicinity. Based on the habitat to be impacted by the project, it is not considered appropriate to allocate offsets, with abundant similar and better-quality habitat in the surrounding terrestrial and marine environment.
- The 'waste management hierarchy' has been applied as per Section 27.2 of the EP Act. The major waste product by volume will be dredged material, the majority of which is planned to be reused in this and other projects. The project is expected to produce waste typical of a civil and maritime construction project that will be managed and disposed of appropriately off-site. Accidental production of waste is a risk to be properly managed and, therefore, avoided. Ongoing operation of the facility will produce waste typical of a public terminal. Best practice design will ensure this waste is contained, treated (if necessary) and properly disposed of.

Climate Change Considerations

Due to the proposal's coastal location, it is critical to consider the impact of climate change over the asset's design life. Assets on the northern Australian coastline will experience significant challenges associated with rising sea levels and the intensification of cyclones, leading to increase in storm surge and wave action. Both of these phenomena have been incorporated in the design of the facilities, where appropriate.

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1 Introduction

This Environmental Referral document, prepared on behalf of the Proponent - Department of Infrastructure, Planning and Logistics (DIPL), provides formal notification to the Northern Territory Environment Protection Authority (NT EPA) of the proposed development of marine facilities at Mandorah, located near the eastern tip of the Cox Peninsula within Darwin Harbour (**Figure 1-1**).

1.1 Proposal

The Northern Territory Government (NTG) has identified the need to develop a safer, *Disability Discrimination Act 1992* (Cwth; DDA) compliant and more weather-resistant ferry berthing facility at Mandorah, to improve transport connectivity between Cox Peninsula and Darwin. The proposed facility uses two large breakwaters to form a safe harbour around new ferry berthing and passenger boarding infrastructure. The project is located adjacent the existing Mandorah Jetty, which currently services the transfer of ferry passengers, but does not comply with access requirements for persons with a disability. Key components of the proposed facilities are:

- A safe harbour formed by rock armoured breakwaters – large northern breakwater and smaller southern breakwater;
- Capital dredging of an access channel, turning basin and berthing areas for the ferry, as well as safe navigation of recreational vessels to and from the boat ramp;
- A new single lane boat ramp within the harbour, connecting to the existing carpark at the site;
- A new floating pontoon, gangway, jetty (TBC) and rock armoured causeway inside the harbour to allow passengers to access the ferry from land;
- A ferry terminal building established by repurposing an existing building at the site (Lot 50) and new carpark with a short road connecting it to the existing carpark, as well as pedestrian paths and minor onshore amenities; and
- Minor modification to the existing carpark to incorporate access and manoeuvring for the new boat ramp, as well as allow additional trailer parking.

1.2 Proponent and Project Team

The proponent for the project is DIPL. General details are provided in **Table 1-1**.

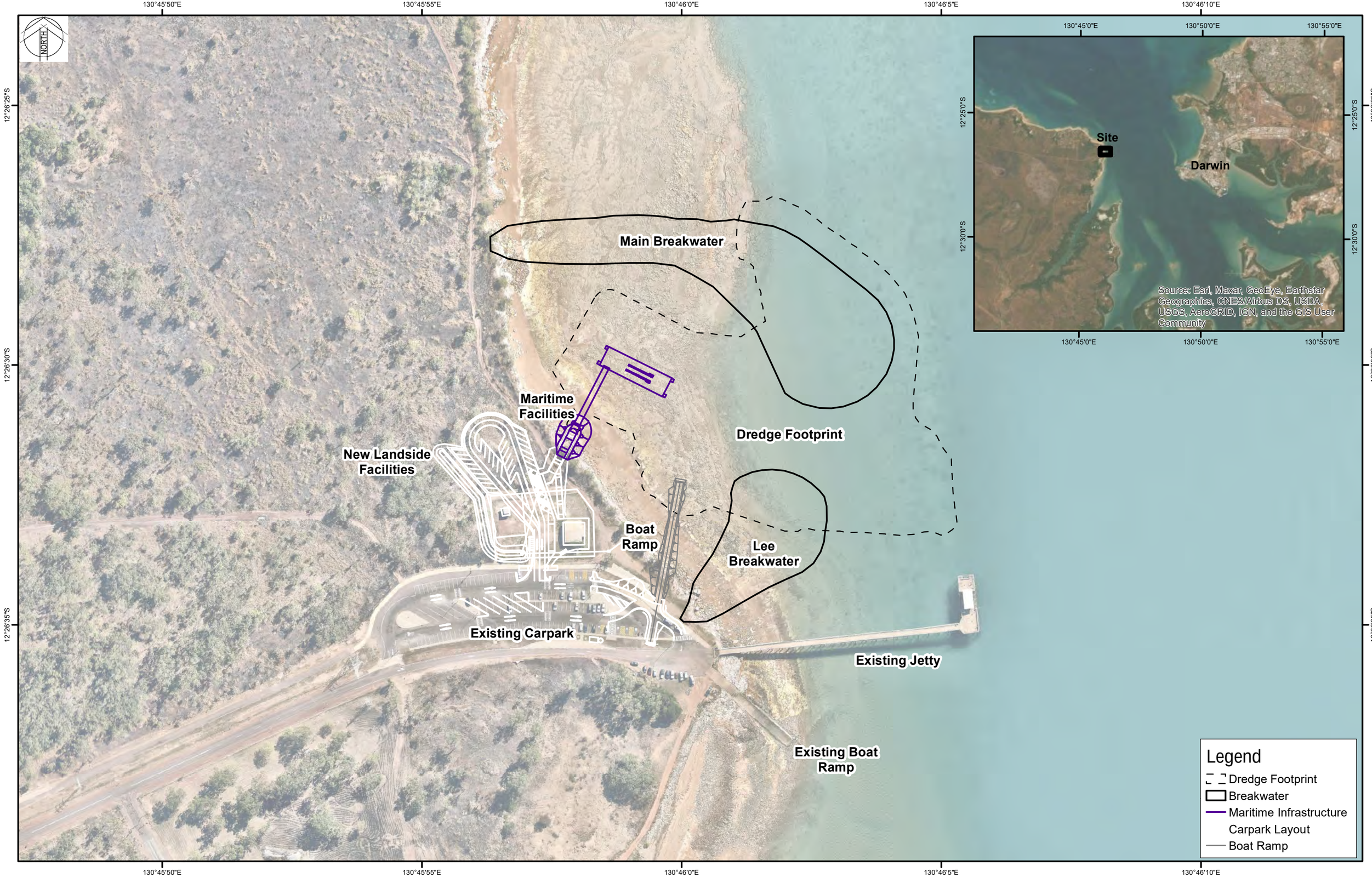
Table 1-1 Proponent details

Proponent Details	
Name	Department of Infrastructure, Planning and Logistics (DIPL)
Address	Unit 1/35 Export Drive, East Arm, NT 0822
Primary Contact	Shane Dahlhelm – 08 8999 3643 / shane.dahlhelm@nt.gov.au

Cardno is the professional services consultant assisting with design and environmental assessment of the project. Cardno's details are provided in **Table 1-2**.

Table 1-2 Consultant details

Consultant Details	
Name	Cardno (NT) Pty Ltd
Address	93 Mitchell Street, Level 6, Darwin, NT 0800
Primary Contact	Daniel Strickland – 08 6461 0703 / daniel.strickland@cardno.com.au



Cardno

Perth, Western Australia

Date
19/11/2021

Size
A3

Scale
0 100 Meters

SITE LOCALITY

MANDORAH MARINE FACILITIES

ENVIRONMENTAL REFERRAL REPORT

FIGURE 1-1

1.3 Background

The existing Mandorah Jetty and boat ramp are key infrastructure facilities servicing the Mandorah, Wagait and Belyuen communities, as well as visitors to the area from Darwin and surrounds. The Jetty facilitates the only ferry service from Darwin to the Cox Peninsula. The boat ramp is located just south of the Jetty, with both facilities sharing a common onshore carpark facility (**Figure 1-1**).

Previous studies (e.g. Jacobs, 2016) identified shortcomings in the design and condition of the existing facilities, such as DDA non-compliance of the Jetty, and investigated various options for relocation of the ferry berthing facility and boat ramp. The recommendations from these studies included building a rock breakwater, new floating pontoon and boat ramp at a location just north of the existing jetty. A further study (Jacobs, 2019) undertook field investigations and marine modelling to determine the optimised location, configuration and size of new rock breakwater, pontoon and boat ramp structures. This study investigated various sizes and configurations of these facilities, with siting of the pontoon based on available water depths for future ferry operations and to limit dredging.

DIPL then tendered a consultancy contract to refine the design and reduce its estimated capital cost, including further optioneering. This consultancy, undertaken by Cardno, has arrived at the present design for the facilities. Tender documentation has been prepared to issue a design and construct (D&C) contract to complete design and undertake construction of the project.

1.3.1 Project Objectives and Functional Requirements

The key project objectives for DIPL include selection and design of a ferry berthing facility that:

- Minimises construction and whole-of-life costs;
- Allows for uninterrupted ferry service operation during construction;
- Provides a safe and enjoyable passenger experience; and
- Addresses existing issues faced by the Mandorah Jetty and boat ramp. This includes the highly exposed nature of the site, DDA compliance, passenger safety issues and siltation of the existing boat ramp.

Specific functional requirements for the Project are summarised below:

- Provision of a more weather-resistant, dual-berthing facility that can safely accommodate the ferry vessel operated by SeaLink between Darwin and Mandorah (including provision for potential future ferry vessel);
- Provide DDA compliant access from the carpark to ferry berthing facility;
- Provision of an improved boat ramp that provides a safer user experience and requires minimal ongoing maintenance; and
- Improvements to land side facilities, including improved traffic flow, allowance for car and trailer parking, and provision of a ferry commuter terminal structure that provides essential facilities and protection against environmental factors.

1.3.2 Project Need

The immediate project need is to ensure that the ferry service for Cox Peninsula is safe and all-inclusive (DDA compliant), which is not currently the case for the existing facility. This has been described as part of the project objectives and functional requirements above.

From a longer-term perspective, the project is considered important to improve connectivity for, and development of, the Cox Peninsula. The Darwin Regional Land Use Plan 2015 (the ‘Land Use Plan’) (NTG, 2015) sets out the vision, goals and intended outcomes of future development within the Darwin Region, including the Cox Peninsula. A key output of the Land Use Plan is the identification of large areas of the Cox Peninsula as “planned urban and peri urban areas”. Existing land use on Cox Peninsula is limited to fishing and recreational activities with the exception of the Aboriginal community at Belyuen and the Wagait community.

The 'Land Use Plan' anticipates long-term development of the northern half of Cox Peninsula for a range of urban purposes, including residential and associated community facilities and services, and commercial and industrial uses. The coast in this area is unique in the region in that it is largely free from mangroves and other coastal wetlands - this is considered to contribute to the potential for environmentally attractive urban areas with high amenity for residents and visitors.

However, any major development on Cox Peninsula is dependent on the provision of improved transport connectivity and essential services infrastructure (such as a reticulated water system). Improved transport infrastructure is required to provide a frequent, reliable connection between the Cox Peninsula and Darwin.

This Project has been developed to provide a more weather-resistant ferry berthing facility that improves transport connectivity between Cox Peninsula and Darwin, and facilitates long-term economic development of this region.

1.4 Purpose and Structure of this Report

The purpose of this report is to summarise the proposed project and its anticipated actual and potential environmental impacts, to inform review by the NT EPA under the *Environment Protection Act 2019* (EP Act). The report has been structured to address the matters stipulated in EPA (2021), and comprises:

- This Section (**1**), providing an introduction of the proposal and proponent, as well as the project background and purpose of this Referral Report;
- A description of the project site, presented in **Section 2**;
- A detailed description of the proposal, presented in **Section 3**;
- A summary of legislative and regulatory context for the proposal, presented in **Section 4**;
- A detailed description of the existing environment, presented in **Section 5**;
- Discussion of project alternatives and alternative sites, presented in **Section 6**;
- A detailed summary of community and stakeholder engagement undertaken as part of the proposed project to date, presented in **Section 7**;
- An assessment of key environmental factors and those with potential to be impacted by the project, presented in **Section 8**;
- An environmental impact assessment of the project, presented in **Section 9**; and
- An Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) 'self-assessment', presented in **Section 10**; and
- Demonstration of the application the *Principles of Environment Protection and Management* (Part 2 of the EP Act) in **Section 11**.

Various investigations and studies have been carried out, and management plans prepared, to inform this referral document. Technical studies have also been undertaken for the overall development and design project to date. The following documents are referenced in, or should be given due consideration when reading, this report:

Directly relevant:

- Chapter Report 1 – *Terrestrial Environment Report* (Cardno, 2022a): Details the terrestrial environment and ecology relevant to the project site, critical to understand risk of the project to these environmental aspects. The report also includes, as its appendix:
  - Asbestos Asset Survey (Cardno, 2021);
- Chapter Report 2 – *Marine Environment Report* (Cardno, 2022b): Details the marine environment and ecology relevant to the project site, critical to understand risk of the project to these environmental aspects.

- Chapter Report 3 – *SAP Implementation Report* (Cardno, 2022c): Details marine sediment quality investigations undertaken to understand any contamination within the dredging and disturbance area and guide proper handling and disposal of dredge material;
- Chapter Report 4 – *Sediment Transport Report* (Cardno, 2022d): Details dredging and disposal plume dispersion, sedimentation and harbour siltation associated with the project, required to inform risk to sensitive marine environmental receptors;
- Chapter Report 5 – *Draft Dredging and Spoil Disposal Management Plan (DSDMP)* (Cardno, 2022e): Defines the proposed dredging actions and necessary controls to avoid or minimise risk for, and impact to, the marine environment; and
- Chapter Report 6 – *Draft Construction Environmental Management Plan (CEMP)* (Cardno, 2022f): Defines likely construction activities and controls required to avoid or minimise environmental impact.

Relevant to the overall project:

- *Design Report* (Cardno, 2022g): Details the design requirements, basis, inputs, calculations and outcomes for the new proposed infrastructure;
- *Geotechnical Investigations Report* (Cardno, 2022h): Details the geotechnical information and investigations for the project site that inform design of the new proposed infrastructure; and
- *Metocean Investigations Report* (Cardno, 2022i): Details the metocean information and investigations for the project site that inform design of the new proposed infrastructure.

2 Site Description

2.1 Location

Mandorah is located on the Cox Peninsula west of Darwin (**Figure 1-1**). Specific site details include:

- Address: 10 – 15 Charles Point Rd, Mandorah NT 0822; and
- Geographic location: 12.4429° S, 130.766° E.

2.2 Existing Land Use

The project site includes the existing Mandorah Jetty (**Figure 2-1** and **2-2**) and Boat Ramp which are key infrastructure facilities servicing the Wagait (461 people) and Belyuen (164 people) communities, as well as visitors to the area from Darwin and surrounds (ABS 2016). Mandorah Jetty was built in the 1960s and supports the only ferry service from Darwin to the Cox Peninsula. Ferry users from Darwin travel to Mandorah and Wagait Beach for the beach, fishing, camping and to visit the Cox Country Club and, up until 2013, the Mandorah Pub. The ferry also provides a link between the residents of the Cox Peninsula and necessary services found in Darwin.

Figure 2-1 Mandorah Jetty looking back towards the existing carpark

The carpark servicing the existing boat ramp (**Figure 2-2**) was upgraded in 2016 and is also within the project site. The boat ramp was installed to provide residents of the Cox peninsula and tourists the ability to launch recreational vessels into Darwin Harbour. However, as described in **Section 1.3**, the ramp has poor useability due to safety and siltation issues. North of the existing carpark is Lot 50, containing a large abandoned building and smaller communications building (**Figure 2-3**). It is understood that the large building was originally built for Radio Australia in the late 1960's / early 1970's. It is intended that the building be repurposed for use as a ferry passenger terminal. Native Title rights have been extinguished on the majority of Lot 50, with approximately the western third of the lot having native title still in place (**Figure 2-4**). Proposed development has been designed to avoid disturbance of this portion of the lot.

The existing operations of the Jetty and Boat Ramp are not anticipated to have led to the degradation/contamination of soils, surface water or groundwater, and there are no previous or current investigations into or activities involving, the remediation of soil, surface water or groundwater contamination on-site. No portion of the site has previously been registered as a contaminated site under the *Waste Management and Pollution Control Act 1998*. Recent assessment of Lot 50, surrounding the abandoned building has indicated that asbestos containing material (ACM) is present. This will require remediation prior to reuse of the site, and is discussed further in **Section 5.5.4**. Marine uses have the potential to add contaminants to marine sediments. This potential contamination has been assessed extensively as part of the project and is discussed further in **Section 5.5.3**.

Figure 2-2 Existing carpark, footpaths and the Mandorah Jetty

Figure 2-3 Existing abandoned building on Lot 50 and adjacent land – predominantly cleared

2.3 Existing Land Tenure and Zoning

The site lies within the Hundred of Bray land parcel, Cox Peninsula. The landside project footprint is within the existing Charles Point Road Reserve, Lot 116 and Lot 50, which are under the ownership of the NT Government. Current zoning is as follows (see **Figure 2-4**):

- Charles Point Road and Existing Carpark – Main Road (M);
- Lot 116 – A portion of Lot 116 has recently been rezoned from Rural (R) to M: from its western, southern and eastern boundaries to a northern boundary that runs east-west, approximately 100 metres north of the northern breakwater's abutment to land. The remainder of Lot 116 is zoned R;
- Lot 50 – Recently rezoned from Rural Living (RL) to M; and
- Lot 44 – Rural Living (RL): Private property adjacent project area.

2.3.1 Native Title

Lot 50 has been investigated by the NT Government to understand the status of Native Title. The investigations have divided the lot into three areas (see **Figure 2-4**):

Area A

According to the plans, the Radio Australia 'Jetty Garage and Store Terminal Building' was built at Cox Peninsula in approximately 1966. Available evidence indicates that native title has been extinguished in relation to the area required for this facility, which would include the internal road and hardstand area depicted in aerial photography from 1994.

Area B

Telstra has confirmed that an Optical Fibre Cable Repeater facility is sited on Section 50 Hundred of Bray. The available information suggests that the building in Area B was constructed by Telstra and not Telecom and therefore cannot be classified as public work. Therefore, the evidence does not suggest that Native Title over this section of the site has been extinguished. The proposed development has been designed to limit the disturbance of this portion of the lot.

Area C

Plans and aerial imagery depict a demountable structure in Area C. This facility has now been removed. There is no evidence of construction by government and therefore cannot be classified as public work. In addition, the fact that the infrastructure has now been removed suggests it was not a fixture. The available evidence does not suggest that native title has been extinguished in Area C. The proposed development has been designed to limit the disturbance of this portion of the lot.

2.3.2 Significant Sites

Several significant Aboriginal heritage sites have been identified in the vicinity of the project, and restricted work areas have been established to prevent disturbance of these areas (**Figure 2-4**). These are captured by the Aboriginal Areas Protection Authority (AAPA) certificate (**Appendix A**) and discussed further in **Section 5.14**.

FILE: K:\Projects\DZ1910_Mandorah Marine Facilities\Design Tech\Sketches\ArcGIS\Build\Figure 4-2_Existing and Proposed Land ZoningREV.mxd

Cardno

Darwin, Northern Territory

Date
21/12/2021

Size
A3

Scale
1:3,000

0 0.05 0.1km

EXISTING LAND ZONING

MANDORAH MARINE FACILITIES

ENVIRONMENTAL REFERRAL REPORT

FIGURE 2-4

3 Proposal Description

3.1 Project Details

3.1.1 Project Features

New marine facilities are required at Mandorah to improve safety for all users and to provide better access for people with disabilities. Existing boarding and disembarking from the ferry is by the stairs with multiple landing arrangement at the head of the Mandorah Jetty. This is considered inadequate due to:

- Exposure of the berthing to adverse ocean conditions, making boarding and disembarking unsafe at times;
- Access only by stairs which is not compliant with the Disability Discrimination Act (1992) and the Disability Standards for Accessible Public Transport (2012);
- Multiple landings meaning the transit from deck to ferry is not compliant with the *Disability Discrimination Act* (1992) and the *Disability Standards for Accessible Public Transport* (2012). I.e. compliance could not be met even with the addition of compliant ramps to the jetty;
- Excessive marine growth and corrosion of the landings and their fixings, creating safety hazards and ongoing maintenance requirements; and
- Concerns expressed by some ferry users about recreational fishing use of the jetty conflicting with the comfort of some passengers boarding and alighting from the ferry.

The existing boat ramp is understood to be rarely used and is considered inadequate due to:

- Exposure to adverse conditions, making launching and retrieving unsafe;
- Excessive sedimentation and erosion leading to various restrictions on use and safety issues; and
- Structural damage and inappropriate ramp angle, making use difficult and unsafe.

To solve these issues associated with existing infrastructure, and enhance the opportunities and user experience associated with upgraded facilities, the NT Government (through DIPL) have undertaken extensive optioneering and design develop to arrive at the present design (**Figure 3-1**). Key components of the proposed project are:

- A safe harbour formed by rock armoured breakwaters – a large northern breakwater and a smaller southern breakwater;
- Capital dredging of an access channel, turning basin and berthing areas for the ferry and recreational vessels, as well as dredging to prepare the breakwater foundations and ensure stability;
- A new single lane boat ramp within the harbour, connecting to the existing carpark at the site;
- A new floating pontoon, gangway, jetty (TBC) and rock armoured causeway inside the harbour to allow passengers to access the ferry from land. These facilities will provide a DDA compliant access solution for people who need mobility assistance and may include a mechanical lift (to be confirmed in the D&C stage);
- A ferry terminal building established by repurposing an existing building at the site (Lot 50) and new carpark with a short road connecting it to the existing carpark, as well as pedestrian paths and minor onshore amenities; and
- Minor modification to the existing carpark to incorporate access and manoeuvring for the new boat ramp, as well as allow additional trailer parking.

A list of key infrastructure components to be added as part of the project development is provided in **Table 3-1**, with associated quantity. It should be noted that at the time of preparation of this referral document, the landside and maritime access facilities are at a preliminary layout stage, while remain marine infrastructure is close to final design.

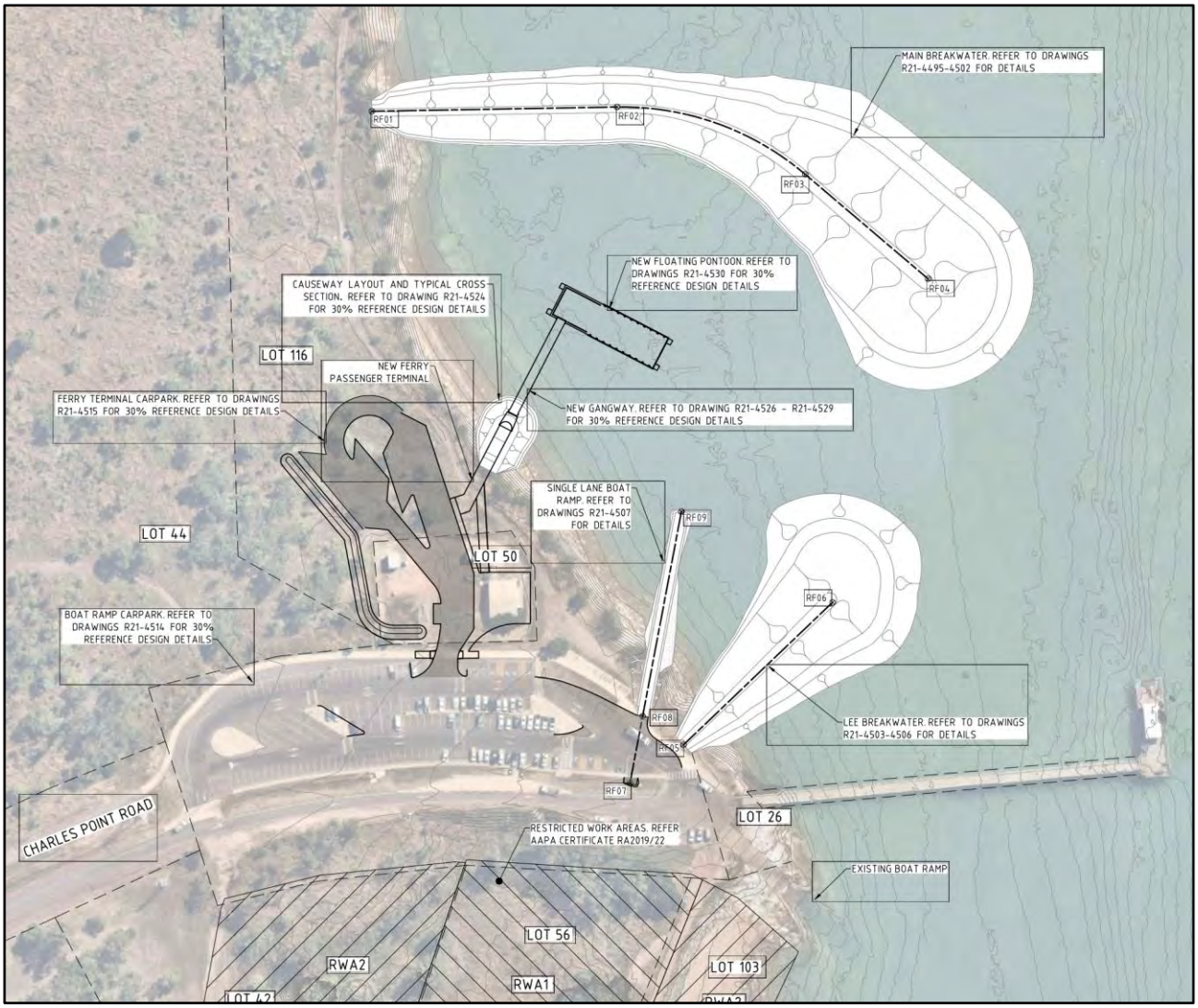


Figure 3-1 Project infrastructure layout (extract from design drawing R21-4488)

Table 3-1 Proposed infrastructure quantities and areas (approximate as some components are Design & Construct)

Project Element	Component	Approximate area / volume/ quantity
Landside (generally above high tide)		
Pavement (additional to existing)	Paths	~600 m^2
	Carparking and Roads	~1945 m^2
Terminal Building	Structure (Existing building repurposed or reconstructed)	~150 m^2
	Rainwater tanks	< 30,000 L
	Toilet block	< 40 m^2
Earthworks	Boat ramp connection	≈ 100 m^3
	Causeway connection	≈ 100 m^3

Stormwater Drainage	Pits	~4
	Pipe network	~115 m
Landscaped areas	Minor native	~150 m^2
Construction disturbance areas	Laydown and transit	~30,000 m^2
Total new terrestrial infrastructure footprint		3,000 m^2
Marine (generally below high tide)		
Main breakwater	Imported rock material	45,000 m^3
	Reused dredge material	19,700 m^3
	Footprint	10,800 m^2
Lee breakwater	Imported rock material	8,500 m^3
	Reused dredge material	8,200 m^3
	Footprint	4,400 m^2
Boat ramp	Concrete pavement	16 m^3
	Imported rock material	170 m^3
	Reused dredge material	760 m^3
	Footprint	650 m^2
Maritime facilities	Pontoon	500 m^2
	Gangway	125 m^2
	Causeway	400 m^2
	Mechanical lift	1
	Piles	Up to 10
Dredging	Unconsolidated sediment	15,000 m^3
	Rock	70,000 m^3 (note volumes to be reused above)
	Dredge footprint (excluding breakwater footprint)	20,200 m^2
Total new marine facilities footprint		37,000 m^2

3.1.2 Project Construction

3.1.2.1 Overview

The project comprises relatively distinct infrastructure items that are expected to be developed in a staged approach, with some stages overlapping or constructed in tandem. The exact construction program will be defined by the contractor. It is anticipated that the project will proceed as follows:

- Dredging;

- Breakwater construction;
- Installation of boat ramp and causeway;
- Installation of maritime infrastructure;
- Installation of landside infrastructure including carpark, roads and paths; and
- Refurbishment of existing building as ferry terminal.

3.1.2.2 Dredging and Disposal

The dredging works shall see a total volume of approximately 85,000 m^3 dredged. Management associated with dredging and disposal actions is covered in the project's Draft DSDMP. Handling of material once brought onshore, is covered in the Draft CEMP. The dredging is planned to occur in two stages, which may occur concurrently if practicable, as follows:

Stage 1

Approximately 15,000 m^3 of unconsolidated marine sediments will be dredged by Cutter Suction Dredge (CSD) and piped offshore approximately 1 kilometre for dispersal in the water column.

Stage 2

Approximately 70,000 m^3 of rock material will be dredged by back-hoe dredger and deposited on land for reuse in the breakwater cores. The construction of the breakwaters will occur concurrently with the dredging to reduce the impacts of onshore stockpiling of material. Any dredge spoil that is not used within the breakwater cores will be utilised within the causeway construction or as general fill. There may be the need to transport minor volumes of unused fill offsite for use in other projects.

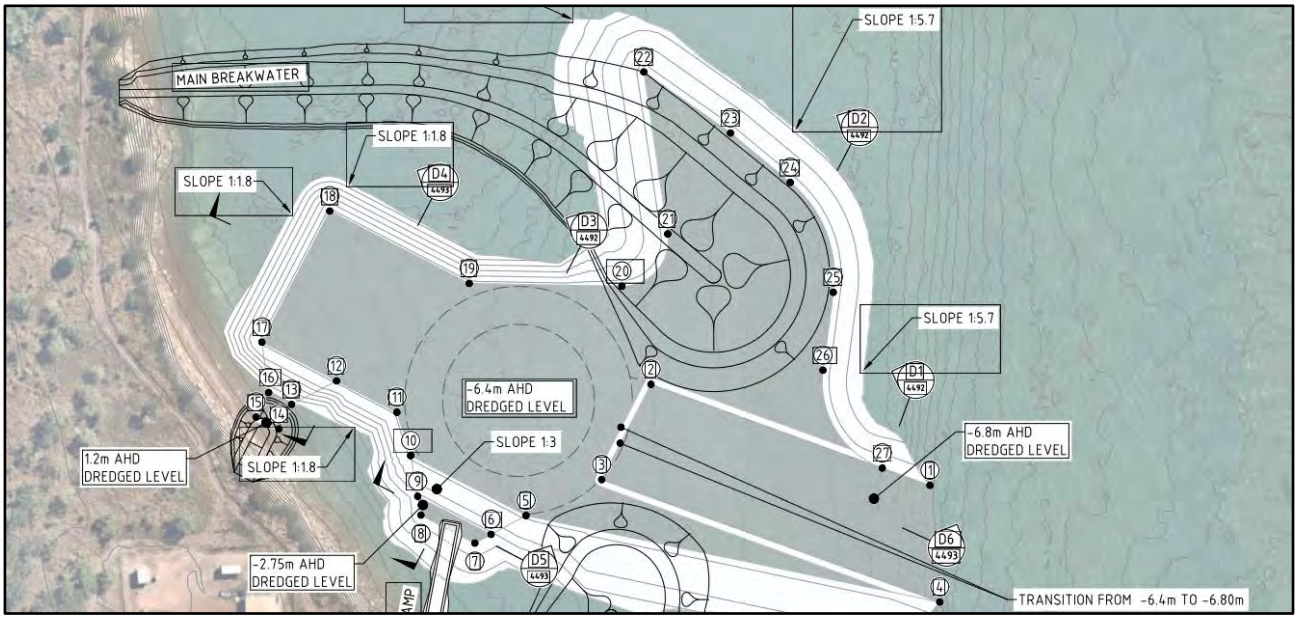


Figure 3-2 Dredge layout (extract from design drawing R21-4491)

3.1.2.3 Breakwater Construction

The breakwaters are expected to be constructed outwards from land, using land-based equipment (see **Figure 3-3**). The core will be placed and then armoured immediately, so that it is retained. Portions of the core may also be placed directly as the material is dredged. A layered construction approach may be employed due to the breakwater height; whereby a portion of the profile is built out to the end of the breakwater, then the crest is installed working back towards the land.

Figure 3-3 Example of staged breakwater construction (Ocean Reef Marina – DevelopmentWA, 2021)

The construction of the breakwaters is expected to involve the following plant:

- Dump trucks/Moxys for transport and dumping of the core material;
- Excavators for levelling and shaping of the crest of the core after it is dumped by the trucks;
- Trucks and wheel loaders for transport and handling of the filter layer and blinding layer;

> Flatbed trucks/road trains for transport of the armour rock from the quarry to the site;

> (Long reach) excavators for:

- Shaping of the (sides of the) core;
- Placement of the filter layer over the core;
- Placement of the armour rock; and
- Placement of the toe construction rock.

The main breakwater is expected to take 3-4 months to construct and the lee breakwater 1-2 months, depending on construction methodology and weather. The main breakwater should be constructed first, followed by the lee breakwater.

3.1.2.4 Boat Ramp and Causeway Construction

The causeway and boat ramp involve similar construction techniques to the breakwaters, though on a smaller scale. They cannot be constructed until the breakwaters are complete, as they have been designed assuming harbour protection. The construction will involve installation of a retained core (by rock armour) then placement of pre-cast concrete panels or cast in-situ concrete for their respective surfaces. The core is to be retained by geotextile and the rock armour is to be grouted.

The infrastructure is expected to take approximately 1-2 months to install.

3.1.2.5 Maritime Facilities Construction

Maritime facility infrastructure is to include a floating pontoon, gangway, piles and potentially a jetty (piled). The maritime infrastructure cannot be constructed until the breakwaters are complete, as they have been designed assuming harbour protection. The facilities will ultimately connect to the causeway described above. It is expected that piles will be installed first (driven or screwed) then infrastructure installed as necessary, e.g.:

> Pontoon installed amongst guide piles;

> Jetty placed on piles (if applicable); and

> Gangway connected between causeway and pontoon.

Piles are likely to be installed from a pilling barge, but some may be installed from landside, depending on contractor preference. The pontoon will be floated and towed into position and the gangway likely installed by crane.

3.1.2.6 Carpark, Roads and Paths

Carparks, roads and paths are expected to be installed once the large construction plant have left site, to avoid degradation of such infrastructure if built earlier (e.g. over transport routes). Earthworks associated with pavement is expected to be minimal, with some cutting required for the boat ramp connection and maritime facilities access ramps, as well as drainage. This may employ an excavator and be carried out alongside internal maritime infrastructure installation – e.g. boat ramp and causeway connection.

Clearing and levelling for the carpark will be minimised but necessary to dictate drainage. A portion of the carpark footprint is already cleared. Earthworks in the vicinity of the existing building may require containment and disposal off-site, due to the presence of Asbestos containing material.

3.1.2.7 Building Refurbishment

The existing building (former Radio Australia) is to be refurbished for use as a ferry terminal. This will involve the removal of cladding and structurally inadequate components and replacement to ensure structural conformance. Installation or reinstatement of facilities such as ablutions is also required. It is expected that the refurbishment will be one of the last project construction activities.

3.1.3 Project Equipment

The plant and equipment likely to be required to construct the project is listed in **Table 3-2**.

Table 3-2 Project equipment details

Construction area	Plant/equipment	Quantity
Marine	Cutter Suction dredger	1
	Back Hoe Dredger (if needed)	1
	Dredge material transfer barges	2
	Tug for barges	1
	Piling barge	1
Onshore	Excavator	1
	Long-reach excavator	1
	Crane	1
	Semi-trailer	2+
	Bulldozer	1
	Dump truck	2
	Flatbed truck	1

3.1.4 Project Operation and Usage

The design life for the facility is 50 years. **Table 3-3** lists construction and operational elements of the overall project.

The facilities are being proposed to improve amenity for existing usage and demand and, therefore in terms of the new facilities as a single factor, are not expected to generate significant increased usage. However, it is hoped that the improved facilities will encourage opportunity for further usage of Cox Peninsula over the decades to come.

Some facilities, such as ablutions and a mechanical access lift (though other disability compliant solutions are being considered), are being introduced which will increase power usage and production of waste by the facilities, in comparison to the operation of existing facilities.

Table 3-3 Key features of the proposal

Project Element	Component	Size / number / quantity / time
Whole of proposal	Project area	≈ 75,000 m^2
	Design life	50 years (breakwaters) 50 years (carpark, accessways) 25-50 years (maritime access infrastructure) 25 years (ferry terminal building) 25 years (boat ramp)

	Workforce (local, no onsite accommodation required)	25-50 people (construction) 1-2 people (operation)
Marine facilities	Ferry access infrastructure usage	≈ 13 trips per day ≈ 4750 trips per year ≈ 20 persons per trip
	Boat ramp usage	≈ 25 launches per week
Onshore facilities	Parking bays (additional to existing)	3 (car) 6 (disabled) 1 (bus bay) 6 (motorcycle) 5 (bicycle) 1 (rigging bays)
	Ferry terminal	50-person capacity Ablutions with rainwater tank
Access roads	Arnhem Hwy Cox Peninsula Road Stuart Highway	≈ 5 semi-trailer round trips per day (construction only)
Service and utilities	Electricity	TBC during detailed design (MWh/year)
	Water	TBC during detailed design (ML/year)
	Sewerage discharge	TBC during detailed design (m^3 /year)
Dredged material management	Dredged volume	≈ 85,000 m^3
	Reused in breakwater cores	> 35,000 m^3
	Disposed offshore	≈ 15,000 m^3
	Reused in other areas and projects (e.g.: causeway, boat ramp, general fill)	Remainder

4 Legislative and Regulatory Context

4.1 Relevant Legislation and Other Obligations

The NT *Environment Protection Act 2019* (EP Act) aims to protect the environment through sustainable development and manage significant disturbances through an environmental approval process. Under the act, the NT EPA regulates the environment impact assessment process to identify potential environmental impacts of development proposals. This initial step is undertaken through a referral in which the NT EPA determines if further assessment is required (i.e. the tier of assessment). The first tier of assessment would involve the NT EPA assessing the Project based on the referral information; whereas, a determination for further assessment would require the submission of either a supplementary environmental report (SER), Environmental Impact Statement (EIS) or assessment by inquiry.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage sites, referred to as Matters of National Environmental Significance. Developments likely to have significant impact on these matters require referral under provisions of the Department of Environment and Energy's *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (2013) under the provisions of the EPBC Act.

Territory and Commonwealth legislation applicable to the project and this referral is summarised in **Table 4-1** and **Table 4-2**, respectively.

Table 4-1 Relevant Territory Legislation

Document	Purpose / Objectives	Agency
Environment Protection Act 2019 (EP Act)	> Protect the environment of the Territory; > Promote ecologically sustainable development so that the wellbeing of the people of the Territory is maintained or improved without adverse impact on the environment of the Territory; > Recognise the role of environmental impact assessment and environmental approval in promoting the protection and management of the environment of the Territory; > Provide for broad community involvement during the process of environmental impact assessment and environmental approval; > Recognise the role that Aboriginal people have as stewards of their country as conferred under their traditions and recognised in law, and the importance of participation by Aboriginal people and communities in environmental decision-making processes.	Department of Environment, Parks and Water Security
Environment Protection Regulations 2020 (EP Regulations)	Support and guide the implementation of the EP Act.	Department of Environment, Parks and Water Security
Northern Territory Environment Protection Authority Act 2012 (NT EPA Act)	> Promote ecologically sustainable development; > Protect the environment, having regard to the need to enable ecologically sustainable development; > Promote effective waste management and waste minimisation strategies; and > Enhance community and business confidence in the environmental protection regime of the Territory.	Department of Environment, Parks and Water Security

Document	Purpose / Objectives	Agency
Waste Management and Pollution Control Act 1998	> Protect, and where practicable to restore and enhance the quality of, the Territory environment by: - Preventing pollution; - Reducing the likelihood of pollution occurring; - Effectively responding to pollution; - Avoiding and reducing the generation of waste; - Increasing the re-use and re-cycling of waste; and - Effectively managing waste disposal; > Encourage ecologically sustainable development; and > To facilitate the implementation of national environment protection measures made under the National Environment Protection Council (Northern Territory) Act 1994 (described below).	Department of Environment, Parks and Water Security
Waste Management and Pollution Control (Administration) Regulations 1998	Details regulations to administer the *Waste Management and Pollution Control Act 1998.*	Department of Environment, Parks and Water Security
Marine Pollution Act 1999	The overall purpose of this Act is to protect the Territory's marine and coastal environment by minimising intentional and negligent discharges of ship-sourced pollutants into coastal waters. This purpose is to be achieved primarily by giving effect to relevant provisions of the following annexes of MARPOL: > Annex I (which deals with pollution by oil); > Annex II (which deals with pollution by noxious liquid substances in bulk); > Annex III (which deals with pollution by harmful substances in packaged form); > Annex V (which deals with pollution by garbage). The purpose is also to be achieved by: > Providing an approach to protecting the Territory's marine and coastal environment from ship-sourced pollutants complementary to the approach of the Commonwealth and the States of the Commonwealth; > Making provision about the discharge of sewage from ships; > Enabling shipping casualties that are polluting, or threatening to pollute, coastal waters, to be dealt with; and > Imposing severe penalties on persons who pollute the Territory's marine and coastal environment in contravention of this Act.	Department of Environment, Parks and Water Security
Marine Pollution Regulations 2003	Details regulations under the *Marine Pollution Act 1999.*	Department of Environment, Parks and Water Security
National Environment Protection Council (Northern Territory) Act 1994	The object of this Act is to ensure that, by means of the establishment and operation of the National Environment Protection Council:	Department of Environment, Parks and Water Security

Document	Purpose / Objectives	Agency
	> People enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia; and > Decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures.	
Territory Parks and Wildlife Conservation Act 1976	> Provides for the protection, conservation and sustainable utilisation of wildlife; and > Provides protection of listed threatened species for which proponents must consider direct and indirect impacts on a listed threatened species or place covered under this Act.	Department of Environment, Parks and Water Security
Territory Parks and Wildlife Regulations 2001	Details regulations under the *Territory Parks and Wildlife Conservation Act 1976.*	Department of Environment, Parks and Water Security
Water Act 1992	> Provides for the investigation, allocation, use, control, protection, management and administration of water resources, including extraction of groundwater, waste water management and water pollution; and > Provides for water allocation plans, drilling licences, bore construction permits, water extraction licences, waste discharge licences, fees and charges, and penalties for offences against the Act.	Department of Environment, Parks and Water Security
Water Regulations 1992	Details regulations under the *Water Act 1992.*	Department of Environment, Parks and Water Security
Ports Management Act 2015	To provide for the control, management and operation of ports, and for related purposes.	Department of Infrastructure, Planning and Logistics
Ports Management Regulations 2015	Details regulations under the *Ports Management Regulations 2015.*	Department of Infrastructure, Planning and Logistics
Weeds Management Act 2001	The purpose of this Act is: > To prevent the spread of weeds in, into and out of the Territory and to ensure that the management of weeds is an integral component of land management in accordance with the Northern Territory Weeds Management Strategy 1996 – 2005 or any other strategy adopted to control weeds in the Territory; > To ensure there is community consultation in the creation of weed management plans; and To ensure that there is community responsibility in implementing weed management plans.	Department of Environment, Parks and Water Security
Weeds Management Regulations 2006	Details regulations under the *Weeds Management Act 2001.*	Department of Environment, Parks and Water Security
Heritage Act 2011	The object of this Act is to provide for the conservation of the Territory's cultural and natural heritage.	Department of Territory Families,

Document	Purpose / Objectives	Agency
	The object is achieved by: > Declaring places and objects of heritage significance to be heritage places and objects; > Declaring classes of places and objects of heritage significance to be protected classes of heritage places and objects; > Establishing the Heritage Council; > Providing for heritage agreements to encourage the conservation, use and management of heritage places and objects; > Regulating work on heritage places and objects; and > Establishing enforcement and offence provisions.	Housing and Communities
Heritage Regulations 2012	Details regulations under the *Heritage Act 2011.*	Department of Territory Families, Housing and Communities
Northern Territory Aboriginal Sacred Sites Act 1989	Facilitates the protection and registration of sacred sites, through: > Providing entry onto sacred sites and the conditions to which such entry is subject; > Procedures for avoidance of sacred sites when developing and using land; > Establishing an Authority for the purposes of the Act; and > Procedures for the review of decisions of the Authority by the Minister.	Aboriginal Areas Protection Authority
Northern Territory Aboriginal Sacred Sites Regulations 2004	Details regulations under the *Northern Territory Aboriginal Sacred Sites Act 1989.*	Aboriginal Areas Protection Authority
Planning Act 1999	The purpose of this Act is to establish a system to facilitate planning for the orderly use and development of land to achieve the following objectives: > To ensure that strategic planning is applied to planning schemes and implemented in individual planning decisions; > To ensure that strategic planning reflects the wishes and needs of the community; > To ensure that appropriate public consultation and input are included in the formulation of planning schemes and the making of decisions under planning schemes; > To ensure that the planning system is clear, comprehensive, effective, efficient and accessible to the community; > To promote the sustainable development of land; > To promote the responsible use of land and water resources to limit the adverse effects of development on ecological processes; > To maintain the health of the natural environment and ecological processes; > To protect the quality of life of future generations;	Department of Infrastructure, Planning and Logistics

Document	Purpose / Objectives	Agency
	> To assist the provision of public utilities, infrastructure and facilities for the benefit of the community; > To promote the good design of buildings and other works that respects the amenity of the locality; > To assist the conservation and enhancement of places, areas, buildings, other works and landforms that are of cultural, aesthetic, architectural or historical value; > To respect and encourage fair and open decision making and public access to processes for review of planning related decisions.	
Planning Regulations 2000	Details regulations under the *Planning Act 1999.*	Department of Infrastructure, Planning and Logistics

Table 4-2 Relevant Commonwealth Legislation

Document	Purpose / Objectives	Agency
Environment Protection and Biodiversity Conservation Act 1999	> Provides for the protection of the environment and conservation of biodiversity, particularly species and places of national significance. > Invoked only if a development is likely to have environmental impacts of national significance	Australian Government Department of Agriculture, Water and the Environment
Environment Protection (Sea Dumping) Act 1981	> Regulates the loading and dumping of waste at sea and the placement of artificial reefs within Australian Waters. Australian Waters stretch from the low water mark of the Australian shoreline out to 200 nautical miles, but does not include waters within the limits of a state or territory. > The Act, therefore, does not need to be adhered to when disposing of dredge spoil within Darwin Harbour limits. However, the same assessment process and methods should generally be applied.	Australian Government Department of Agriculture, Water and the Environment
National Environment Protection Measures (Implementation) Act 1998	The objects of this Act are: > To make provision for the implementation of national environment protection measures in respect of certain activities carried on by or on behalf of the Commonwealth and Commonwealth authorities; and > To protect, restore and enhance the quality of the environment in Australia, having regard to the need to maintain ecologically sustainable development; and To ensure that the community has access to relevant and meaningful information about pollution.	Australian Government Department of Agriculture, Water and the Environment
National Environment Protection Measures (Implementation) Regulations 1999	Details regulations under the National Environment Protection Measures (Implementation) Act 1998.	Australian Government Department of Agriculture, Water and the Environment
National Environment Protection (Assessment of Site Contamination) Measure 1999	The purpose of the Measure is to establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, land owners, developers and industry.	Australian Government Department of Agriculture, Water and the Environment

	The desired environmental outcome for this Measure is to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination.	
Aboriginal Land Rights (Northern Territory) Act 1976	The main purpose of the Act is to reinstate ownership of traditional Aboriginal land in the Northern Territory to Aboriginal people. It provides for the grant of inalienable freehold title for Aboriginal land, meaning that the land cannot be bought or otherwise acquired, including by any NT law.	Commonwealth Attorney General, Prime Minister and Cabinet
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	Provides for the preservation and protection of places, areas and objects from injury or desecration of particular significance to Aboriginal people in accordance with Aboriginal tradition.	Commonwealth Attorney General Agriculture, Water and the Environment

4.2 Policies and Guidelines

In addition to standards of information / data pertaining to the environmental values there are a number of relevant documents that guide the information requirements for environmental assessment of projects in the Northern Territory. Key guidelines are presented in **Table 4-3**.

Table 4-3 Relevant guidelines

Document	Purpose / Objectives	Providing Agency
Referring a proposal to the NT EPA: Environmental impact assessment - Guidance for proponents (2021)	This document provides guidance to proponents about: > When a proponent should submit a referral to the NT EPA for consideration; > The matters that must be addressed in the referral (form and report) to allow decision making by the NT EPA and Minister for Environment (Minister); > A suggested structure for the referral report that is clear, and a standard of information that is of high quality so that the proposal and its potential significant environmental impacts (direct, indirect and cumulative) are clearly and sufficiently understood by the reader; > Where to submit the referral documents; > The environmental impact assessment process for a referral, including opportunities for public comment, decision points and timeframes; and > How a referral is assessed by the NT EPA, including guidance on how a referral will be considered, and the resulting decision by the NT EPA.	Department of Environment, Parks and Water Security
NT EPA Environmental factors and objectives: Environmental impact assessment – General technical guidance (2021)	The NT EPA must consider the action within the context of the environment in which the action is proposed and how the action is likely to impact land, sea, air, freshwater systems, and people. The EP Act provides for the Minister to declare environmental objectives to identify environmental matters that have value to the Territory and that need to be protected; and to state the objective to be achieved for each matter. At present, there are no environmental objectives declared by the Minister. The NT EPA has prepared these environmental objectives and organised these in structured divisions of the environment, called environmental factors, for the purpose of environmental impact assessment under the EP Act. If environmental	Department of Environment, Parks and Water Security

	objectives are declared by the Minister in the future, they would replace the NT EPA's environmental objectives. The purpose of this guidance is to introduce the NT EPA's environmental factors and objectives and to describe their use in organising and systemising information about the environment to enable effective environmental impact assessment and reporting, while taking a holistic view of the environment.	
Stakeholder Engagement and Consultation: Environmental impact assessment - Guidance for proponents (2021)	This document provides guidance to proponents on the NT EPA's expectations for how effective stakeholder engagement is to be conducted and demonstrated, for proposals subject to assessment under the EP Act. It is expected that all engagement with stakeholders will comply with this guidance and will inform decision making under the EP Act. The effective application of this guidance will assist proponents in addressing: > The objects of the EP Act, in particular sections 3(d) and 3(e) > The proponents' general duties under the EP Act (sections 42 and 43) > The statutory requirements relating to the purpose of environmental impact assessment > Long-term stakeholder engagement related to the proposal > The standard of information required in a referral to increase the NT EPA's confidence in the prediction of potentially significant impacts of an action.	Department of Environment, Parks and Water Security
Guideline for the Preparation of an Environmental Management Plan (2018)	Details the environmental protection measures to be included in Environmental Management Plans.	Department of Environment, Parks and Water Security
Guidelines for The Environmental Assessment of Marine Dredging in the Northern Territory (2013)	> Provides information for those planning to dredge in the marine and estuarine waters of the Northern Territory; > Explains issues for proponents to consider when submitting their proposals for environmental assessment, for the acquisition of the necessary statutory instruments and the development of appropriate Environmental Management Plans for their projects.	Northern Territory Environment Protection Authority
Guidelines for Assessment of Impacts on Terrestrial Biodiversity (2013)	These guidelines are provided so that proponents of development: > Have a clear understanding of what is required when they undertake an assessment of a project's impacts on biodiversity as required for a Public Environmental Report or an Environmental Impact Statement; > Are able to focus their biodiversity assessments on significant impacts potentially caused by their projects, rather than an unfocused broad scale biodiversity survey of an area; and > Develop information sufficient to allow planning for mitigation of potential impacts and future rehabilitation of the development site.	Northern Territory Environment Protection Authority
Guidelines on Waste Discharge Licensing Under the Water Act (2013)	Details specific requirements and assessment procedures that form the administration process of waste discharge licensing	Northern Territory Environment Protection Authority

ISO 31000 Risk management- Principles and guidelines	> This international standard provides a standardised to identify, assess and manage risk; > Assessment of risk in EMP's shall be undertaken in alignment with this guideline.	International Organization for Standardization
Northern Territory Land Clearing Guidelines 2019	Clearing and land disturbance associated with developments must be carried out in accordance with Land Clearing Guidelines.	Department of Environment and Natural Resources
Northern Territory Noise Management Framework Guideline 2018	Establishes regulatory framework and community reference for industry noise management.	Northern Territory Environment Protection Authority

4.3 Other Obligations

Statutory approvals relevant to the Project include:

> DIPL (Harbourmaster / Marine Safety Branch) and Darwin Port consent for dredging and installation of structures, as per the *Ports Management Act 2015* (NT);

> NT EPA consent for dredging operations;

> Aboriginal Areas Protection Authority (AAPA) certificate – *Northern Territory Aboriginal Sacred Sites Act 1989* (NT) (**Appendix A**);

> Waste Discharge Licence – *Water Act 1982* (NT); and

> Access Agreement – Negotiated access agreement formed between DIPL, neighbouring land title holders and the Northern Land Council.

5 Existing Environment

5.1 Precipitation and Temperature

Darwin has a tropical climate with distinct wet and dry seasons and a similar average maximum temperature throughout the year. The driest period of the year, with an average of approximately 5 mm of monthly rainfall on average, is between May and September. In the coolest months of June and July, the daily minimum temperature may dip to as low as 14 °C. The extreme temperature range at Darwin airport station is between 10.4 °C and 38.9 °C. Mean annual maximum and minimum temperature at the Darwin Airport station are 32.1 °C and 23.2 °C, respectively. The average temperature of the sea ranges from 25.8 °C in July to 31.5 °C in December.

The wet season is associated with tropical cyclones and monsoon rains. The majority of rainfall occurs between December and March (the southern hemisphere summer), when thunderstorms are common and afternoon relative humidity averages over 70 percent during the wettest months. The dry season runs from about May to September, during which nearly every day is sunny, and afternoon relative humidity averages around 30%.

Variation of the mean maximum, minimum, 9am and 3pm temperature at different months of the year as per temperature data recorded at Darwin airport station is presented in **Figure 5-1**. **Figure 5-2** also shows the monthly variation of mean 9am and 3pm relative humidity at this station. In addition, monthly variation of mean rainfall and mean number of the days of rain ≥ 1mm is provided in **Figure 5-3**.

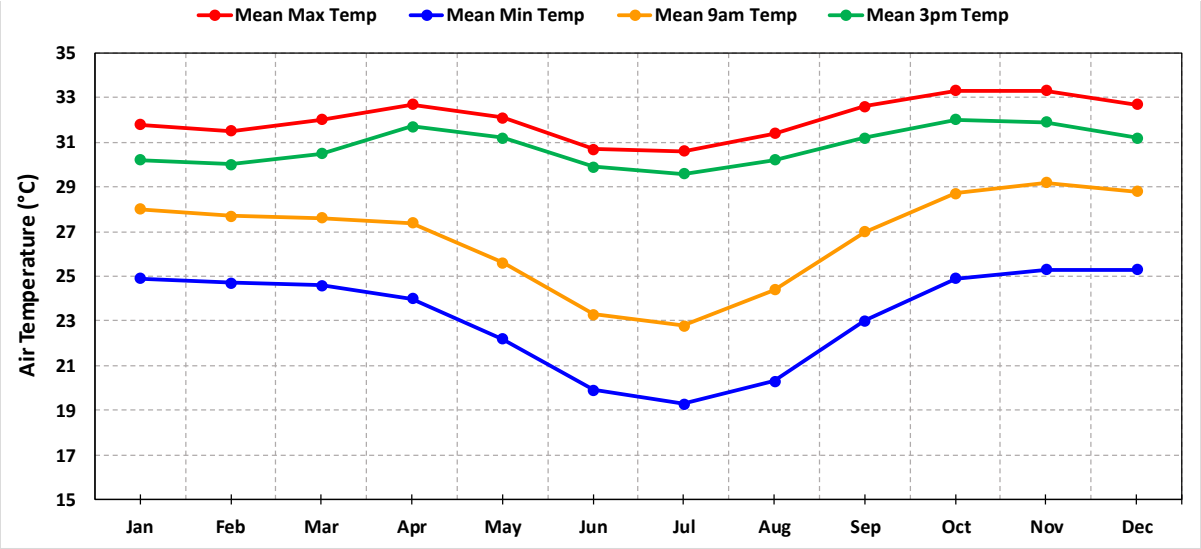


Figure 5-1 Monthly variation of the mean maximum, minimum, 9am and 3pm temperature based on Darwin airport data

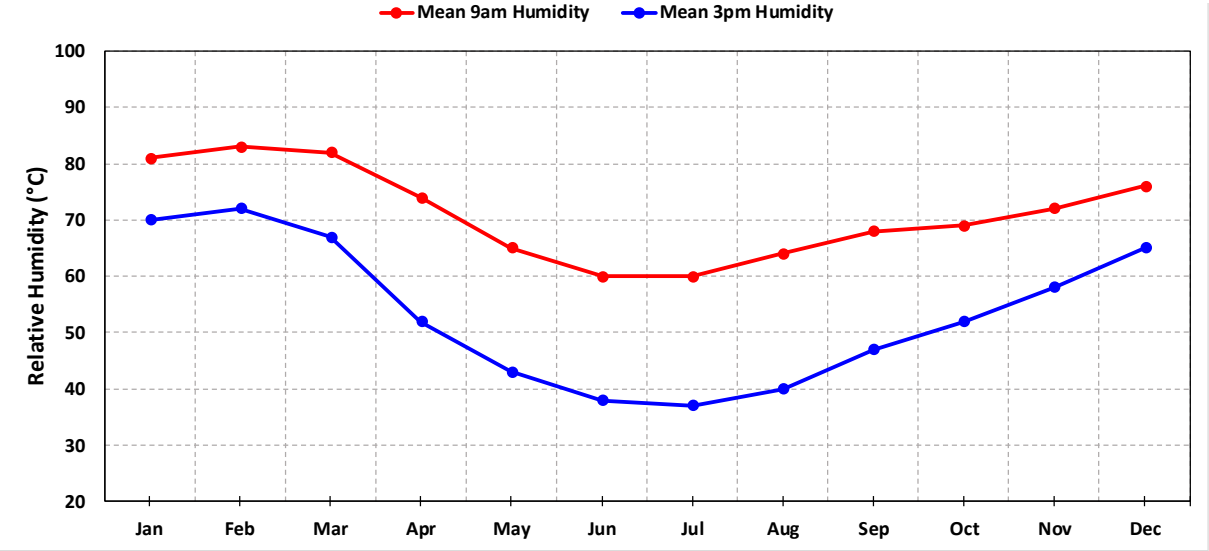


Figure 5-2 Monthly variation of the mean 9am and 3pm relative humidity based on Darwin airport data

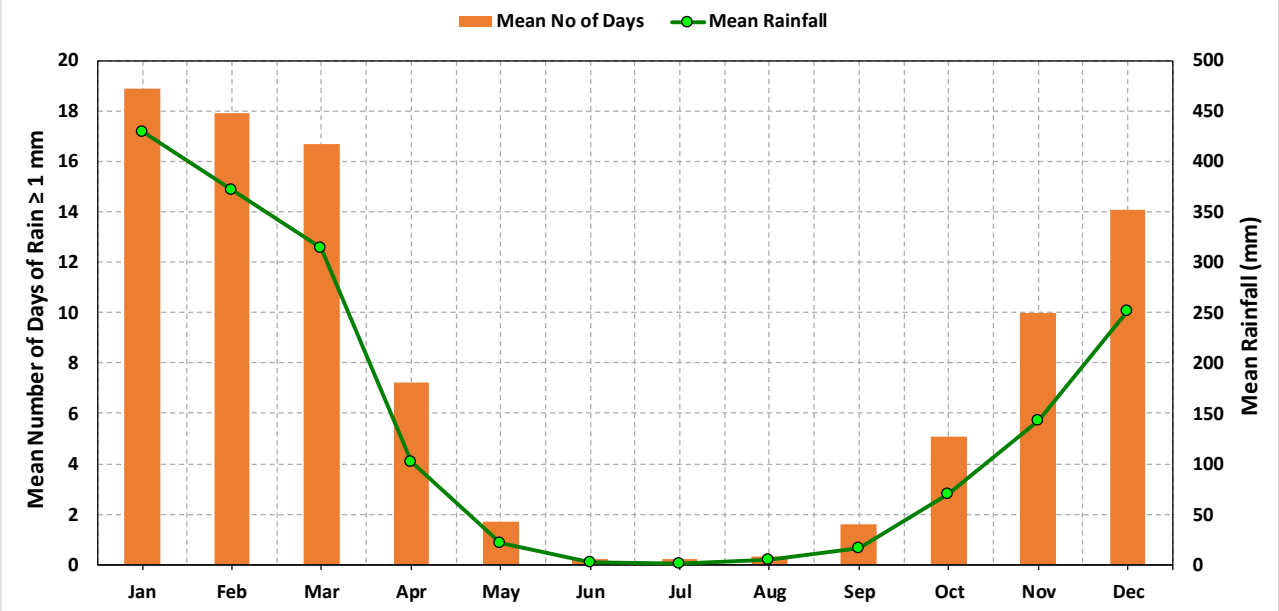


Figure 5-3 Monthly variation of mean rainfall and mean number of days of rain ≥ 1mm based on Darwin airport data

5.2 Wind Climate

Darwin Airport wind data (BoM, 2020) was analysed for the project in terms of wind speed (10-minute average) and directions for annual, seasonal and monthly distributions. The annual and seasonal distributions of the joint occurrence of wind speed and direction are presented in **Figure 5-4** and **Figure 5-5**, respectively. These winds have been converted to a 10 minute, 10m wind speed over water.

The average wind speed is relatively constant throughout the year, ranging from 6.7 m/s in April to 7.7 m/s in January and February. The average annual wind speed is 7.2 m/s. The maximum wind speeds during the wet season (1st of November to 30th of April) are generally higher than those during the dry season (1st of May to 31st of October). This is to be expected due to the cyclonic activity and tropical lows that occur during the wet season.

The wind direction also varies throughout the year, displaying a seasonal variation. The winds are predominantly from the west to north (270-360 °N) from the start of September to the end of February (spring and summer) and predominantly from the east to the south east (90-135 °N) from the start of March to the end of August (Autumn and Winter). The months of March, August and September show the transition from the

easterly winds to the westerly winds. This variation in winds is consistent with the formation of the Indo – Australian monsoon.

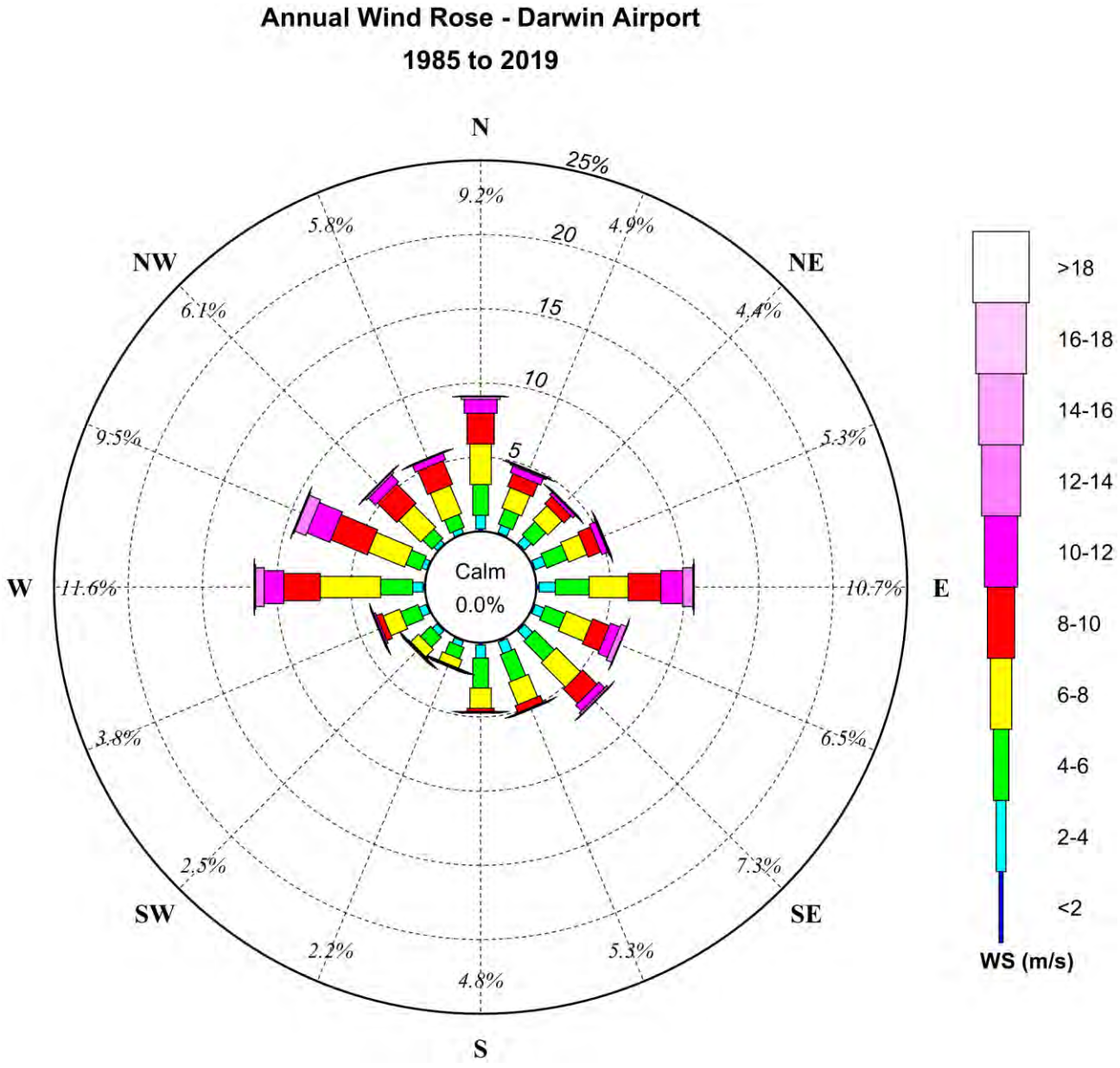


Figure 5-4 Annual wind rose based on Darwin airport wind data (1985 to 2020)

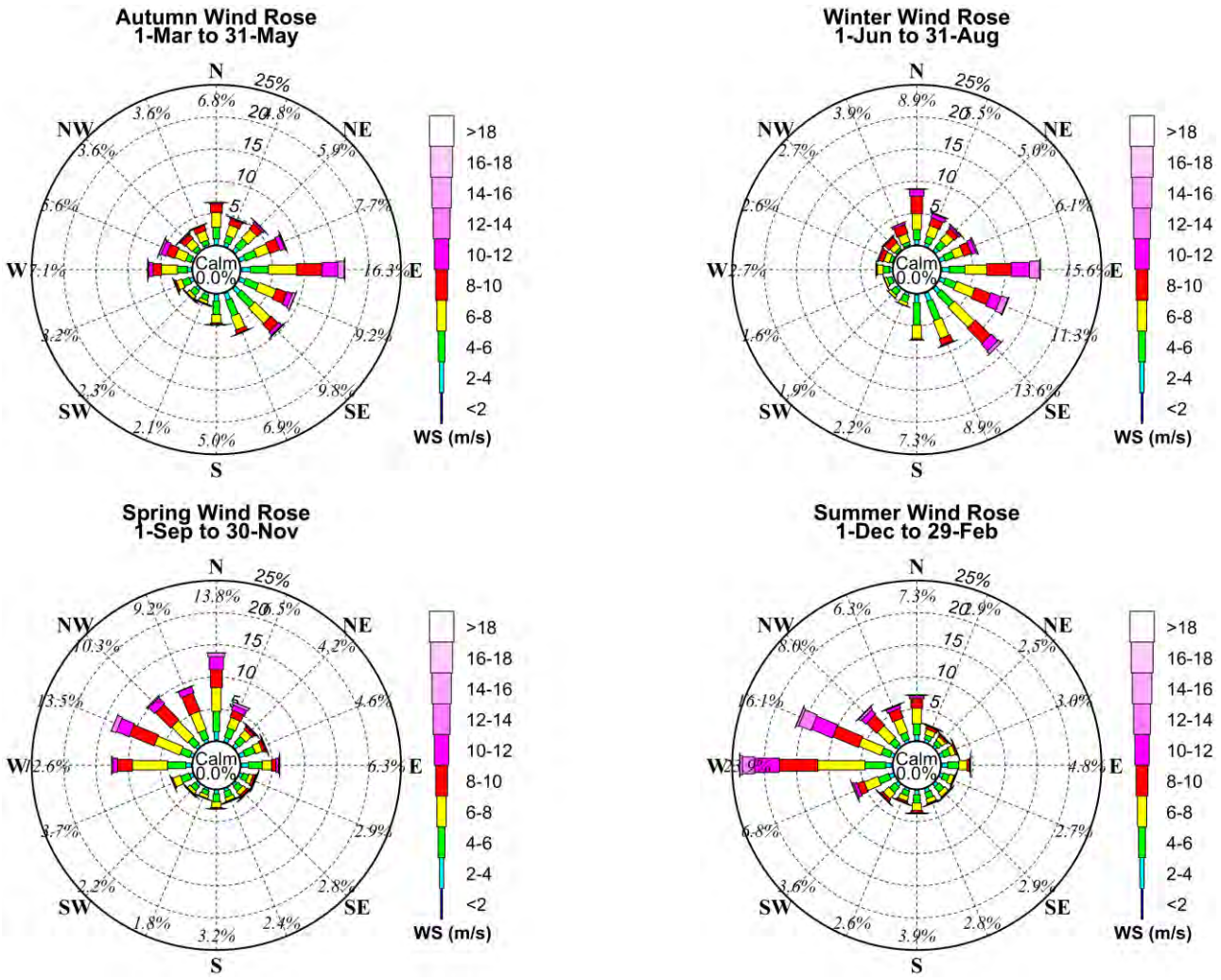


Figure 5-5 Seasonal wind roses based on Darwin airport wind data (1985 to 2019)

5.3 Metocean Climate

5.3.1 Water Levels

5.3.1.1 Tides

Coastal water levels in the study area are dominated by the astronomical tide. Tides in Darwin Harbour are semi-diurnal, which means the location experiences two high tides and two low tides per day. Tidal planes for Darwin Harbour (National Tides Centre, pers. comm 2020) are presented in **Table 5-1**, relative to Australian Height Datum (AHD) and Chart Datum (CD).

Table 5-1 Tide planes for Darwin Harbour (National Tides Centre, 2020)

Tidal Plane	Level (m, CD)	Level (m AHD)
Highest Astronomical Tide (HAT)	8.17	4.07
Mean High Water Springs (MHWS)	7.05	2.94
Mean High Water Neaps (MHWN)	5.13	1.02
Mean Sea Level (MSL)	4.24	0.13
Australian Height Datum (AHD)	4.10	0.00

Mean Low Water Neaps (MLWN)	3.34	-0.76
Mean Low Water Springs (MLWS)	1.42	-2.68
Lowest Astronomical Tide (LAT)	-0.01	-4.11

5.3.1.2 Climate Change

It is generally accepted that climate change will impact coastal areas in the future. The predominant mechanisms are:

- Sea level rise; and
- Cyclone intensification.

According to the Intergovernmental Panel on Climate Changes (IPCC) fifth assessment report (AR5) released in 2013, the thermal expansion of the oceans and glacial melting have been the dominant contributors to 20th century global mean sea level rise. AR5 makes projections for global mean sea level rise during the 21st century. Projections are made for a number of different global greenhouse gas emissions scenarios, known as Representative Concentration Pathways (RCP's). AR5 states that "*It is very likely that the rate of global mean sea level rise during the 21st century will exceed the rate observed during 1971–2010 for all Representative Concentration Pathway (RCP) scenarios due to increases in ocean warming and loss of mass from glaciers and ice sheets*". The AR5's Global Mean Sea Level Rise (GMSLR) projections are provided in **Table 5-2**.

The Queensland Coastal Hazard Technical Guideline Determining Coastal Hazard Areas (DEHP, 2013) states that the implications of projected sea level rise for Queensland's coast include a progressive worsening of the apparent severity and frequency of storm tide inundation that will cause inundation to occur further inland. The Queensland Department of Environment and Heritage Protection presently adopts a Mean Sea Level Rise (MSLR) projection of 0.8 m above present day levels by 2100. This is in line with the AR5 (IPCC, 2013) RCP8.5 emission scenario.

Based on the current research and sea level rise horizons adopted within Australia, it is recommended to include an allowance of 0.3m in 2050 and 0.8m in 2100. This translates to an allowance of 0.43m at 2075 – aligning to the 50-year design life for the facility. Furthermore, an additional allowance should be included to allow for any future intensification of cyclones. An additional allowance of 0.3m in 2050 and 0.5m in 2100 is recommended for future intensification of cyclones.

Table 5-2 Global mean sea level rise projections in AR5 (IPCC, 2013)

Scenario Name	Global Annual Greenhouse Gas Emissions Scenario	MSLR Mean Over 2046-2065 Mean and likely (>66% probability) range (m)	MSLR Mean Over 2081-2100 Mean and likely (>66% probability) range (m)	MSLR In 2100 Mean and likely (>66% probability) range (m)
RCP2.6	Emissions peak between 2010 and 2020, and decline substantially thereafter.	0.24 (0.17 to 0.32)	0.40 (0.26 to 0.55)	0.44 (0.28 to 0.61)
RCP4.5	Emissions peak around 2040, then decline.	0.26 (0.19 to 0.33)	0.47 (0.32 to 0.63)	0.53 (0.36 to 0.71)
RCP6.0	Emissions peak around 2080, then decline.	0.25 (0.18 to 0.32)	0.48 (0.33 to 0.63)	0.55 (0.38 to 0.73)
RCP8.5	Emissions continue to rise throughout the 21st century.	0.30 (0.22 to 0.38)	0.63 (0.45 to 0.82)	0.74 (0.52 to 0.98)

5.3.2 Waves

Wave conditions at Mandorah are governed by two simultaneously occurring sets of wave conditions:

- Longer period oceanic swell waves from the Beagle Gulf that penetrate into the Darwin Harbour (Mandorah project area); and
- Shorter period local wind waves generated locally by winds blowing across Darwin Harbour.

An annual wave rose for Mandorah is provided in **Figure 5-6**. The following general observations are made:

- Swell waves typically approach the site from the north to north east, however wind sea waves approach the site from different directions, ranging from north-north-west to south-east.
- The seasonal distribution of swell waves is almost the same throughout year, but the wind sea waves typically approach the site from the north-north-east to south east during autumn and winter, and from the north-north-west to north-north-east during spring and summer.

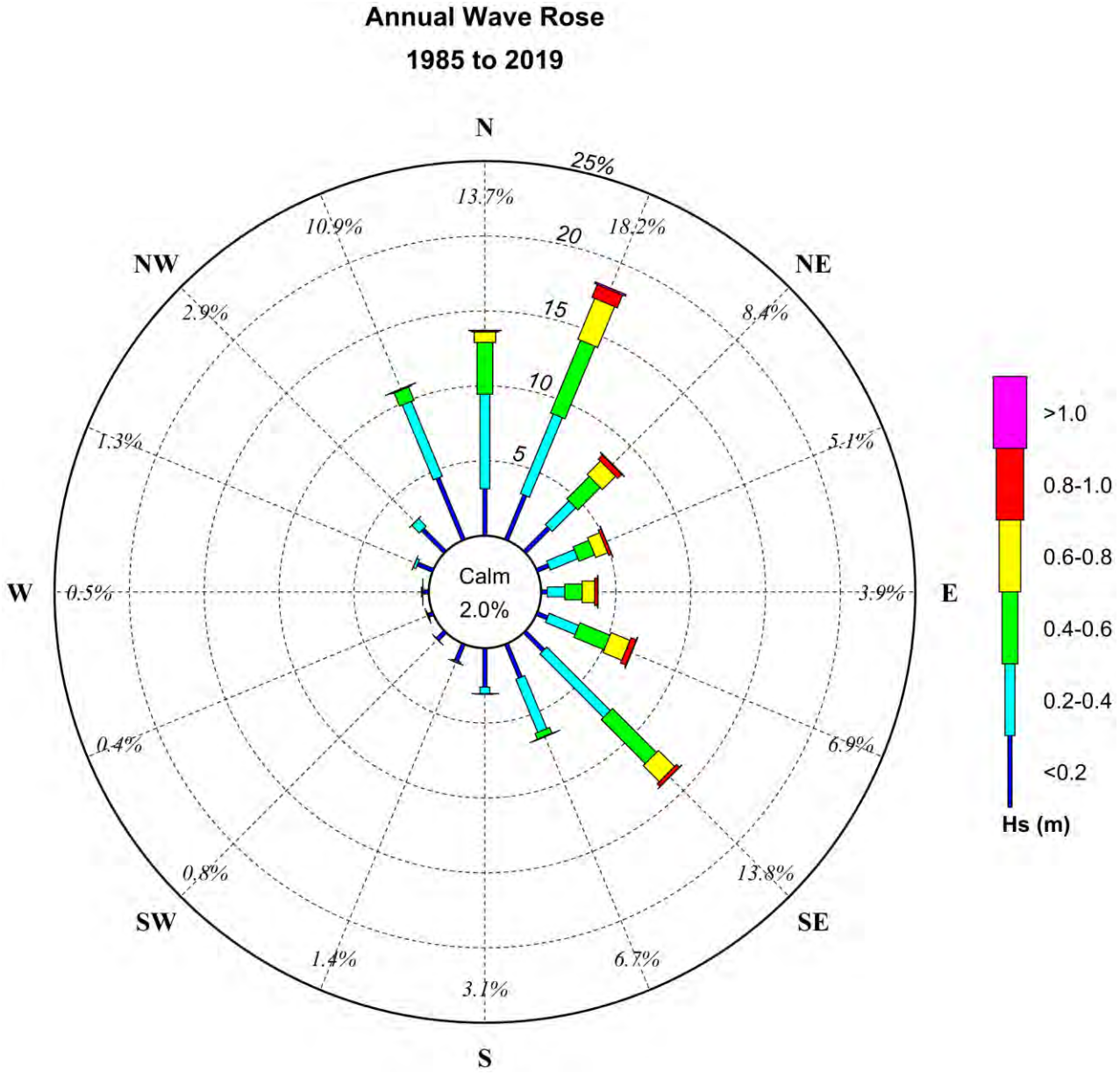


Figure 5-6 Annual total wave rose at Madorah site (1985 to 2019)

5.3.3 Currents

The major causes of currents in the Darwin harbour are the tides. Typically, in the vicinity of the site, currents are directed towards the north during an ebb tide and towards the south during a flood tide. Generally, ebb currents are stronger than flood currents. Ebb tidal currents are predicted to reach up to 1.1 m/s during a spring tide and flood currents approach 0.4 m/s. Vector plots of peak flows for flood and ebb, during the spring tides, are provided in **Figure 5-7**.

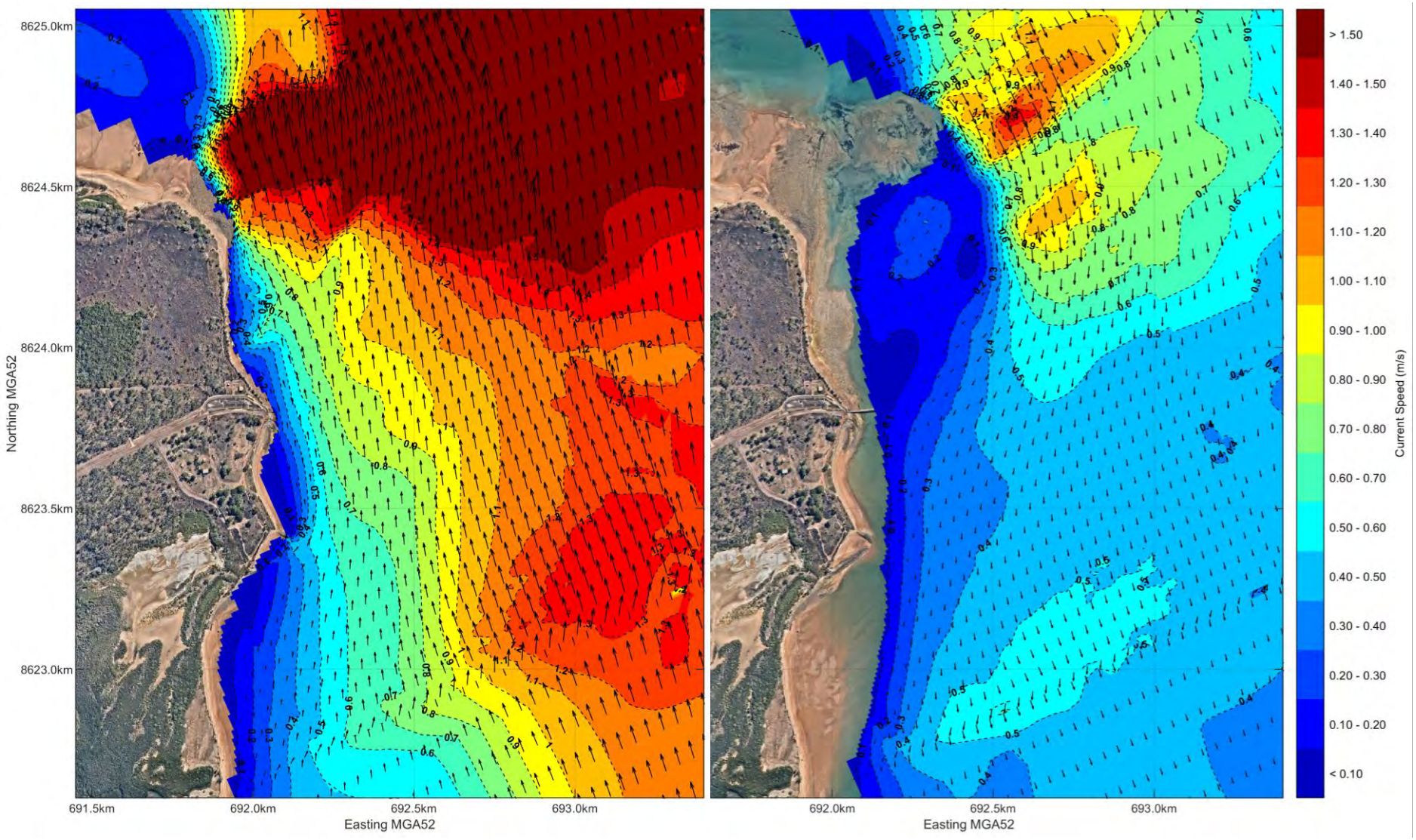


Figure 5-7 Spring tide ebb (left) and flood (right) flow vector plot

5.3.4 Cyclones

Being close to equator, much of the Northern Territory coastline is in a region where cyclones tend to form. This can be advantageous, as a cyclone forming near the coast will often cross the coast before it has a chance to substantially intensify, however, this also reduces available warning time. Tropical cyclones in the region mostly form from lows within the monsoon trough, between November and April. There are on average 7.7 days per season when a cyclone exists in the Northern Territory Region. The north western Gulf of Carpentaria near Gove has the highest concentration of cyclone days. The Gulf of Carpentaria averages two cyclones a year, while the Arafura and Timor Seas average one a year. Cyclones in the Gulf of Carpentaria move very erratically, whereas those in the Arafura and Timor Seas tend to follow more regular tracks to the southwest. Over half the cyclones generated in the Northern Region move either southwest or southeast into adjoining regions. **Figure 5-8** shows the tracks of the 25 most severe cyclones recorded in the study area since 1964.

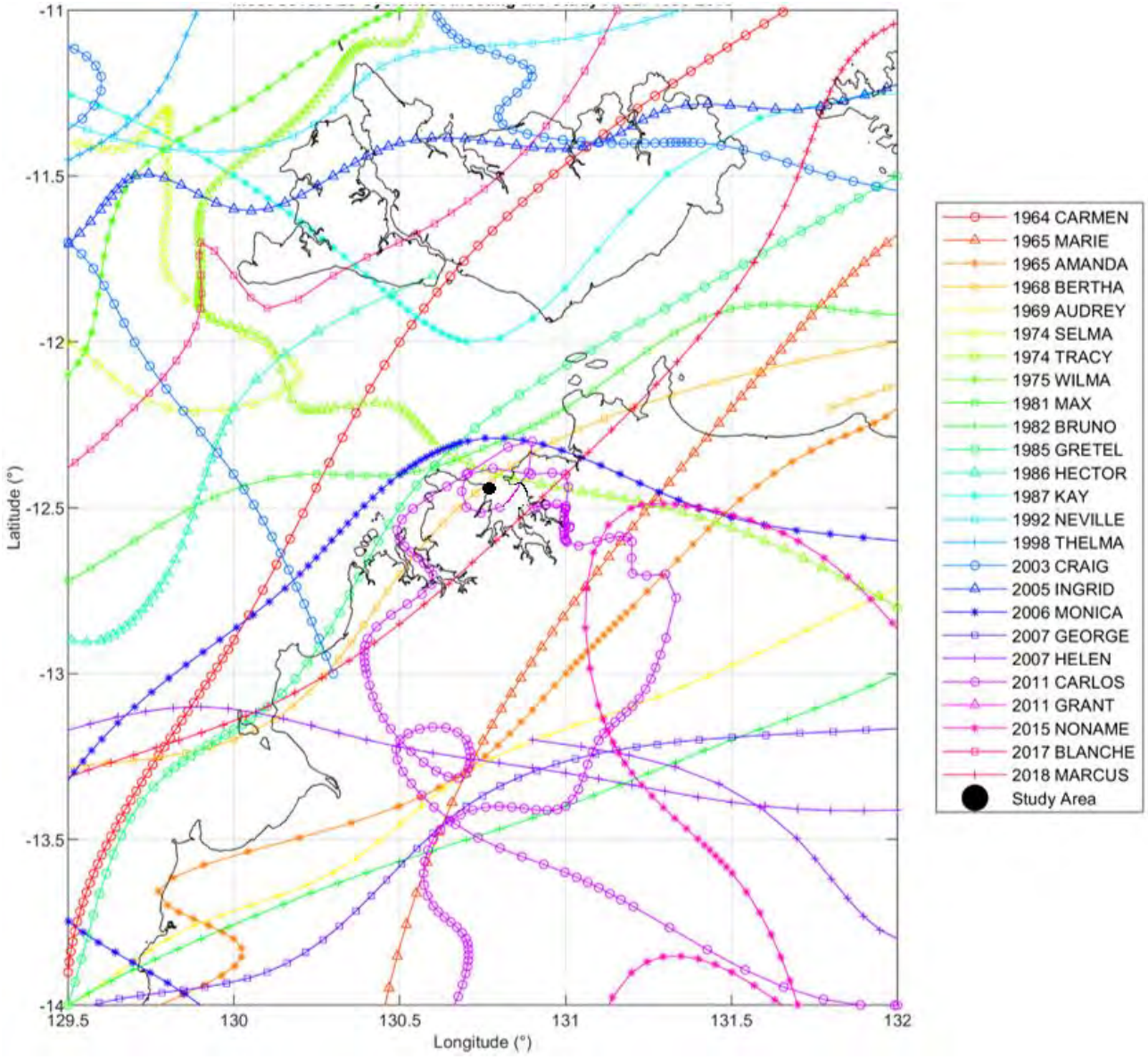


Figure 5-8 Tracks of the 25 most severe cyclones that have affected Darwin since 1964

5.3.5 Water Quality

5.3.5.1 Site Specific Data and Modelling

Baseline water quality, in terms of turbidity or suspended sediment concentration, is well understood at the project site, with monitoring being conducted continuously by Cardno for over 2 years during the INPEX Nearshore Environmental Monitoring Program. Changes to suspended sediment concentrations at the site are associated with tidal flow, wave action and seasonal rainfall runoff from Woods Inlet. The project has the potential to alter suspended sediment concentrations significantly during dredging and construction. The facility itself may also alter suspended sediment patters in the area by changing the local hydrodynamic regime. These effects have been considered by modelling sediment transport processes and are detailed in the *Sediment Transport Report* (Cardno, 2022e).

5.3.5.2 Darwin Harbour Region Report Cards

Ongoing water quality monitoring of Darwin Harbour is undertaken by the Department of Environment, Parks and Water Security's (DEPaWS) Aquatic Health Unit. The water quality monitoring has been ongoing since 2009 and includes the following categories/parameters:

- Algae – Chlorophyll-a;
- Dissolved Oxygen;
- Water Clarity – Turbidity (NTU); and
- Nutrients – Filterable Reactive Phosphorus, Ammonia as N and NO_x.

Supplementary parameters include:

- Salinity;
- Temperature; and
- pH.

Mandorah lies within 'Zone 5 – Middle Harbour' for the monitoring program, which was reported as 'very good for all parameters except nutrients ('good') for the annual 2020 report card (DEPaWS, 2022). Historically, water quality has been reported as 'very good' overall for the zone, sporadically dropping to 'good'. None of the field monitoring locations are in close proximity to the project location.

5.4 Landforms

5.4.1 Regional Geomorphology

Darwin Harbour is a classed as a ria shoreline, or submerged river valley, formed after the end of the last glacial period approximately 12,000 years ago. The Northern Territory was previously joined to what is now known as West Papua. Glacial flooding increased world sea levels, cutting the Northern Territory off from Indonesia and forming Darwin Harbour. Surface erosion from the land surrounding Darwin Harbour has resulted in substantial quantities of sediment entering the harbour, forming much of the intertidal flats overlying bedrock on the banks of Darwin Harbour (AECOM, 2017).

5.4.2 Topography

A detailed engineering survey was undertaken across the landside footprint of the project, completed between 14/11/2019 and 18/11/2019 by Cross Solutions. The onshore area is relatively flat with substantial high relief landward of the cliff features at the shoreline. The gentle land slope is generally perpendicular to the shoreline from approximately 8 mAHD at the landward edge of development to 7m AHD at the edge of the cliffs along the shoreline. No significant terrestrial land features exist at the site. Topography is presented in **Figure 5-9**.

5.4.3 Bathymetry

In 2017, a hydrographical survey was undertaken of the project site area by Astute Surveying. The hydrographic survey covered the marine area footprint of the proposed facility. The nearshore area of the site

is relatively flat and shallow (approximately LAT or -4 m AHD) for approximately 150m offshore. After this flat, intertidal area the seabed drops off steeply into deeper water.

The proposed marine facilities are within the shallow intertidal region of Darwin Harbour. Whilst Darwin Harbour is greater than 20 m deep in the main channel, the footprint of the main breakwater extends to approximately -4 m AHD with the dredge footprint extending to approximately -7 m AHD. Bathymetry is presented in **Figure 5-9**.

5.5 Geology

5.5.1 Regional Geology

The Mandorah area is characterised by a distinct wet-dry tropical monsoonal weather system, which has created the geological conditions as seen today. Generally, coastal regions of the Northern Territory display Cenozoic regolith consisting of iron and aluminium rich weathered laterites overlying Cretaceous marine sediments. Various basements rocks of Proterozoic age are prominent, generally consisting of various end-members of the metamorphic family. In the Mandorah area, basement rock of quartz-rich gneiss is unconformably overlain by Cretaceous claystones, both montmorillonitic and kaolinitic (as shown in **Figures 5-10** and **5-11**, sourced from *Darwin, Northern Territory Australia 1:250,000 Geological Series - Sheet SD 52-4)*.

5.5.2 Site Specific Geology

During site investigations (Cardno, 2022h), the basement rock was described as a phyllite because of the grade of metamorphism and the high degree of micas present. Site conditions were confirmed onsite during the field investigation, with the primary material retrieved comprising fine to coarse grained, cohesive alluvial/ residual sandy-clay overlying rock varying in weathering and strength.

Previous geotechnical investigations, and geotechnical investigations and seismic refraction survey undertaken as part of this project (as detailed in the *Geotechnical Investigations Report* [Cardno, 2022h]) have been interpreted to develop a preliminary geological site model (**Figure 5-13**).

Observations are as follows:

- A thin Porcelanite ‘shelf’ (generally 1 to 1.5 metres thick, up to 3 metres thick) is present at the surface of the site’s nearshore area, extending offshore to where the seabed bathymetry is between -3.2 m AHD and -3.4 m AHD (**Figure 5-12**);
- Underlying this caprock is weathered rock that should be relatively easy to dredge and will also be suitable for reuse as core fill. A portion of the underlying geology (defined on **Figure 5-13**) may comprise softer materials;
- There is a small portion of the site that may contain high strength rock to depth (defined on **Figure 5-13**); and
- Directly offshore (east) of the edge of the Porcelanite shelf is a deep layer of soft muds / marine deposits, extending from the seabed surface to depths between -6 m AHD and -9 m AHD.

130°45'55"E
130°46'0"E
130°46'5"E
12°26'25"S
12°26'30"S
12°26'35"S
12°26'40"S
NORTH

Legend

- Boat Ramp
- Breakwater Footprint
- Dredge Footprint
- Carpark Layout
- Maritime Infrastructure

Elevation (mAHD)

- -12 - -11
- -11 - -10
- -10 - -9
- -9 - -8
- -8 - -7
- -7 - -6
- -6 - -5
- -5 - -4
- -4 - -3
- -3 - -2
- -2 - -1
- -1 - 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10

Cardno

Date
22/12/2021

Size
A3

Scale
1:1,500

0 12.5 25 50 m

SITE TOPOGRAPHY AND BATHYMETRY

MANDORAH MARINE FACILITIES

ENVIRONMENTAL REFERRAL REPORT

FIGURE 5-9

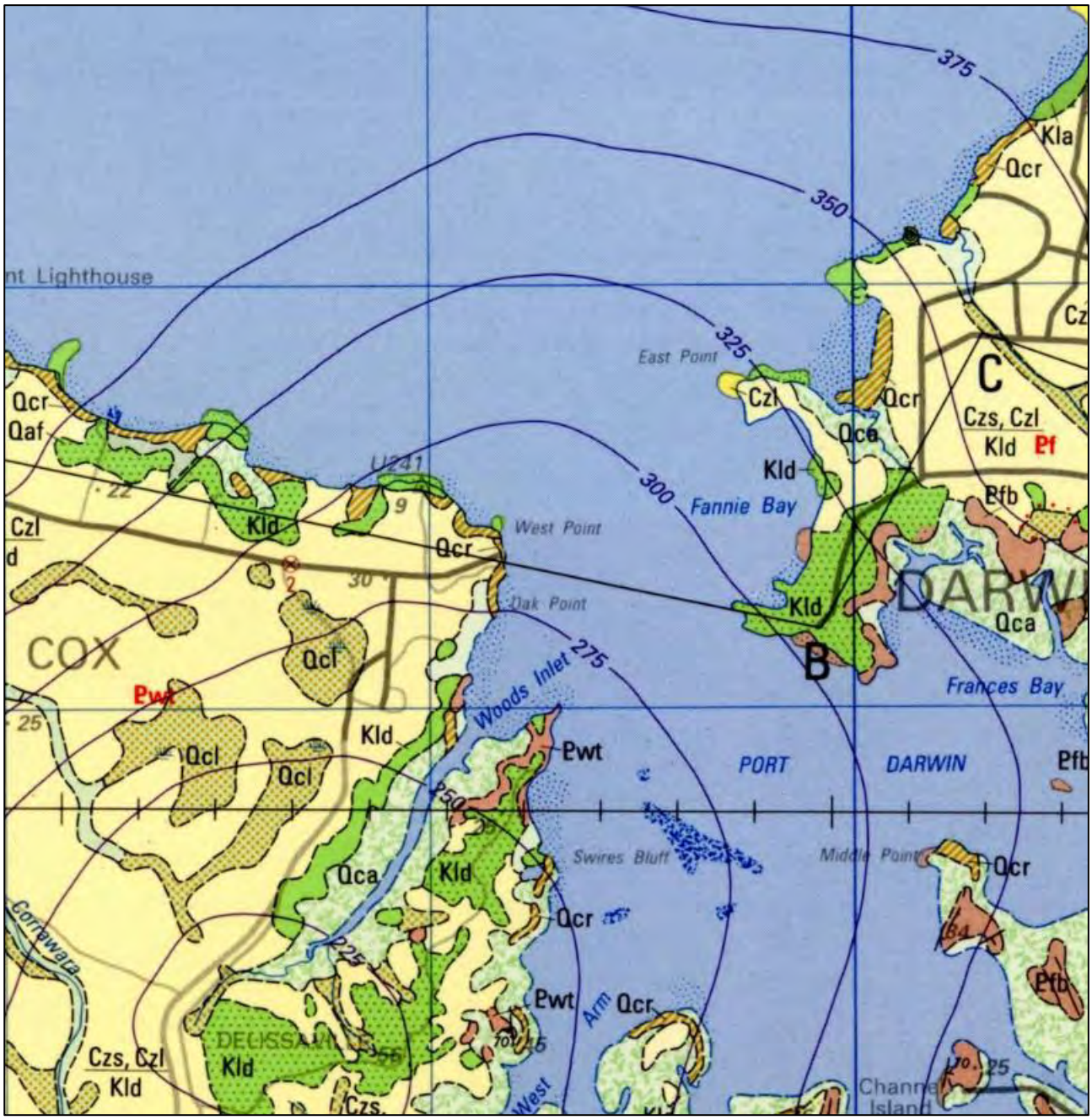


Figure 5-10 Regional geology of the Mandorah area, from Darwin, Northern Territory Australia 1:250,000 Geological Series (Sheet SD 52-4).

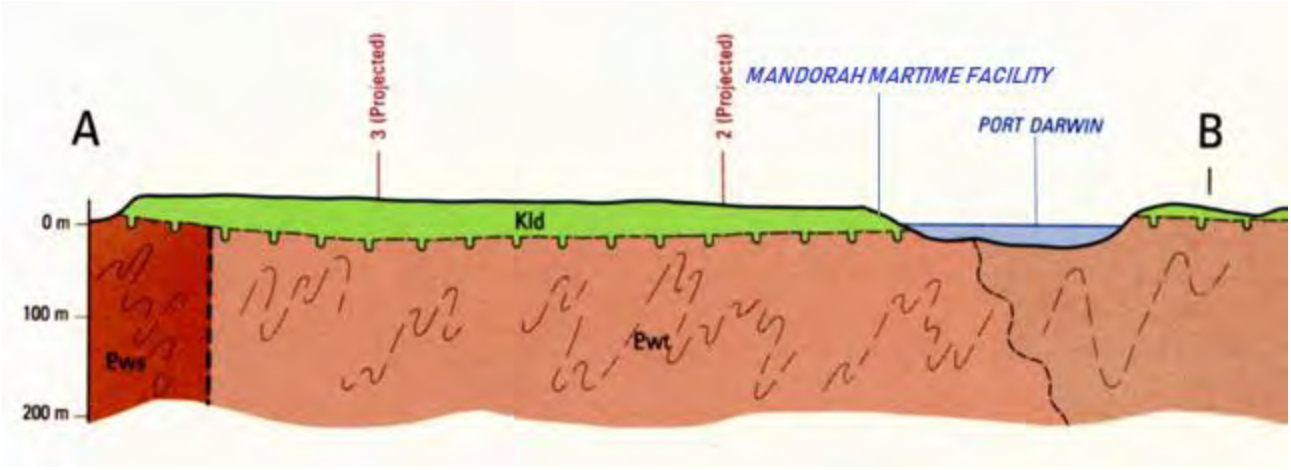


Figure 5-11 Cross section of the Mandorah area, altered from Darwin, Northern Territory Australia 1:250,000 Geological Series (Sheet SD 52-4).

Table 5-3 Legend for regional geology (Figure 5-10) and cross section (Figure 5-11) above, from *Darwin, Northern Territory Australia 1:250,000 Geological Series (Sheet SD 52-4).*

Qcr	Quaternary – sand; shelly sand; coralline sand.	**Czs, Czl**	Cenozoic – unconsolidated sand, ferruginous and clayey, sandy and gravelly soils: commonly containing limonite pisolites.
Qcl	Quaternary – sand; silt; clay.	**Kld**	Cretaceous – Kaolinitic claystone, commonly radiolaria-rich, montmorillonitic when fresh; minor silty claystone.
Pws	Proterozoic - marble, in places graphitic; ara-amphibolite; calc-silicate gneiss; quartz feldspar-biotite gneiss.	**Pwt**	Proterozoic - quartz-feldspar-biotite gneiss, commonly containing garnet and sillimanite; quartzitic gneiss; quartzite, minor quart-feldspar-muscovite gneiss.

Figure 5-12 Claystone cliffs along the Mandorah shoreline

130°45'55"E
130°46'0"E
130°46'5"E
12°26'25"S
12°26'30"S
12°26'35"S

NORTH

Porcelanite caprock to approximately 1.5m below seabed. Weathered rock anticipated below this

Approximate extent of porcelanite shelf

Area potentially contains high strength rock to depth

Soft alluvial mud between -5m and -9m

Main Breakwater

Boat Ramp

Lee Breakwater

Area potentially contains softer materials below porcelanite

Legend
- Dredging Footprint
- New Infrastructure
- Bathymetry mAHD

Cardno

Darwin, Northern Territory

Date
1/12/2021

Size
A3

Scale
1:1,500

0 50Meters

PRELIMINARY GEOLOGICAL SITE MODEL

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL REPORT
FIGURE 5-13

5.5.3 Marine Sediments

5.5.3.1 Darwin Harbour

Numerous broadscale monitoring and research programs have been undertaken in Darwin Harbour to characterise its marine sediments (Munksgaard et al 2013; URS 2009; Fortune 2006). Results from these studies indicate that nearshore seabeds vary from mud, fine- to medium-grained muddy sand, shell grit, medium- to coarse-grained gravel, pebble and cobble, and rocky reef. Intertidal areas adjacent to the coast are mainly characterised by mud and muddy fine- to medium-grained sand. Sediments in channels are mainly comprised of shell grit and coarse-grained sand, with large cobbles also found in the channel adjacent to Cullen Bay.

Analysis of potential contaminants in Darwin Harbour such as metals (including metalloids) determined that arsenic concentrations commonly exceed the low (20 mg/kg) and high (70 mg/kg) interim sediment quality guidelines Screening Levels (ANZECC and ARMCANZ 2000a). However, these high concentrations have been attributed to local geology (weathering of arsenic rich coastal substrata) rather than anthropogenic sources (Fortune, 2006). Furthermore, previous bioavailability testing has indicated that only a small proportion is bioavailable indicating that it is unlikely to be toxic in the marine environment.

A range of other metals (e.g. chromium, mercury, nickel and silver) have also been recorded to exceed Screening Levels for individual samples; however, their mean concentrations have always remained below Screening Levels.

Few programs have analysed samples for other contaminants such as organic compounds. The sampling undertaken during the EIS phase of the Inpex Project (URS, 2009) is the most comprehensive in the area and found that tributyltin (TBT), BTEX, polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) were all below the laboratories LOR. The majority of samples analysed for PAHs and TPHs have also been below LOR.

5.5.3.2 Mandorah

Detailed assessment of the physical and chemical properties of sediments sampled in the project area are found in the *SAP Implementation Report* (Cardno, 2022c).

5.5.3.3 Profile Description

- There is limited marine bed sediment in the area, the deepest refusal depth for push coring was 0.8 metres and for most sample locations the refusal depth was less than 0.5 metres;
- Field observations did not identify any visual signs of contamination;
- Field observations noted unconsolidated sediment largely as marine SAND, dark grey; and
- Field pH testing reported material between 8.7 and 9.1 (alkaline).

A summary of the laboratory results of sediment chemical testing is presented in the following sub-sections.

5.5.3.4 Metals and Metalloids

All concentrations of metals and metalloids for the site were below all assessment criteria for offshore and onshore disposal of sediments.

5.5.3.5 Organotin

During initial sampling, two sampling locations returned a concentration of Tributyltin (3.8 µg/kg and 9.5 µg/kg) above the limit of reporting (LOR). One of these samples was located within the proposed dredge footprint. The 95% UCL for Tributyltin corrected for 1% TOC (9.5 µg/kg) marginally exceeded the NAGD low screening level of 9 µg/kg. No other samples recorded concentrations of organotin compounds above the LOR.

Further sampling was undertaken at multiple sites in the vicinity of the site with elevated TBT concentration, to identify if a contamination hotspot exists. All results of this sampling returned concentrations below the LOR for TBT.

5.5.3.6 Organic Compounds

No organic compounds were detected, with all BTEX, TRH, PAH and organochlorine pesticide concentrations were below their respective LORs in all samples.

5.5.3.7 Acid Sulfate Soils

Two samples were found to have Net Acidity values above the management action criteria recommended in the *National Acid sulfate soils guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management* (Simpson et al., 2018) for dredging of sands to loamy clays; > 1000 tonnes.

The analysis shows that potential acid sulfate soils (PASS) are present at the site and likely to be present in surface-level seabed sediments, rather than in those at depth. It should be conservatively assumed that all sediments within the top 0.5 m are PASS and be managed as such. It should be noted that when saturated the opportunity for oxidisation of dredged material is negligible as the available supply of oxygen necessary for a significant rate of acid formation is too low.

5.5.4 Terrestrial Sediments

Limited characterisation of terrestrial sediments has been undertaken in the new terrestrial project footprint. Nearby test-pitting (Douglas Partners, 2018) indicates the site is likely to comprise gravelly silty sand or sand, which may overlay bedrock near the surface. The physical and aesthetics characteristics of the soils within the project area have been previously disturbed through land clearing and development of the existing civil infrastructure.

While the chemical composition of the soils has not been historically characterised, the non-industrial land uses and bitumen encapsulation of sub soils does not provide a basis for soil contamination. In addition, no areas within project area are listed on the NT EPA public register for contaminated land audits, pollution abandonment notices or reported incidents.

Cardno conducted a hazardous material survey and assessment of the fenced property north of the existing carpark in order to confirm the location, condition and risk presented by any asbestos containing materials (ACMs) within the existing building structure and its surrounds including the preliminarily assessment of the nature and extent of ACM soil contamination. The presence of ACM soils with in the sub-surface remains unknown and requires further intrusive soil investigation to confirm, prior to, or as part of, earthworks and civil construction. Any such contamination would be removed and disposed at an appropriate waste facility, prior to earthworks for construction.

5.6 Hydrology

5.6.1 Surface Water

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

5.6.2 Groundwater

Groundwater gauging was undertaken in the groundwater network throughout Cox Peninsula, in the vicinity of the project site, in July and September 2013 (dry season) and repeated in 2014 February and April 2015 (wet season) (AECOM, 2017). Significant seasonal fluctuation in groundwater levels were observed between dry season and wet season. Of the 13 monitoring wells, the western most well and a well located 600 m to its east reported groundwater levels in the 2013 dry season of 13.62 mAHD and 11.95 mAHD, respectively and in the 2015 wet season of 16.06 mAHD and 15.26 mAHD, respectively. The data suggests that there is a slight gradient, with groundwater migrating in a general easterly direction towards Darwin Harbour.

5.7 Marine Ecosystems

A detailed assessment of marine ecosystems in the region and relevant to the project site is provided in the *Marine Environment Report* (Cardno, 2022b), with information derived from both desktop review and field investigations. Key components of the marine ecosystem in which the project will take place are detailed in the sub-sections below.

5.7.1 Benthic Communities and Habitats

A benthic communities and habitats (BCH) map has been developed for the project area and surrounds (**Figure 5-14**). The map contains a combination of field mapped BCH within the project footprint and near vicinity and recently developed interpreted BCH mapping (Geoscience Australia, AIMS and DEPaWS, 2021). The mapping demonstrates the presence of:

- An assemblage of very low-density seagrass lies within the direct project footprint;
- An assemblage of low-density seagrass lies in close proximity, directly to the north of the project footprint;
- Significant coral coverage is present to the north, north east of the project footprint; and
- Assemblages of sponges and mixed filter feeders are present in the vicinity of the project footprint.

BCH mapping suggests that the following sensitive environmental receptors will be, or have the potential to be, impacted by the project:

- Seagrass (*Halodule* and/or *Halophila*); and
- Corals.

130°45'40"E
130°46'0"E
130°46'20"E
12°25'40"S
12°26'0"S
12°26'20"S
12°26'40"S

NORTH

692284, 8625178
692334, 8625178
692284, 8625100
692334, 8625100

Legend

- Offshore Disposal Area (sediments)
- Breakwater
- Dredging Area

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
20/12/2021

Size
A3

Scale
1:7,779

0 300Meters

BENTHIC HABITAT MAP

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL REPORT
FIGURE 5-14

5.7.2 Marine Fauna

The following database searches were undertaken to identify listed marine species with the potential to occur in the project area and surrounds:

- Northern Territory Department of Environment and Natural Resources (DENR) natural resources maps to identify known records of vegetation, threatened communities, threatened species and pest species (accessed on 18 February 2020);
- DEWA's PMST to identify species listed under the *EPBC Act* and Matters of National Environmental Significance (MNES) (accessed November 2021);
- Atlas of Living Australia to identify known records of threatened, least concern and pest species recorded within the vicinity of the project site (accessed February 2020); and
- The NT Government websites for threatened fauna and flora was also reviewed for any territory-listed (*Territory Parks and Wildlife Conservation Act 1976* and *Fisheries Act 1988*) threatened species with potential to occur in close proximity to the Project site.

A 10 km search radius from the Project site was applied for the PMST, identifying:

- 109 listed marine species;
- 15 of these species are listed as threatened:
  - 5 Vulnerable;
  - 7 Endangered; and
  - 3 Critically endangered.
- 1 species of river shark was listed as Endangered (*Glyphis garricki*); and
- 3 species of sawfish were listed as Vulnerable.

Full database search records are included as **Appendix B**.

The species that require further environmental risk assessment ('species of concern') for the project are those that are listed as Threatened or Migratory and have moderate to high likelihood of occurring in the study area (refer to **Section 10-3** likelihood of occurrence assessment). **Table 5-4** lists these species and their listed status. Specifically, these species identified include:

- 20 species of Migratory bird, seven of which are Threatened;
- The Green Sawfish (*Pristis zijsron*), listed as Threatened and Migratory;
- The Dugong (*Dugong dugon*), listed as Migratory;
- Three Migratory species of dolphin:
  - Australia Snubfin Dolphin (*Orcaella heinsohni*);
  - Indo-pacific Humpback Dolphin (*Sousa chinensis*); and
  - Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*);
- Four species of Threatened and Migratory turtle:
  - Green Turtle (*Chelonia mydas*);
  - Hawksbill Turtle (Eretmochelys imbricata);
  - Olive Ridley Turtle (*Lepidochelys olivacea*); and
  - Flatback Turtle (*Natator depressus*); and
- The Saltwater Crocodile (*Crocodylus porosus*), listed as Migratory.

Table 5-4 Marine species of concern for the project

Scientific name	Common name	EPBC Act	TPWC Act
Birds			
Actitis hypoleucos (M)	Common Sandpiper	-	-
Arenaria interpres (M)	Ruddy Turnstone	-	-
Calidris acuminata (M)	Sharp-tailed Sandpiper	-	-
Calidris alba (M)	Sanderling	-	-
Calidris canutus (T, M)	Red Knot	E	V
Calidris ferruginea (T, M)	Curlew Sandpiper	C	V
Calidris melanotos (M)	Pectoral Sandpiper	-	-
Calidris tenuirostris (T, M)	Great Knot	C	V
Charadrius leschenaultia (T, M)	Greater Sand Plover, Larger Sand Plover	V	V
Charadrius mongolus (T, M)	Lesser Sand Plover, Mongolian Plover	E	V
Charadrius veredus (M)	Oriental Plover, Oriental Dotterel	-	-
Fregata ariel (M)	Lesser Frigatebird, Least Frigatebird	-	-
Hirundo rustica (M)	Barn Swallow	-	-
Limosa lapponica baueri (M)	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed	V	V
Limosa limosa (M)	Black-tailed Godwit	-	-
Numenius madagascariensis (T, M)	Eastern Curlew, Far Eastern Curlew	C	V
Numenius phaeopus (M)	Whimbrel	-	-
Pandion haliaetus (M)	Osprey	-	-
Pluvialis squatarola (M)	Grey Plover	-	-
Sternula albifrons (M)	Little Tern	-	-
Tringa nebularia (M)	Common Greenshank, Greenshank	-	-
Fish, Sharks & Rays			
Pristis zijsron (T, M)	Green Sawfish, Dindagubba, Narrowsnout Sawfish	V	V
Mammals and Cetaceans			
Dugong dugon (M)	Dugong	-	-
Orcaella heinsohni / brevirostris (M)	Australian Snubfin Dolphin, Irrawaddy Dolphin	-	-
Sousa chinensis (M)	Indo-Pacific Humpback Dolphin	-	-
Tursiops aduncus (M, C)	Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	-	-
Reptiles			
Chelonia mydas (T, M)	Green Turtle	V	-
Crocodylus porosus (M)	Salt-water Crocodile, Estuarine Crocodile	-	LC
Eretmochelys imbricata (T, M)	Hawksbill Turtle	V	V
Lepidochelys olivacea (T, M)	Olive Ridley Turtle, Pacific Ridley Turtle	E	V

Scientific name	Common name	EPBC Act	TPWC Act
Natator depressus (T, M)	Flatback Turtle	V	DD

Key:

C = Critically endangered, DD = Data deficient, E = Endangered, LC = Least concern, N = Near Threatened, V = Vulnerable, *EPBC Act:* M = Migratory, T = Threatened

5.7.3 Invasive Marine Pests

Marine pests are plants or animals that are not native to a region, usually introduced from overseas, that have a significant impact on our marine industries and environment. Marine pests can grow or reproduce quickly and out-compete other native species by preying directly on them or competing for food. The most common way marine pests are introduced is via boats and other large vessels, either attached to the submerged surfaces of ships ('biofouling') or in the ballast water carried by modern vessels to maintain stability. Marine pests considered a significant threat to NT waters include:

- Asian bag mussel (*Arcuatula senhousia*);
- Asian green mussel (*Perna veridis*); and
- Black-striped mussel (*Mytilopsis sallei*).

These species are found overseas in countries frequently visited by boats that travel to the NT (NT Government 2021). The black-striped mussel is of particular concern as it invaded Darwin Harbour marinas in 1999 but was successfully eradicated. The mussel spreads on the hulls and in the internal seawater plumbing of commercial or recreational vessels and multiplies rapidly to form dense groups that can reduce local biodiversity. It can also cause fouling on wharves, marinas and seawater systems, and can damage marine farms.

Marine pests were surveyed extensively as part of the INPEX Nearshore Monitoring Program (2012 – 2014), however, the only pest species detected were a few individuals of the Asian green mussel, reported in 2012.

5.8 Terrestrial Ecosystems

A detailed assessment of terrestrial ecosystems relevant to the project site is provided in the *Terrestrial Environment Report* (Cardno, 2022a), with information derived from both desktop review and field investigations. Key components of the terrestrial ecosystem are detailed in the sub-sections below.

A desktop review was undertaken based on published literature, technical reports, publicly accessible databases and mapping relevant to the Darwin Region, Project site and its surrounds. Sources consulted during the desktop review include:

- EPBC Act 1999 Protected Matters Search Tool to identify threatened species and Matters of National Environmental Significance (MNES) likely to occur at the project site (accessed November 2021);
- Atlas of Living Australia and Australia's Virtual Herbarium databases to identify known records of threatened, least concern and pest species recorded within the vicinity of the project site (these resources include Herbarium HERBRECs records) (accessed 19 February 2020);
- Northern Territory Department of Environment, Parks and Water Security (DEPWS) natural resources maps to identify known records of vegetation, threatened communities, threatened species and pest species (accessed on 18 February 2020); and
- Environmental Management Register and Contaminated Land Register for the properties on which works are proposed.

Full database search outcomes are included as **Appendix B**.

5.8.1 Terrestrial Flora

The Northern Territory Flora and Fauna Atlases were questioned on 18th February 2020. The following was found with regards to records of terrestrial flora:

- No known records of threatened, significant and restricted range flora species occur therein;
- Eight known flora records among seven native flora species are known in the locality; and
- 68 known flora records among 37 introduced flora species are known to occur in the locality.

Vegetation communities identified by desktop review were supplemented by field surveys in March 2020, which focused on ground-truthing existing vegetation mapping applicable to areas within the Project footprint. DENR (2003) has classified the project area as a combination of cleared land and Eucalypt woodland (**Figure 5-15**).

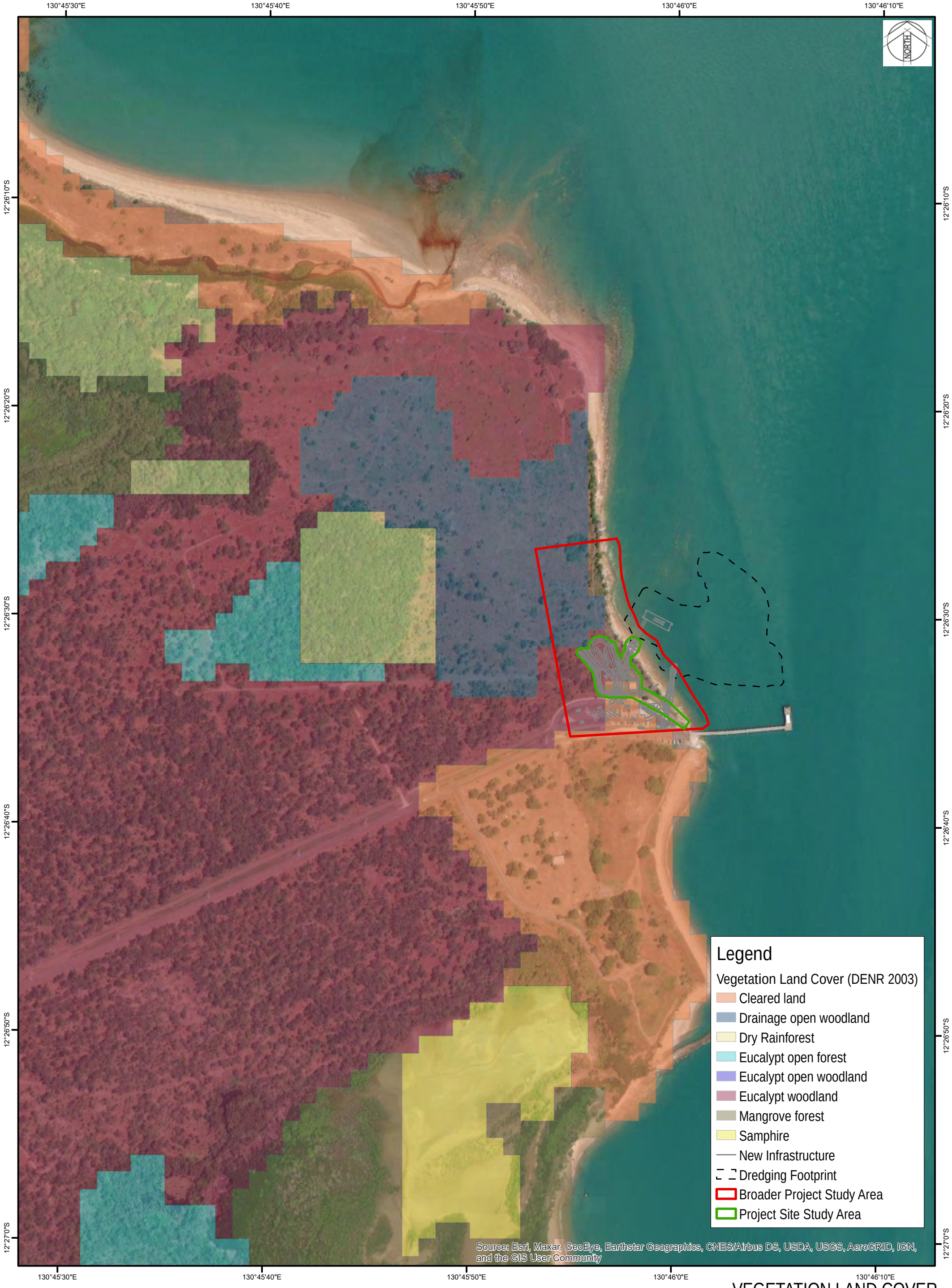
The proposed infrastructure footprint has been evaluated through habitat assessment which included identification of native vegetative zones, habitat condition, and fauna attributes (i.e. burrows, grass cover, tree hollows). The area can be characterised as *Terminalia spp* open woodland providing for a mixed sparse shrubland understory and *Cenchrus spp* mixed low tussock grassland. The field investigations identified 18 native terrestrial floral species within the Project Area. All species recorded during the field investigation are listed in **Table 5-5**.

Table 5-5 Native terrestrial floral species identified

Common name	Genus	Species
Kakadu/Billy-Goat Plum	*Terminalia*	*ferdinandiana*
Sand-binder	*Ipomea*	*pes-caprae*
Large-leaf Cabbage Gum	*Eucalyptus*	*grandifolia*
Darwin Woolybutt	*Eucalyptus*	*miniate*
Darwin Stringbark	*Eucalyptus*	*tetradonta*
Northern Black Wattle	*Acacia*	*aurculiformis*
Velvet Wattle	*Acacia*	*holosericea*
Green Plum	*Buchanania*	*obovata*
Jack/beach Bean	*Canavalia*	*rosea*
N/A (tussock grass)	*Cymbopogon*	*procerus*
Fig	*Ficus*	*scobina*
Whip Vine	*Flagellaria*	*indica*
Speargrass	*Heteropogon*	*contortus*
Current bush	*Ixora*	*klanderana*
Coffee bush	*Leucaena*	*leucocephala*
N/A (multi stemmed shrub)	*Trema*	*Tomentosa-aspera*
Cocky Apple	*Planchonia*	*careya*
N/A (coastal shrub)	*Premma*	*Serratifolia*

5.8.1.2 Weeds

The field investigation recorded high densities of *Cenchrus spp*, commonly known as mission grass, throughout the Project Area. The weed infestation was categorised as large density, consisting of 15% seedlings, 20% juveniles and 65% adults.



Cardno

Darwin, Northern Territory

Date
1/12/2021

Size
A3

Scale
1:5,000

0 200Meters

VEGETATION LAND COVER FOR GREATER DARWIN REGION

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL REPORT
FIGURE 5-15

5.8.2 Terrestrial Fauna

The Northern Territory Flora and Fauna Atlases were questioned on 18th February 2020. 61 known terrestrial fauna records, including four records of threatened species and 16 records of significant species were returned. Fauna records corresponded to 30 bird and one terrestrial mammal species.

Table 5-6 shows list of fauna recorded within 500m of the Study Area, respectively.

Table 5-6 NT Fauna Atlas Records within 500m of the project footprint

Scientific Name	Common Name	Species Type	Number of records	TPWC Act	EPBC Act
Birds					
Actitis hypoleucos	Common Sandpiper	S	2	LC	-
Cacatua galerita	Sulphur-crested Cockatoo	N	1	LC	-
Cacatua sanguinea	Little Corella	N	1	LC	-
Centropus phasianinus	Pheasant Coucal	N	1	LC	-
Chlamydera nuchalis	Great Bowerbird	N	1	LC	-
Chroicocephalus novaehollandiae	Silver Gull	N	1	LC	-
Coracina novaehollandiae	Black-faced Cuckoo-shrike	N	1	LC	-
Corvus orru	Torresian Crow	N	1	LC	-
Dacelo leachii	Blue-winged Kookaburra	N	1	LC	-
Dicaeum hirundinaceum	Mistletoebird	N	1	LC	-
Egretta sacra	Eastern Reef Egret	S	2	LC	-
Eolophus roseicapilla	Galah	N	1	LC	-
Esacus magnirostris	Beach Stone-curlew	N	6	LC	-
Gelochelidon macrotarsa	Australian Gull-billed Tern	N	3	LC	-
Geopelia placida	Peaceful Dove	N	1	LC	-
Grallina cyanoleuca	Magpie-lark	N	6	LC	-
Haliaeetus leucogaster	White-bellied Sea-Eagle	S	6	LC	Mi
Haliastur indus	Brahminy Kite	N	2	LC	-
Merops ornatus	Rainbow Bee-eater	S	2	LC	Mi
Milvus migrans	Black Kite	N	6	LC	-
Numenius madagascariensis	Far Eastern Curlew	N, S	6	VU	CR, Mi
Numenius phaeopus	Whimbrel	S	4	NT	Mi
Phalacrocorax varius	Pied Cormorant	N	1	LC	-

Scientific Name	Common Name	Species Type	Number of records	TPWC Act	EPBC Act
Sphecotheres vieilloti	Australasian Figbird	N	1	LC	-
Thalasseus bergii	Crested Tern	N	4	LC	-
Todiramphus pyrrhopygius	Red-backed Kingfisher	N	1	LC	-
Todiramphus sanctus	Sacred Kingfisher	N	1	LC	-
Trichoglossus rubritorquis	Red-collared Lorikeet	N	1	LC	-
Vanellus miles	Masked Lapwing	N	1	LC	-
Reptiles					
Fordonia leucobalia	White-bellied Mangrove Snake	N	1	LC	-
Notes: * = exotic; N = native; S = Significant Species; DD = Data Deficient; LC = Least Concern; NE = Not Evaluated; VU = Vulnerable; CR = Critically Endangered; Mi = Migratory; NT = Near Threatened;					

5.8.2.2 EPBC Act Protected Matters

DEWA's Protected Matters Search Tool (PMST) was questioned to identify Matters of National Environmental Significance (MNES) listed under the EPBC Act and predicted to occur within 10km locality surrounding the proposed development footprint. The PMST report indicates the following:

- 30 Threatened Species were identified as likely to occur within the 10 km locality. Several threatened terrestrial fauna and avian species were identified with potential to occur within the 10 km locality, including:
  - 13 bird species (five vulnerable, four endangered and four critically endangered);
  - Nine terrestrial mammals (six vulnerable and three endangered). Terrestrial mammals included six ground-dwelling species, two microbats and one arboreal species; and
  - One vulnerable terrestrial reptile.
- 70 Migratory Species were identified as likely to occur within the 10 km locality, including:
  - Six migratory terrestrial bird species; and
  - 34 migratory wetland bird species.

5.8.2.3 Observed Habitat

Terrestrial Habitats within the Project footprint can be placed in the following categories based on the resources available to fauna and their landscape:

Terminalia Woodland

Terminalia spp mid-open woodland is the abundant native vegetation type throughout the terrestrial footprint of the project. *The Terminalia spp* woodland was not found to be providing habitat for any species listed under the *TPWC Act*.

Field surveys did not record tree hollows, consistent leaf litter or stags within the habitat unit. One bird's nest was observed; however, no birds were observed during the survey. These habitat resources provide habitat for an array of species including reptiles, birds, bats and arboreal mammals. The lack of debris which provides habitat for ground dwelling animals can be explained by fires which occur in the area yearly.

Coastal Cliff

The low-lying cliffs which run from the existing boat ramp and jetty past the northern point of the proposed carpark and breakwater are formed by sedimentary rock commonly known as Porcelainite which has been naturally eroded, largely by wave action from the ocean. *Cenchrus spp* infestation prevailed close to the edge of the cliff where few *casuarina*, *eucalypt* and *terminalia* species were observed along the narrow cliff edge, no nests or signs or foraging were observed along the cliff edge.

Intertidal Zone

The intertidal zone of the Project footprint consists of coastal sandflats, fringing reef and saline claypans. The intertidal zone does not contain mangrove forests, which can provide habitat for migratory species.

Cleared Land

Areas of cleared land were observed during terrestrial surveys including the Radio Australia fenced property north of the existing carpark and a dirt track running parallel to the cliff form.

5.9 Air Quality

Existing air quality in close proximity of the Project Area is affected by local traffic, ferry services and other boating activities occurring in the area. Local traffic operates predominantly on sealed bitumen roads, however, unsealed tracks in the area have the potential to contribute to dust when used. Smoke from bushfires occurring each dry season is also a major contributor to airborne particulate matter in the Darwin Region.

The NT EPA undertakes periodical ambient air monitoring in the greater Darwin Region, reporting annually to the National Environment Protection Council (NEPC). These studies describe the emissions of air pollutants as being low as per the *NEPM Ambient Air Quality* (DLPE, 2001).

The National Greenhouse and Energy Reporting (NGER) found that the manufacturing industry was the leading emitter of greenhouse gases in the NT (NGER, 2016). There is no manufacturing industry on Cox Peninsula and the population density is low. It is considered likely that air quality in the vicinity of the site is good, particularly with respect to Darwin and surrounds.

5.10 Noise and Lighting

Current activities generating noise and lighting are predominantly attributed to vessel operations and traffic associated with the ferry service using Mandorah Jetty. Routine ferry services occur between 6:00 AM and 11:20 PM daily, generating noise and light.

Ferry service operations contribute to underwater noise levels due to running engines, onboard generators and the loading and unloading of vessels. Vessels using the boat ramp also contribute to underwater noise in the area. Light sources associated with the site include night time ferry services, fixed jetty and carpark lighting and local traffic entering and exiting the existing carpark.

5.11 Waste and Pollution

Very limited waste and pollution is produced at the project site, as it is a place of transit with very limited facilities. There are currently no ablutions at the site. Bins are provided and these are collected by the Wagait Shire Council.

5.12 Traffic

Currently, road access to the Project site is via Charles Point Road which terminates at a col de sac and carpark before the entrance of the existing jetty. Local traffic levels are considered to be low, consisting mainly of residents utilising the ferry service as well as launching and retrieving vessels via the boat ramp.

Charles Point Road is the only road access to the site intersected by Cox Peninsula Road providing the main link to the Stuart Highway. Stuart highway provides access to Darwin’s CBD and all major industrial areas.

5.13 Social Environment and Communities

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. Commercial opportunities are currently limited due to poor potable water supply infrastructure and the area's isolation. Previously, the Mandorah Beach Hotel operated to the south of the site, approximately 350 m from the jetty, from the 1970s until its closure in 2013.

It is expected that this project will improve accessibility to the area and increase economic opportunities for residents and visitors to the area. The area provides a unique experience compared to Darwin City, via a relatively short ferry ride.

5.13.1 Ferry Operations

The Mandorah Ferry, operated by Sealink, services the area with at least a dozen ferry services per day, with more frequent servicing in the morning and afternoon for patrons to get to and from work and school. The service is essential for many Cox Peninsula residents to complete everyday activities in Darwin.

5.14 Cultural Heritage

Aboriginal sacred sites exist directly to the south of the project site which are protected under the *Northern Territory Sacred Sites Act* (1989). DIPL has received an Authority Certificate from the Aboriginal Areas Protection Authority (AAPA) for works associated with the Project (**Appendix A**). The Authority Certificate identifies two Restricted Works Areas (RWAs) that protect known Aboriginal Sacred Sites. The project has been constrained so that no works will occur south of the northern extent of the RWAs.

Recorded and registered sacred sites also exist more than 500 metres north of the project site.

The proposed project area does not intersect any sites listed under the NT Heritage Register. Nearby heritage sites include World War II Gun Emplacements at Wagait Beach and the Delissaville (Belyuen) Cemetery. Although not listed, the existing Jetty itself is considered by many local residents to have heritage value. The project does not plan to impact the jetty.

6 Project Site Options / Alternatives

6.1 Site Selection

It should be noted that the proposed project will service the same ongoing functional requirements as the existing facilities at Mandorah (ferry passenger transfer, boat ramp etc.), but in a safer and disability access compliant manner. Landside transport connectivity such as car parking and access roads have already been established for the proposed project location, including a recent carpark upgrade (2016). Notwithstanding this, as part of initial planning for the project, alternative sites for the marine facilities were considered. Such options were considered as part of the *Mandorah Jetty and Boat Ramp – Assessment and Upgrade Concept Study* (Jacobs, 2016).

Of the alternative sites proposed, Woods Inlet was assessed in further detail, but was not considered a preferred option to be progressed. The reasons for this included:

- Potential environmental impacts associated with substantial mangrove assemblages in the area;
- Cost and environmental implications of dredging to access the area; and
- Cost and environmental impact for terrestrial areas due to limited existing landside access.

The key feature of the Mandorah site that makes it favourable for sea to land connectivity at Cox Peninsula (which also led to its selection for establishment of the Mandorah Jetty) is the close proximity between land and deep water. This proximity is closest at the Jetty location. This has allowed ferry service access to date without any capital or ongoing dredging. The new facilities would also benefit from this proximity, minimising the dredging required to create and maintain an access channel. The proposed facilities have, therefore, been placed adjacent the existing Jetty. Further constraints for siting the proposed facilities included:

- Avoiding the area to the south of the jetty due to Aboriginal sacred sites;
- Maintaining a certain distance from the jetty so that the ferry service could continue uninterrupted during construction;
- Achieving the shortest possible walking distance to the ferry from parking at the existing carpark; and
- Minimising the footprint required to connect new landside facilities to the existing (e.g. roads/paths).

6.2 Alternatives

Alternative project options have been considered throughout the planning process, with significant weight attributed to environmental acceptability. The *Mandorah Jetty and Boat Ramp – Assessment and Upgrade Concept Study* (Jacobs, 2016) was the first to assess various options for the facility. While alternative sites were considered (as described above), this study primarily assessed the range of infrastructure options that could meet the desired improvements for the facility. The comparison of options from this study considered:

- Technical feasibility;
- Cost;
- Environmental impacts; and
- Heritage/social impacts.

The key recommendation of this study was to improve safety and access for the existing facilities by developing a ‘safe harbour’, comprising two large breakwaters. This recommended option was then further refined and developed in *Mandorah Jetty and Boat Ramp Engineering Studies – Coastal Modelling and Preliminary Design Report* (Jacobs, 2019). This second study evolved the design with large breakwaters enclosing existing infrastructure at the site. Preliminary cost estimates for the design option were well above the available capital budget, prompting DIPL to undertake further refinement and optioneering to achieve a design to meet available funding.

The first stage of Cardno's design project was to consider various options for a harbour facility at Mandorah (the existing site), which is presented in the *Concept Design Options Report* (Cardno, 2020). The project developed a "long-list" of five harbour concept options, which were assessed by multi-criteria assessment (MCA). The MCA included the following categories:

- Capital cost;
- Operational cost;
- Safety and user experience;
- Constructability; and
- Environmental impacts.

Although the differences between options was relatively minor in terms of potential environmental impact, this concept optioneering stage included the collation of existing environmental data for the site (desktop study). This allowed consideration of potential environmental impacts and adequate mitigation to be considered in the full design process of the current project, from its commencement.

7 Stakeholder Engagement

7.1 Overview

The importance of community involvement in the environmental impact assessment process, particularly of Aboriginal people and communities, is expressly recognised in the objectives of the *Environment Protection Act 2019* (EP Act). Specifically, these objectives include:

- *To provide for broad community involvement during the process of environmental impact assessment and environmental approval*; and
- *To recognise the role that Aboriginal people have as stewards of their country as conferred under their traditions and recognised in law, and the importance of participation by Aboriginal people and communities in environmental decision-making processes.*

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.

Throughout the project's planning and development, extensive ongoing consultation has been undertaken with the local community and relevant stakeholders. Formal consultation has occurred and been documented at several key project stages, including the:

- Project Development Stage: Siting and scoping of facility upgrades to inform concept optioneering and project funding;
- Concept Optioneering Stage: Development of engineering options for comparison and selection of a preferred option to progress; and
- Design Development Stage: Refinement of the preferred concept option to meet available budget.

A description of the consultation and its outcomes for each of these stages is provided in the following sub-sections.

7.2 Project Development Stage

Significant stakeholder engagement was undertaken as part of the *Mandorah Jetty and Boat Ramp – Assessment and Upgrade Concept Study* (Jacobs, 2016). The focus of this consultation was to identify past and current issues with existing facilities at Mandorah and collect suggestions on how the facilities could be improved. The most common issues raised were regarding safety and useability of the existing jetty and boat ramp. The results of the stakeholder engagement were incorporated to form the functional requirements for the facility to be further developed and designed as part of this Project.

7.3 Concept Optioneering Stage

A *Stakeholder Engagement Plan* was developed to guide engagement for the concept engineering stage of the Project (Cardno, 2019), provided as **Appendix C**. The plan was developed in line with the International Association of Public Participation (IAP2, 2019) Consultation Framework, as well as the NTG's Remote Engagement and Coordination (REC) Strategy (2015). It identified key internal and external stakeholders and outlined the methods for engagement. As part of the concept options development, key stakeholders were engaged regarding the short-listed options. The purpose of the consultation was to keep community and stakeholders informed and gain feedback on the acceptability of the design options. Key outcomes of the engagement are summarised in the following subsections.

7.3.1 DIPL Internal Stakeholders Workshop

A workshop was held with DIPL internal stakeholders on the 31st of October 2019. The key items of feedback, relevant to the concept design stage, were as follows:

- The estimated capital costs were above budget and options need to be investigated to reduce cost;
- There is no desire to reduce any of the specified functional requirements to reduce costs;
- Staged construction of design could be considered, if feasible, to meet initial capital works budget;
- Suggested either rock or concrete armour could be used for breakwaters, no strong preference but suggested community feedback should be sought;
- Suggested pontoon materials and general design should be consistent with that at Cullen Bay;
- Suggested that reducing to single lane boat ramp should be considered to reduce cost;
- Suggested that carpark size could be reduced to reduce cost;
- Suggested that if existing jetty is retained as a fishing platform, it may require upgrade so that emergency vehicles can access; and
- Reiterated that there is no capacity to encroach on private land or restricted areas as part of the design.

The key concern was the capital costs for all three options. No strong opinions were expressed in regards to preferences or objections to any design elements of the three shortlisted options.

7.3.2 External Stakeholder Engagement

Multiple external stakeholder engagement sessions were conducted, inviting all the relevant parties identified in the *Stakeholder Engagement Plan* (Cardno, 2019). The key items of feedback, relevant to the concept design stage, were as follows:

- Sealink (ferry operator) were comfortable with the general facility layouts and dimensioning. They had a preference that the pontoon be oriented towards the entrance channel. They did not see that, based on the layouts, there would be unmanageable conflict between the ferry and recreational vessels;
- With regards to sizing for future vessels, Sealink stated that if required capacity increases in the future, they are more likely to run an additional ferry of the same size, rather than upgrade to a larger ferry;
- Disability advocacy groups were generally content with how the concept designs aimed to cater for use by persons with a disability. Feedback was provided on finer design details in this regard;
- There was general agreement from disability advocacy groups the *Disability Standards for Accessible Public Transport 2002* could be used as the prevailing document in design of access at the facility – e.g. gangway;
- There was feedback from many stakeholders that changes to current patterns and sedimentation could be an issue, and should be strongly considered;
- General community members and groups were happy with all concept designs in how they addressed previous concerns for the facility. There were various suggestions for finer details of the design, particularly landside amenities;
- There was general acceptance of retaining the existing jetty for use as a dedicated fishing platform from community stakeholders;
- AFANT stated that all options appeared to present a reduction in amenity for fisherman, due to:
  - Increased walking distance from ferry disembarkation to fishing platform (many fishers catch the ferry to Mandorah, carrying equipment);
  - Installation of rock walls changing fishing style and prohibiting full range of fishing angles;
- Suggested fishing from northern breakwater would add significant recreational value but understanding of significant cost to upgrade this. Would recommend that fisherman are not prevented from accessing the breakwaters at their own risk;

- Design should optimise distance between southern groyne and fishing platform to enhance fishing experience;
- Agreement from AFANT that the concept designs do not preclude the fishing experience from being improved in the future;
- NT fisheries suggested that strong consideration should be given to how recreational boaters will use the facility – tie off points, pontoon, distance from parking to boarding etc.
- Consideration to be given to direct and indirect impacts to the local currents and marine environment; and
- St. John Ambulance were consulted and they suggested they would not require ambulance access to the pontoon. Medical emergencies by Mandorah will generally be attended to by air.

Generally, the concept designs were acceptable to external stakeholders, who were pleased to see that the requests from previous engagement had been considered and incorporated where feasible.

7.4 Design Development Stage

The project was handed from DIPL's planning team to their delivery team in early 2021, and further stakeholder engagement was conducted advising the phased approach to construction.

Stakeholder consultation in many projects, including this project, in the early planning phases typically casts a very broad net, to capture, encourage and collect a broad range of stakeholder feedback, ideas, perspectives and needs. The Masterplan for the delivery of new Mandorah Marine Facilities was developed, informed by the previous broader stakeholder consultations and when at an appropriate level of detailed planning commensurate with stakeholder feedback, a final Masterplan was presented to stakeholders.

When this project transitioned from planning to delivery, stakeholder engagement also transitioned from information and needs gathering to information dissemination, and the focus turned to a more refined and smaller key stakeholder group. The delivery phase then set out to deliver the accepted Masterplan effectively, efficiently and within the project's constraints.

Between May and October 2021, the delivery team arranged meetings and delivered project updates to nine key project stakeholders and representative organisations including:

- Minister for Infrastructure, Planning and Logistics, Eva Lawler MLA;
- Minister for Recreational Fishing, Paul Kirby MLA;
- Member for Daly, Ian Sloan MLA;
- Sealink Pty Ltd;
- Amateur Fishermen's Association of the NT (AFANT);
- Wagait Shire Council;
- Representatives of the Tommy Lyons Traditional Owner group;
- Northern Land Council;
- Kenbi Rangers;
- Kenbi Reference Group; and
- Wagait Beach Progress Association.

The key purpose of this round of engagement was to advise stakeholders of the current proposed staged delivery of the new facilities, with information shared for feedback.

DIPL were scheduled to present a project update at the Belyuen Council meeting at the end of November, however due to COVID 19 outbreaks in remote communities in the NT during that time, additional travel restrictions were introduced and it was decided in conjunction with the Belyuen council chief executive that personnel would not travel to the community in person at that time, to minimise risk of COVID 19 transmission.

Hard copy, large colour maps were transported to Belyuen in time for the meeting, depicting both the graphically designed concept image showing the project stages, and also the overall site layout more detailed drawing. DIPL ensured they were available for questions and discussion via phone on the day of the meeting, or for later questions.

DIPL plan to attend a Belyuen council meeting at the earliest available opportunity in 2022, pending COVID 19 restrictions.

Stakeholders were advised in these briefings that the initial stage of the project would include:

- Access improvements for people with a disability through a gangway and floating pontoon, and a lift which can carry people who need mobility assistance as well as wheelchairs and prams;
- Breakwaters/rock groynes constructed to provide protection from swells;
- A new single lane boat ramp;
- A new ferry terminal building; and
- Modifications to the car park layout to add car/trailer bays and parking for the disabled.

Stakeholders were advised that a second stage of the project would be planned for delivery approximately five years after completion of stage 1, allowing for the necessary consolidation of the rock walls, and would include;

- A fishing platform built on the main breakwater (northern rock groyne), including a pedestrian walkway from the land;
- Extension of the access road to reach the pedestrian walkway and additional car parking, including car parking for ferry passengers and bays for the disabled; and
- The addition of a second lane to upgrade to a dual lane boat ramp, which may meet the roll on-roll off (ro-ro) needs into the future.

Key feedback garnered from stakeholders during this period included;

- Reinforcement of the priority of ensuring Disability Discrimination Act standard access to board the ferry at Mandorah expressed by Sealink, Wagait Shire Council and Wagait Beach Progress Association to ensure safe access for residents and visitors;
- Calls for improved boat ramp facilities at Mandorah and endorsement of the inclusion of a new boat ramp in the concept expressed by AFANT, Kenbi Rangers;
- AFANT, Sealink and Wagait Beach Progress Association called for the facilities to be delivered in a way that enabled future expansion, with AFANT predicting the facilities would become a tourist drawcard;
- AFANT advocated for the fishing platform envisaged for delivery in Stage 2 to be brought forward and for the Territory Government to commit funding to Stage 2 and deliver it sooner, and predicted that the platform would be more broadly used by visitors and locals beyond a fishing facility;
- Wagait Beach Progress Association called for the new marine facilities to include shade for ferry passengers and for access provisions for residents who were ageing or whom have a disability to be prioritised;
- Wagait Beach Progress Association was concerned that the concept design had changed from what was released in November 2020 and that the scale of the harbour inside the breakwaters was smaller, and also expressed reservations about the technical effectiveness and future maintenance of a lift being proposed to provide disability access;
- Wagait Beach Progress Association expressed some concerns about whether a lift, which was discussed as one of the potential options to provide access for people with disabilities, would be a viable option. DIPL advised that expertise from the successful tenderer would further refine options for disability access, in consultation with stakeholders;

- AFANT, Wagait Beach Progress Association and Wagait Shire Council emphasised the importance of providing toilet facilities; and
- Traditional Owner representatives and Kenbi Rangers expressed desire for local Indigenous employment, training and subcontract opportunities in the delivery of the project and also expressed interest in being involved in the potential operation of a café facility as part of the ferry terminal building should a suitable arrangement be negotiated.

8 Key Environmental Factors

The pre-referral checklist (NT EPA, 2021) was applied to undertake a self-assessment of the proposal's potential impact on each of the NT EPA's Environmental Factors. Brief explanations of potential impacts are provided in **Table 8-1**. Eleven of the 14 environmental factors were deemed to have potential significant impacts associated with the proposal, requiring further risk assessment and subsequent management. The factors identified for potential significant impact have then been further assessed in **Section 9**.

Table 8-1 Project environmental factors

Theme	Factor	Environmental values and sensitivities	Potential significant impact	Brief explanation of potential significant impact (or lack thereof)
LAND	Landforms	• No significant variations in terrestrial landform exist at the proposed project site. • The project site is approximately 500m south of Wagait Beach, a popular site for beachgoers, fishing and other recreational activities. • Construction of large civil infrastructure (breakwaters) in the intertidal zone can be considered a change (addition) to terrestrial landform and may alter adjacent coastal landforms over time (see factor 'Coastal processes' below).	Yes	• The project footprint does not directly impact Wagait beach or any other significant landforms. • No significant change to terrestrial landforms are proposed as part of the project, which predominantly works with existing levels. • Creation of artificial landforms in the form of breakwaters and, to a lesser extent, the causeway and boat ramp. • Changes to coastal landforms (beaches) adjacent to the breakwaters over time.
	Terrestrial environmental quality	• Disturbance of contaminants already present at the project site through construction activities. • Introduction of contaminants to terrestrial environment though construction activities and ongoing operation of the facility.	Yes	• Asbestos containing material identified in soil surrounding existing building. Will require isolation and removal. • Earthworks associated with the construction phase of project are expected to be minimal and majority of the site not identified as, or expected to be, contaminated. • Construction activities can lead to waste discharge and pollution of terrestrial environmental quality. • Long-term use of the new facilities will produce waste with the potential to impact terrestrial environmental quality. • Degradation of soil quality associated with clearing and ongoing erosion issues.
	Terrestrial ecosystems	• Recorded occurrences of native and introduced flora in the locality. • Recorded occurrences of fauna in the locality including four records of threatened species and 16 records of significant species.	Yes	• Project will involve clearing a portion of land to install infrastructure (carpark, roads, paths). • Temporary construction and laydown (cleared) areas will remove existing flora. • Potential for construction activities to impact native fauna. • Ongoing operation of the new facilities could reduce presence of native fauna in the project area (due to removed habitat, noise, lighting etc.).
WATER	Hydrological processes	• Surface water runoff and groundwater infiltration.	No	• No substantial surface water features at the project site. • No significant changes to terrestrial landforms (and therefore overland flows) as described in 'Landforms'. • Increase in impermeable land area (carpark, roads, paths) within footprint will alter natural infiltration. Drainage for the facilities will intervene for this.
	Inland water environmental quality	• Water quality in local surface water features. • Water quality in local groundwater system.	No	• There are no notable inland water features within the project footprint. • Rainfall runoff and infiltration to be aided by designed drainage. Appropriate filtering of gross pollutants before reaching the ocean.

Theme	Factor	Environmental values and sensitivities	Potential significant impact	Brief explanation of potential significant impact (or lack thereof)
				• Groundwater infiltration prohibited by geology. • Wastewater to be treated and managed in terms of release.
	Aquatic ecosystems	• Aquatic flora and fauna.	No	• No aquatic ecosystems exist within the project area.
SEA	Coastal processes	• The coastal geomorphology along the Cox Peninsula and associated processes: waves, hydrodynamics and sediment transport. • Ecosystems and biota dependant on the existing coastal processes.	Yes	• Construction of breakwaters will interrupt nearshore hydrodynamics and sediment transport, altering erosion and accretion patterns either side of the facility. • Localised change to nearshore hydrodynamic and wave climate due to the installation of the harbour. May create local impact to marine flora and fauna.
	Marine environmental quality	• The water, sediment and biota of the marine environment in the project area. • Quality of surface water runoff entering Darwin Harbour. • Water quality within and surrounding the proposed marine facilities once established.	Yes	• Dredging has the potential to release contaminants into the marine environment. Note all contaminants found to be below acceptable thresholds. • Potential water quality (turbidity) issues due to sediment plumes generated by dredging actions. • Dredging and construction activities may release waste and pollutants to the marine environment. • Surface water runoff from the proposed marine facilities may pick up litter, oil or grease from carpark and flow into the marine environment. • Siltation of the proposed marine facilities may occur due to constructed breakwaters lowering velocities within the harbour allowing the settlement of suspended particles (maintenance dredging).
	Marine ecosystems	• Marine and coastal fauna in the project area. • Significant marine and coastal benthos, flora and vegetation, include seagrass and corals.	Yes	• Direct destruction of marine ecosystems within the project's construction footprint. • Indirect impacts of dredging actions to nearby marine ecosystems. • Interaction/impact of construction activities with marine flora and fauna. • Long-term changes to coastal processes impacting marine flora and fauna.
AIR	Air quality	• Local air quality at the proposal site and along the main routes used to access the site both during and after construction.	Yes	• Dust mobilisation during construction. Will require typical suppression on site. • Exhaust emissions during construction and operation.
	Atmospheric processes	• Contribution to the NT's greenhouse gas emissions.	Yes	• Construction of the marine facilities will make a minor contribution to NT emissions overall. • Operation of the marine facilities will make a minor contribution to overall NT emissions. Potential small increase in electricity use

Theme	Factor	Environmental values and sensitivities	Potential significant impact	Brief explanation of potential significant impact (or lack thereof)
				compared to existing. A more reliable ferry service may also lead to less cars on the road and a reduction in overall greenhouse gas emissions.
PEOPLE	Community and economy	• The liveable environment of the Cox Peninsula and Greater Darwin. • Participation in jobs, businesses and education for the people of the Cox Peninsula. • Local and domestic tourism. • Connections to culture and community. • Health of communities on the Cox Peninsula.	Yes	• It is expected that this project will improve accessibility to the area and increase economic opportunities for residents and visitors to the area. • Increase in accessibility for residents of the Cox Peninsula to jobs, businesses, education and healthcare services.
	Culture and heritage	• Aboriginal Sacred Sites • European heritage such as World War II (WWII) sites and artefacts.	Yes	• Aboriginal sacred sites exist in the vicinity of the project and require mitigation and management measures to avoid impact. • WWII sites in the region but not in close proximity to the project area.
	Human health	• Local air quality with respect to nearby ferry patrons and general public. • Water quality in Darwin Harbour for recreational users.	Yes	• Contaminants and dust released during construction could impact nearby users of the area, such as ferry passengers. • Emissions from construction plant unlikely to be concentrated enough to act as an irritant to humans. • Dredging activities not expected to release contaminants at levels dangerous to human health or to areas where humans are present.

9 Environmental Impact and Risk Assessment

9.1 Overview

This section identifies and assesses all potential significant impacts to the NT EPA's Environmental Factors associated with the project. The inherent environmental risk associated with these impacts is then discussed. Management and mitigation measures to reduce this risk to the environment are outlined, allowing the residual risk to be assessed. The environmental risk assessment framework, inputs and outcomes are detailed in **Appendix D**, with relevant summary tables included in the sub-sections below.

9.2 Landforms

9.2.1 Objective

"Conserve the variety and integrity of distinctive physical landforms"

9.2.2 Potential Impacts

The potential impacts associated with the environmental factor 'Landforms' that have been identified are:

- The breakwaters, and to a lesser extent the reclaimed causeway and boat ramp, are large civil structures that will be installed in the nearshore environment. These structures can be considered landforms in their own right and constitute a significant change to the local nearshore morphology at the project site; and
- The installation of the breakwaters in the nearshore zone will alter wave and hydrodynamic patterns, and the sediment transport associated with these processes. This will lead to changes to coastal landforms (beaches) directly adjacent the harbour. These changes are likely to include seasonal patterns of increased erosion and accretion either side of the harbour, dependant on the seasonal direction of sediment. Due to a predicted net annual movement of sediment southwards, there may be a gradual long-term accretion of the beach to the north of the proposed facility and potential erosion to its south (detailed assessment of these sediment transport processes is presented in the *Sediment Transport Report* (Cardno, 2022d).

9.2.3 Guidance and Legislation

The *Ports Management Act 2015* is the piece of NT legislation relevant to the installation of coastal structures and coastal changes in Darwin Harbour. The *Planning Act 1999* legislates land use and development.

At the time of preparing this referral document, a dedicated environmental factor guideline for 'Landforms' was not available from the NT EPA. A guideline is available for the comparable factor from the WA EPA (2016a). It stipulates criteria to be used in determining whether a landform is to be considered significant, including:

- Variety;
- Integrity;
- Ecological importance;
- Scientific importance;
- Rarity; and
- Social importance.

Criteria considered to be relevant are discussed below.

Ecological importance

The landform has a distinctive or exclusive role in maintaining existing ecological and physical processes; for example, by providing a unique microclimate, source of water flow, or shade. The landform supports endemic or highly restricted plants or animals.

Sections of intertidal beach either side of the proposed harbour are likely to provide some ecological value for marine and intertidal fauna, though this is unlikely to be exclusive, nor supporting endemic or restricted range species.

Social importance

The landform supports significant amenity, cultural or heritage values linked to its defining physical features.

The beaches in the region of the project provide social amenity. The most frequented beach is Wagait, which lies well north of the proposed facility. Aboriginal sacred sites exist in nearshore areas to the north and south of the proposed facility, though a substantial distance alongshore.

9.2.4 Impact Assessment

Long-term evolution of the shoreline to the north of the main breakwater has been analysed based on a calculated net sediment transport rate of 12,000 m^3/year (Cardno, 2022d). The potential shoreline evolution over a 15-year period is plotted in **Figure 9-1**. Based on the assessment, it is estimated that after about 11 years the shoreline will reach the tip of the breakwater and sediment could start to be transported around the breakwater, and that the reach of shoreline impact is up to about 1 km alongshore.

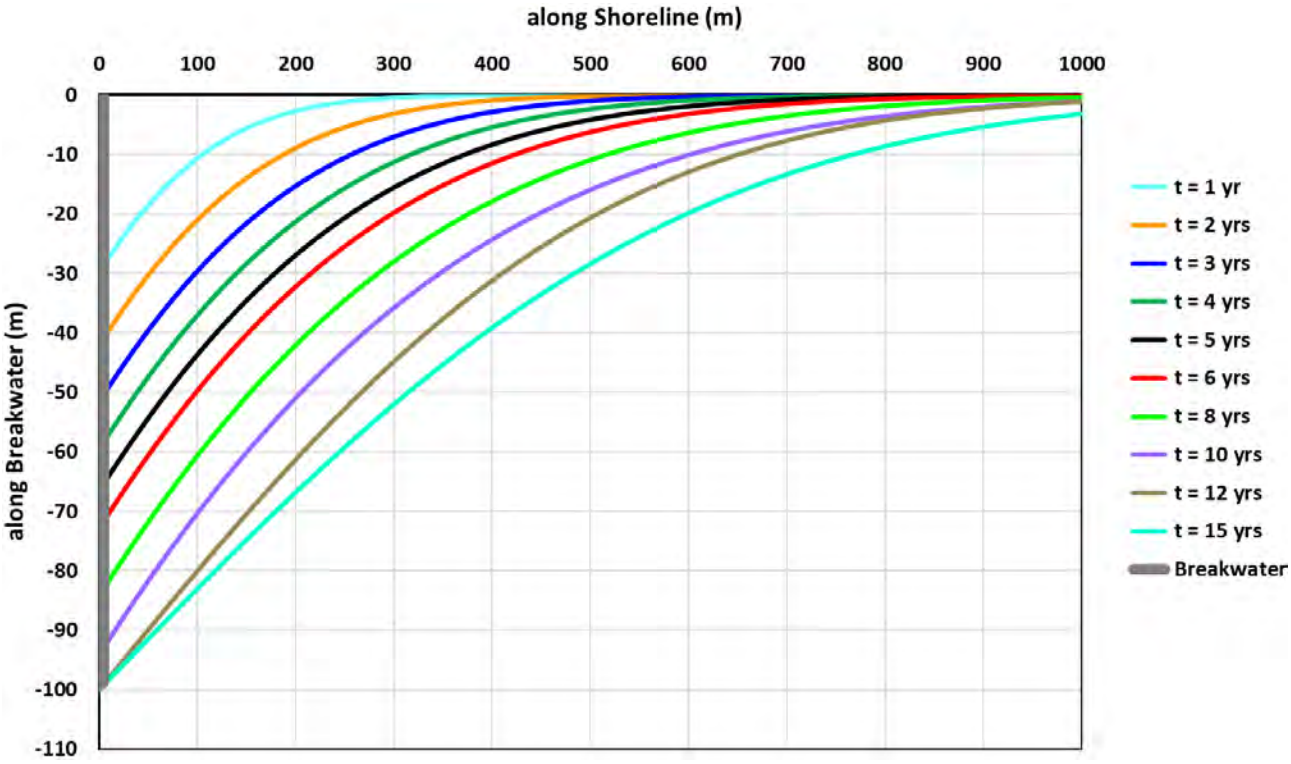


Figure 9-1 Shoreline Morphological Changes Updrift of the Main Breakwater

The assessment assumes a straight section of shoreline and consistent annual sediment transport rates. In reality, the following must be considered:

- There is only 300 m of shoreline north of the main breakwater before shoreline orientation makes a 120° turn to the north west. Accretion rates are unlikely to follow the curves presented in **Figure 9-1** around such a bend. Instead, sediment is likely to accumulate closer to the breakwater and not accumulate beyond the shoreline bend. Effectively, this would reduce the extent of impact and lead to more rapid bypassing of the breakwater; and
- This investigation has used potential sediment transport rates, which assumes that there is sufficient sediment available in the nearshore zone for these rates to occur. Aerial imagery, bathymetric data and

site observations show several areas of rock seabed, suggesting that much less sediment is likely to be available in the nearshore zone at the site.

The breakwater footprint and potential changes to adjacent beaches, due to interference with sediment transport, is presented in **Figure 9-2**. Similar rates of erosion to the south of the harbour (as accretion to the north) would be expected, however, significant surface and sub-surface rock is present that suggests erosion will be minor.

130°45'40"E

130°46'0"E

12°26'20"S

12°26'40"S

NORTH

Legend

- Breakwaters
- Potential long-term accretion (10 years)
- Potential long-term erosion (10 years)

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
2/03/2022

Size
A3

Scale
1:4,250

0 100 200Meters

LONG TERM COASTAL LANDFORM CHANGE

MANDORAH MARINE FACILITIES

ENVIRONMENTAL REFERRAL REPORT

FIGURE 9-2

9.2.5 Environmental Risk Assessment

The environmental risk assessment framework and table for the project is provided in **Appendix D**, with relevant inputs and outcomes for Landforms discussed below.

9.2.5.1 Breakwaters

The establishment of the breakwaters is a key objective of the project and therefore, not considered an impact to be mitigated. The design process has sought to minimise the scale of the breakwaters (being the most significant cost item), while achieving the functional requirements of the facility. The breakwaters may lead to environmental impact under the factor 'Coastal Processes' and has therefore been risk assessed in **Section 9.4**. The breakwaters will also impact the environmental factor 'Marine Ecosystems' and have been assessed in **Section 9.6**.

9.2.5.2 Beaches

The beaches directly adjacent the proposed harbour are not considered to be significant landforms in their own right. Changes to the beaches that are expected to be induced by the project may impact on environmental values under the 'Marine Ecosystems' and 'Culture & Heritage' factors and have been assessed in **Sections 9.6** and **9.10**, respectively.

9.2.6 Mitigation and Management

Long-term changes to the shoreline either side of the facility will be gradual, and are difficult to predict with certainty. It is recommended that the shoreline adjacent the harbour is monitored via aerial imagery and that sediment bypassing be undertaken should it be required. This requirement would be due to the observed erosion or accretion threatening to impact on sensitive ecosystems or cultural values/sites. It may also be due to any potential of ongoing sedimentation to impact operation of the facility. For example, sediment bypassing and entering the access channel.

Bypassing involves the excavation of sediment from the beach and nearshore areas 'updrift' of the harbour using excavators and/or bulldozers. Sediment is then placed and shaped on the 'downdrift' side of the harbour. Such bypassing, whether ad hoc or routine, is common for similar harbour facilities throughout Australia's coastline.

9.2.7 Summary

The environmental risk assessment for 'Landforms; is summarised in **Table 9-1**. Overall, the managed risk to Landforms from the project is considered Low.

Table 9-1 Summary of environmental impact and risk assessment for 'Landforms'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
LAND	Construction of landforms	Breakwaters (and to a lesser degree, causeway and boat ramp) are large structures that could be considered as new landforms.	Significant change to the existing nearshore morphology at the site.	Very High	Design to minimise size of breakwaters, causeway and boat ramp limited to maintaining functionality and safety.	Low
	Changes to local shoreline	Construction of breakwaters disrupts the natural longshore drift of sediment down the adjacent coastline.	> Disruption of net south migration of sediment. > Increase in beach width north of the facilities, smothering the existing benthic communities. > Erosion immediately south of the facilities due to blocking of usual sediment feed".	High	> Design to maximise natural bypassing mechanism. > Understanding (investigation and modelling) of expected sedimentation volumes and locations. > Allowance for ongoing sand bypassing that transfers sand past the marine facilities maintaining the net annual sediment transfer volumes	Low

9.3 Terrestrial Environmental Quality

9.3.1 Objective

"Protect the quality and integrity of land and soils so that environmental values are supported and maintained"

9.3.2 Potential Impacts

The potential impacts associated with the environmental factor 'Terrestrial Environmental Quality' that have been identified are:

- Earthworks and project construction activities may release contaminants already present at the site (e.g. asbestos associated with the existing building);
- Construction activities may lead to the discharge of waste and pollution, impacting terrestrial environmental quality;
- Degradation of soil quality may occur due to clearing associated within the project and subsequent erosion issues; and
- Operation of the new facilities will produce waste with the potential to impact terrestrial environmental quality.

9.3.3 Guidance and Legislation

Relevant legislation and guidelines for the assessment of Terrestrial Environmental Quality include:

- *Waste Management and Pollution Control Act 1998*;
- *Northern Territory Contaminated Land Guideline* (NT EPA, 2017);
- ANZECC & ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra;
- *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) National Environment Protection Council 1999;
- ANZECC/ARMCANZ Sediment Quality Guidelines 2019; and
- National Acid Sulfate Soils Guidance Series 2018.

9.3.4 Impact Assessment

The existing terrestrial geology, soils and landforms are discussed in **Section 5.5**, which outlines the known history of disturbance for the site and the potential presence of asbestos in topsoils immediately north of the existing carpark, associated with the abandoned building on Lot 50 (Cardno, 2022a). Beyond this, there is no basis for assuming contamination of existing soils within the project footprint, given the terrestrial environment observed and known history of site use (minimal and lack of industry).

The proposed project actions that will impact the terrestrial environment include:

- Shallow excavation and preparation of sub-grade for carpark, road and footpath installation;
- Minor excavation of trenches;
- Minor excavation and fill to connect landside and marine infrastructure (levels);
- Disturbance of temporary works areas for transport, site setup and stockpiling; and
- Import and installation of materials such as rock and metals (steel, aluminium).

Disturbance of the terrestrial soils is considered relatively minor for this project, which predominantly works with existing land levels for the majority of the construction footprint.

9.3.5 Environmental Risk Assessment

9.3.5.1 Exposure of contaminants during construction

Previous investigations have identified the presence of asbestos containing material (ACM) in the existing building on Lot 50. There is, therefore, a risk that asbestos may also be present in the surface soils directly surrounding the building. Investigations into the presence and, if necessary, extent of asbestos in the surrounding soils will be undertaken prior to commencing construction activities to identify any presence of friable asbestos, fibrous asbestos, or asbestos fines in sub soils that may become airborne. Based on the outcomes of these investigations appropriate management measures will be incorporated into the Contractor's EMP and implemented to avoid liberation of any ACMs identified in the building or soils. It is likely that the top layer of soils will need to be removed, contained and disposed offsite. This activity is common in development and is considered low risk if appropriately managed.

The likelihood of encountering asbestos at depth or other contaminants during site works is considered low, given the lack of industrial use of the site historically. Disturbance for project works will be relatively shallow and minor and is expected to impact predominantly natural geological material.

9.3.5.2 Release/introduction of contaminants during construction

The risks of petroleum hydrocarbon spills, or contamination by hazardous substances, is considered low given the use of appropriate management and mitigation measures stipulated within the NT Land Clearing Guidelines and Draft CEMP. Implementation of these management and monitoring measures will ensure the EPA's objective for soil quality will be met by the project. The project is not considered specifically high risk in terms of potential pollution or waste release, but the proximity to the marine environment requires increase scrutiny of management and response procedures.

9.3.5.3 Terrestrial clearing

Based on the findings of preliminary site investigations undertaken by Cardno (2022a), the proposed new terrestrial infrastructure footprint, calculated as approximately 3,000 m^2, comprises predominantly cleared land and *Terminalia spp* open woodland and does not affect any significant landforms. Temporary work areas, laydown areas, access routes and site buildings required during construction are anticipated to encompass an additional 30,000m^2 (3 hectares) of disturbance to terrestrial areas.

Impacts to geology and soil quality are not considered significant as the majority of impacts would be associated with increased erosion, loss of topsoil and soil contamination during construction and operation activities which will be minimised or avoided through the management measures detailed in the Draft CEMP (Cardno, 2022f) and only involve short-term or localised effects.

9.3.5.4 Contaminants released during operations

Operation of the facility is expected to produce general waste (litter) and waste associated with ablutions. Production of these will be typical of public terminal in semi-remote location. Appropriate design of waste management systems and ongoing management of the facility is expected to minimise environmental risk associated with waste production.

9.3.6 Mitigation and Management

The proposed measures applicable to the management of impacts on soils and landforms arising from the construction and operation of the landside development portion are described in detail in the Draft CEMP (Cardno, 2022f), which will provide a framework for the environmental management of the terrestrial construction activities associated with the project. The program will include detailed strategies, procedures and work practices, to avoid, mitigate or minimise impacts resulting from construction tasks or actions.

Management measures proposed include, but are not limited to:

- Erosion control features incorporated into the project design, to manage erosion and sedimentation while preserving topsoil and soil quality. Examples of erosions controls include slope stabilisation and diversion of surface run-off; and

> Soil contamination from leaks and spills of chemicals or hydrocarbons as well as incorrect solid and liquid waste disposal will be avoided through strict adherence to management measures laid out by the Draft CEMP. In addition, project design will include features to capture potentially contaminated surface water runoff prior to discharge to the environment in high risk areas.

Further detailed design of landside facilities will mitigate risk to environmental quality through best-practice drainage design and the facilities waste management system, as required by the *Waste Management and Pollution Control Act*. Ongoing maintenance and management of the facility will be required to ensure release of waste to the environment is controlled.

9.3.7 Summary

The environmental risk assessment for 'Terrestrial Environmental Quality' is summarised in **Table 9-2**. Overall, the managed risk to Terrestrial Environmental Quality from the project is considered Low to Medium.

Table 9-2 Summary of environmental impact and risk assessment for 'Terrestrial Environmental Quality'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
LAND	Exposure of contaminants during earthworks	> Construction activities – disturbance, excavation of soils > Exposure of potential Acid Sulfate Soils (ASS) > Exposure of potential metals or hydrocarbons > Exposure of asbestos containing soil	> Reduction in soil quality, stability and fertility > Impact to human health and surrounding terrestrial ecosystem > Contaminated runoff discharging into marine ecosystem	**Medium**	> Assessment of areas for contaminants of potential concern (e.g. asbestos) > Identification and removal of known contaminants prior to proceeding > Stop works if suspected contaminated soils or material encountered and further investigate > Limit the area of exposed earth and period of exposure	**Low**
	Contaminants released during construction activities	> Spills/leaks of petrol, oils, lubricants, hazardous materials, paints, thinners and litter	> Adverse impact on soil quality within and adjacent to project footprint	**Medium**	Contractor to develop a Hazardous Material Management Procedure including but not limited to the following: > Ensure stockpiles of bulk materials are well contained separated from exposed soils; > Training for personnel in implementation of safe work practices to minimise risks and impacts of spillage of fuels, chemicals and other contaminants; > Record and report all POL, chemical and hazardous substance spills; and > Ensure personnel have access to spill kits that contain an absorbent material and contaminated disposal sites.	**Low**

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Clearing areas of existing vegetation	> Removal of vegetation and topsoil leaves area susceptible to erosion	> Loss of topsoil during overland flows > Eroded topsoil causing sedimentation in marine environment	**Medium**	> All clearing to be undertaken in accordance with Land Clearing Guidelines (DENR, 2019) and defined in CEMP > Cleared land outside of the direct footprint is to be rehabilitated using appropriate soils and vegetation > Ongoing rehabilitation during construction > Appropriate drainage design to prevent ongoing erosion issues	**Low**
	Contaminants released during operation of facility	> Release of toxic waste to environment > Pollution and litter	> Hazardous substances contaminating soils > Litter and pollution reducing environmental quality	**Medium**	> Design of appropriate waste storage and management systems > Regular maintenance of waste management systems	**Low**

9.4 Terrestrial Ecosystems

9.4.1 Objective

"Protect terrestrial habitats to maintain environmental values including biodiversity"

9.4.2 Potential Impacts

The potential impacts associated with the environmental factor 'Terrestrial Ecosystems' that have been identified are:

- Clearing of land and terrestrial ecosystems to install infrastructure (carpark, roads, paths);
- Temporary construction and laydown (cleared) areas degrading or destroying ecosystems;
- Movement of machinery and light vehicles and the importation of fill may promote the introduction and/or dispersion of weeds;
- Potential for construction activities to directly impact native fauna;
- Potential creation of wildfire by construction activities; and
- Ongoing operation of the new facilities reducing the presence of native fauna in the project area (due to removed habitat, noise, lighting etc.).

9.4.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of terrestrial ecosystems include the following:

- *Territory Parks and Wildlife Conservation Act 1976*;
- *Weeds Management Act 2001*;
- *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth);
- *Guidelines for Assessment of Impacts on Terrestrial Biodiversity* (NT EPA, 2013); and
- *Northern Territory Guidelines and Field Methodology for Vegetation and Survey Mapping* (Brocklehurst et. al., 2007).

9.4.4 Impact Assessment

A detailed description of the existing flora and fauna within the terrestrial study area, based on desktop and field investigations conducted by Cardno in 2020 (Cardno, 2022a) is provided in **Section 5.8.** Key findings relevant to the terrestrial ecosystems impact assessment include:

- Terrestrial fauna listed under the EPBC Act which could occur within the study area, including 13 bird species (five vulnerable, four endangered and four critically endangered), nine terrestrial mammals (six vulnerable and three endangered), one vulnerable terrestrial reptile and 69 migratory bird species (including marine birds);
- No Endangered or Vulnerable flora and vegetative species under the EPBC Act, or Declared Rare Flora species under the TPWC Act were recorded;
- *Terminalia spp* mid-open woodland and cleared land were the abundant observed habitat;
- Field surveys did not record tree hollows, consistent leaf litter, stags or other obvious evidence of significant faunal habitation within the terrestrial study area; and
- Mission grass, a declared (Class B) weed under the *Weeds Management Act 2001* was identified within the study area.

The area proposed for permanent clearing, leading to direct loss of existing habitat is approximately 2,500m^2. Aforementioned temporary work areas are anticipated to encompass an additional 30,000m^2 of disturbance to

adjacent terrestrial areas encompassing *Drainage Open Woodland* (9,900 m^2) and *Eucalypt Woodland* (4,600 m^2) as mapped by DENR (2003). Detailed in the *Terrestrial Environment Report* (Cardno, 2022a) it is noted that portions of this area have been previously disturbed and do not present large scale vegetative communities relative to their distribution outside of the terrestrial study area. In addition, indications of significant fauna were not found and the habitats identified are well represented locally confirming fauna in the area are not specifically reliant on habitat within the study area and any breeding or foraging resources are not likely to be significantly reduced.

Direct loss of vegetation and faunal habitat caused by the proposed land clearing is not considered significant given any impact to the regional representation of these communities would be negligible. All remaining impacts to terrestrial habitat are to be mitigated through implementation of the Draft CEMP and associated weed management strategies.

9.4.5 Environmental Risk Assessment

The environmental risk posed to flora, vegetation and fauna within the study area as a result of the proposed land clearing are:

- Direct disturbance of up to 2,500m^2 of vegetation and faunal habitat;
- *Terminalia spp* mid-open woodland abundance and distribution will be affected at a local scale and represents a small portion of the widespread vegetation and faunal habitat in the Cox Peninsula area;
- Potential clearing of *Drainage Open Woodland* and *Eucalypt Woodland* as mapped by DENR (2003), represent low portions, 0.02% and <0.01%, respectively, of similar available habitat on the Cox Peninsula;
- Regional terrestrial habitat specific to matters of National Environmental Significance (MNES) and associated biodiversity values will not be affected by project activities; and
- A declared plant, *Cenchrus spp*, commonly known as mission grass, was identified throughout the study area and requires appropriate management strategies to prevent dispersion directly or via propagules.

The EPA's stated objective *protecting terrestrial habitats to maintain environmental values including biodiversity* will be achieved through project design to confine clearing to the terrestrial footprint and lay down area of the project, rehabilitating disturbed areas where practicable and managing potential construction and operational impacts in accordance with the Draft CEMP (Cardno, 2022f).

This objective has also been met through the knowledge of the abundance, diversity and geographic distribution of terrestrial flora and vegetation in the Cox Peninsula area that has been generated through the surveys conducted as part of this assessment (Cardno 2020a).

Risk to individual species considered MNES (or listed under the TPWC Act) have been assessed in detail as part of the EPBC Act 'self-assessment' (**Section 10**). This assessment has generally found low risk to priority fauna from the project, assuming appropriate management of construction activities.

9.4.6 Mitigation and Management

The proposed mitigation measures applicable to the management of impacts on terrestrial ecosystems arising from the construction and operation of the landside development portion are described in detail in the Draft CEMP (Cardno, 2022f), which provides the framework for the environmental management of the terrestrial construction activities. The final CEMP program will include detailed strategies, procedures and work practices, to avoid, mitigate or minimise impacts resulting from construction tasks or actions.

Management measures proposed include, but are not limited to:

- No clearing or disturbance outside of the approved disturbance envelope;
- Where practicable construction laydown areas will be located in previously disturbed areas and will be rehabilitated or used for other purposes following completion of construction activities, if not required for other purposes, to minimise loss of vegetation;

- Clearing methods which minimise potential harm to fauna species to be used (i.e. staged clearing to maximise the potential for mobile species to move to adjoining areas, checking for nests or burrows prior to clearing);
- Dust control measures will be implemented such as regular watering of unsealed roads, exposed surfaces and active construction areas, and progressive rehabilitation of disturbed areas, which are no longer required;
- Fill, if required, will be obtained from weed-free sources;
- The principal contractor will develop and implement a Weed Management Program in consultation with DIPL; and
- Vehicle and equipment access will be restricted to designated access roads where possible.

9.4.7 Summary

The environmental risk assessment for 'Terrestrial Ecosystems' is summarised in **Table 9-3**. Overall, the managed risk to Terrestrial Ecosystems from the project is considered Low.

Table 9-3 Summary of environmental impact and risk assessment for 'Terrestrial Ecosystems'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
LAND	Removal of vegetation due to land clearing of site for construction footprint and temporary work areas	> Removal of native flora including: - Eucalyptus species - open woodland, and - open grassland.	> Loss of biodiversity on the Cox Peninsula	Medium	> Land clearing only to be undertaken in approved areas and as per NT land clearing guidelines > Avoidance of significant and valuable vegetative communities > Any areas temporarily cleared are to be rehabilitated using native seed	Low
	Clearing of potential fauna habitat for construction footprint and temporary work areas	> Removal of fauna habitat	> Injury of death of fauna or destruction of habitat	Medium	> Land clearing only to be undertaken in approved areas and as per NT land clearing guidelines > Pre-clearance relocation of identified fauna	Low
	Noise, vibrations and lighting at Mandorah due to construction activities	> Noise, vibrations and lighting impacting fauna	> Loss of habitable area for fauna	Low	> Contractor to develop a Noise Management Plan > Lighting only focused on works, not surrounding habitat, light shields if needed	Low
	Fire ignition due to construction activities	> Uncontrolled fire	> Loss or damage to terrestrial ecosystems	Medium	> Contractor to develop a Fire Management Plan	Low

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Dust generation due to construction activities	> Generated dust settling on terrestrial ecosystems	> Adverse health impacts to local flora if dust settles on foliage	**Medium**	Contractor to develop a Dust Management Plan including but not limited to the following: > Watering of temporary roads and stockpile areas; > Watering down affected vegetation; > Use of dust suppression equipment; and > Speed limits within on site roads.	**Low**
	Vehicular movement into site carrying weed species	> Introduction of weeds to site	> Loss of native biodiversity on the Cox Peninsula due to pressure from introduced species	**Medium**	Contractor to develop a Weed Management Plan including but not limited to the following: > Review and relevant weed mapping and signpost areas of significant weed infestation; > Vehicle washdown stations; and > Routine monitoring of infestations and controls.	**Low**
	Application of water as a dust control measure	> Contaminated water from water storage facilities or dust suppression measures adversely impacting vegetation	> Loss of vegetation if contaminants leach into soils	**Low**	> Water storage facilities to be located away from vegetation Water used for dust suppression shall be of suitable quality	**Low**

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Increased vehicle traffic during construction activities	> Increased likelihood of vehicle strike	> Death or injury to fauna	Medium	> Training for all drivers and operators on local fauna most likely to be encountered > Suitable speed limits into and around site	Low
	Increased vehicle traffic during operations	> Increased likelihood of vehicle strike	> Death or injury to fauna	Medium	> Signage to watch out for wildlife > Suitable speed limits into and around site	Low
	Asbestos contamination encountered on Lot 50	> Expose asbestos fibres to ecosystems	> Adverse health impacts to local fauna	Low	> If asbestos is encountered when clearing Lot 50, material is to be removed and disposed of by trained personnel	Low
	Increase in noise due to increased patronage	> Noise impacting fauna	> Loss of habitable area for fauna	Medium	> Fencing/pathways designed to keep pedestrians away from bush	Low
	Increase in litter due to increased patronage	> Fauna mistaking litter for food source	> Death or injury to fauna	Medium	> Adequate number of well-lit bins provided	Low
	Lighting at extended car park and ferry terminal	> Light impacting fauna	> Loss of habitable area for fauna	Medium	> Lights to focus on car park and ferry terminal > Minimise light intrusion into surrounding environment	Low

9.5 Coastal Processes

9.5.1 Objective

"Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained"

9.5.2 Potential Impacts

The potential impacts associated with the environmental factor 'Coastal Processes' that have been identified are:

- Installation of the breakwaters will interrupt nearshore hydrodynamics, waves and sediment transport, altering erosion and accretion patterns either side of the facility. This may impact local marine ecosystems, flora and fauna; and
- Localised changes to nearshore hydrodynamic and wave climate due to the installation of the harbour. This may lead to local impact to marine ecosystems, flora and fauna.

9.5.3 Guidance and Legislation

The *Ports Management Act 2015* is the piece of NT legislation relevant to developments that will influence coastal processes in Darwin Harbour.

A guideline is available for the comparable factor from the WA EPA (2016b). In general, the purpose of the guideline is to ensure potential changes to coastal processes associated with projects have been properly considered and quantified, to allow assessment of impacts to other factors such as Landforms and Marine Ecosystems.

9.5.4 Impact Assessment

The purpose of installing a harbour is to create a tranquil, internal water body for safe use. In this case, for safe ferry passenger transfer and safe boat ramp launching and retrieving. This diverts coastal energy to the areas around the harbour. Because this is a design goal, significant local impacts to coastal processes are expected. The design process looks to minimise concentration of coastal energy with smooth curvature that diverts current flow and void spaces that dissipate wave energy upon impact.

A detailed description of the existing metocean climate within the study area, based on available datasets and additional data collection conducted by Cardno (Cardno, 2022i) is provided in **Section 5.3**.

9.5.4.1 Tidal Current Impacts

Tidal flow ebbs and floods in a north-south direction approximately parallel to the shoreline at the proposed facility. Illustrated below in **Figure 9-3** the higher velocity tidal current velocities, approaching 1.0 m/s are constrained to deeper water approximately 250 m offshore, with peak current velocities within close proximity of the proposed development not exceeding 0.4 m/s.

The breakwater structures will create an impermeable obstruction to the north-south nearshore flow, causing localised flow redistribution. Potential impacts to tidal currents are considered localised and insignificant, therefore not having any potential to affect tidal currents on a broader regional scale (e.g. Darwin Harbour or its compartments).

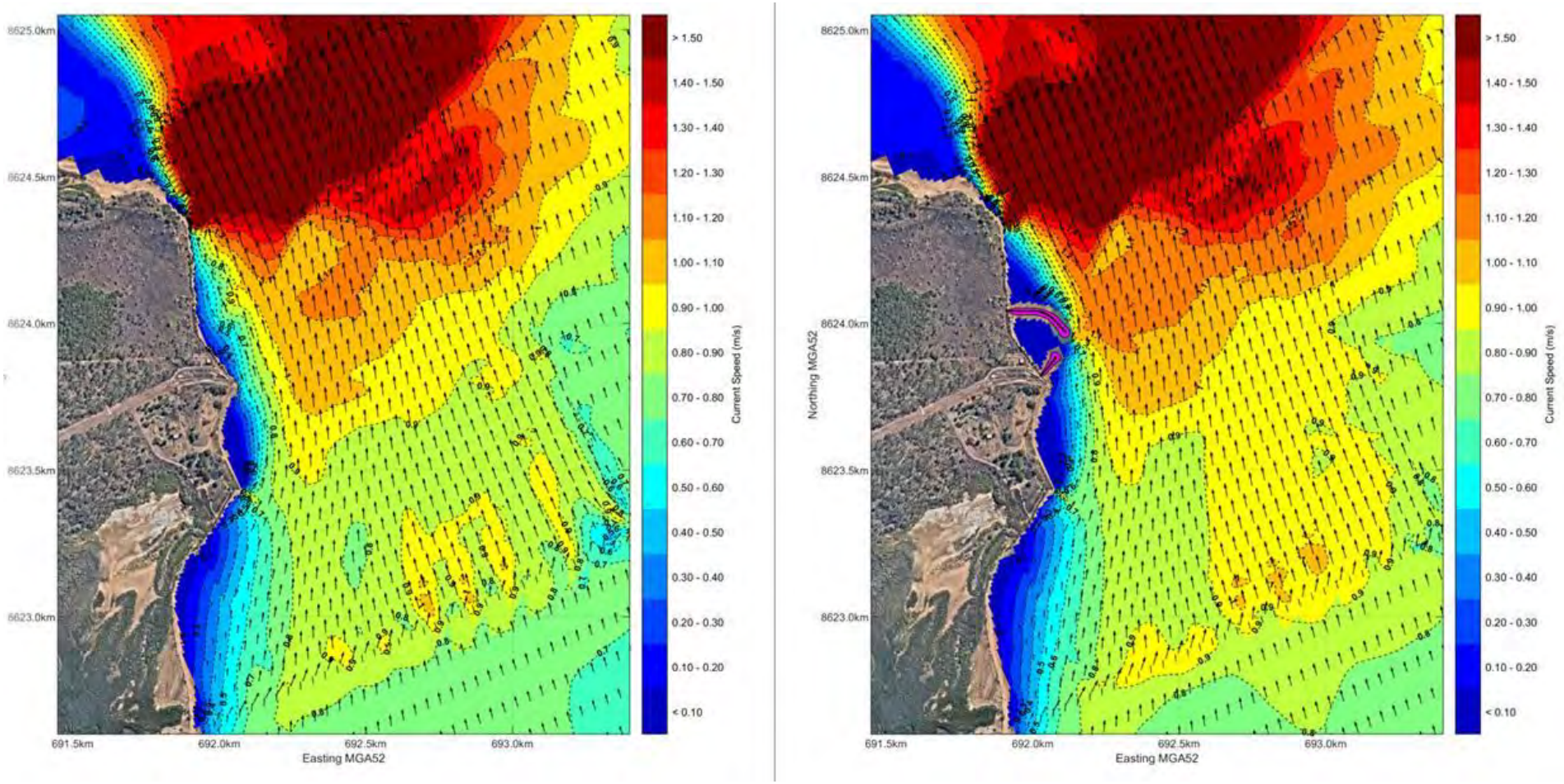


Figure 9-3 Pre- and post-development spring tide ebb flows.

9.5.4.2 Sediment Transport Impacts

Detailed in the *Sediment Transport Report* (Cardno, 2022d), the net potential for sediment transport was found to be between 2,000 and 12,000 m^3/year in a southerly direction and is considered to be in equilibrium with the current wave climate. By way of detailed sediment transport modelling, the report assessed the impact breakwaters would have on the longshore sediment transport which concluded that the shoreline is likely to accrete on the updrift side, with commensurate erosion on the downdrift side.

The build-up of sediment unable to migrate south due to the northern breakwater will cause the beach width to widen, smothering the existing seabed and intertidal zone. Based on the littoral drift analysis undertaken by Cardno (2022d) it is estimated that after approximately 11 years the shoreline will reach the tip of the breakwater and sediment could start to be transported around the breakwater. Previous **Figure 9-2** illustrates the potential shoreline change.

9.5.4.3 Wave Conditions

As demonstrated for a range of wave conditions (directions) in **Figure 9-4** to **9-6**, wave energy is generally dissipated rather than reflected or focused by the harbour structures. Some local focusing and reflection is expected and this will contribute to the changed sedimentation patterns mentioned above. The lack of wave energy entering the harbour is expected to have the effect of increased siltation rate, due to sediment settling out of suspension.

9.5.5 Environmental Risk Assessment

The environmental risks posed by changes to coastal processes are associated with the environmental factors ‘Landforms’ (see **Section 9.2**), ‘Marine Environmental Quality’ (**Section 9.6**) and ‘Marine Ecosystems’ (**Section 9.7**). In general, these managed impacts are expected to pose low risk to the environment.

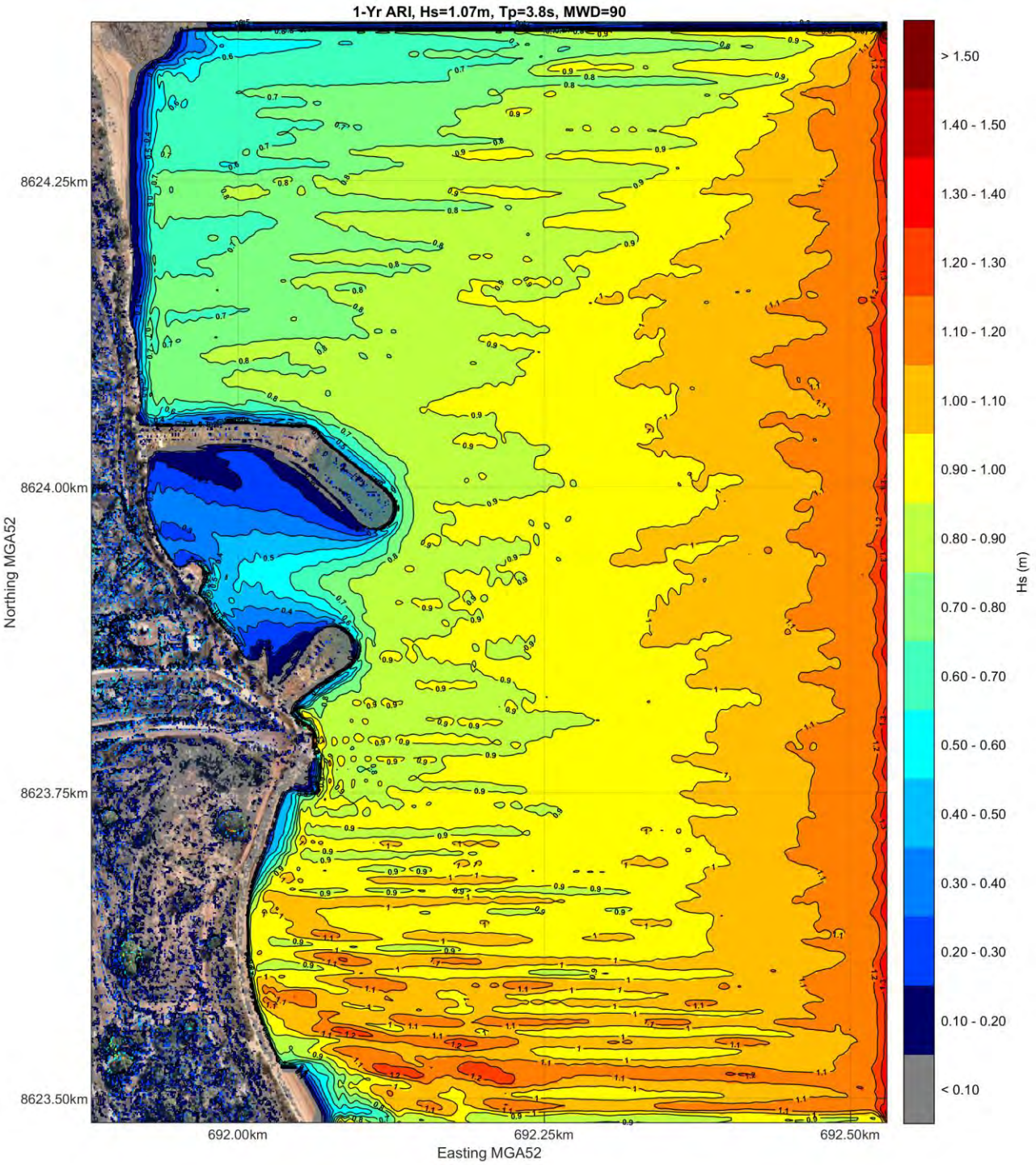


Figure 9-4 SWASH wave modelling result for 1-year ARI waves from E direction

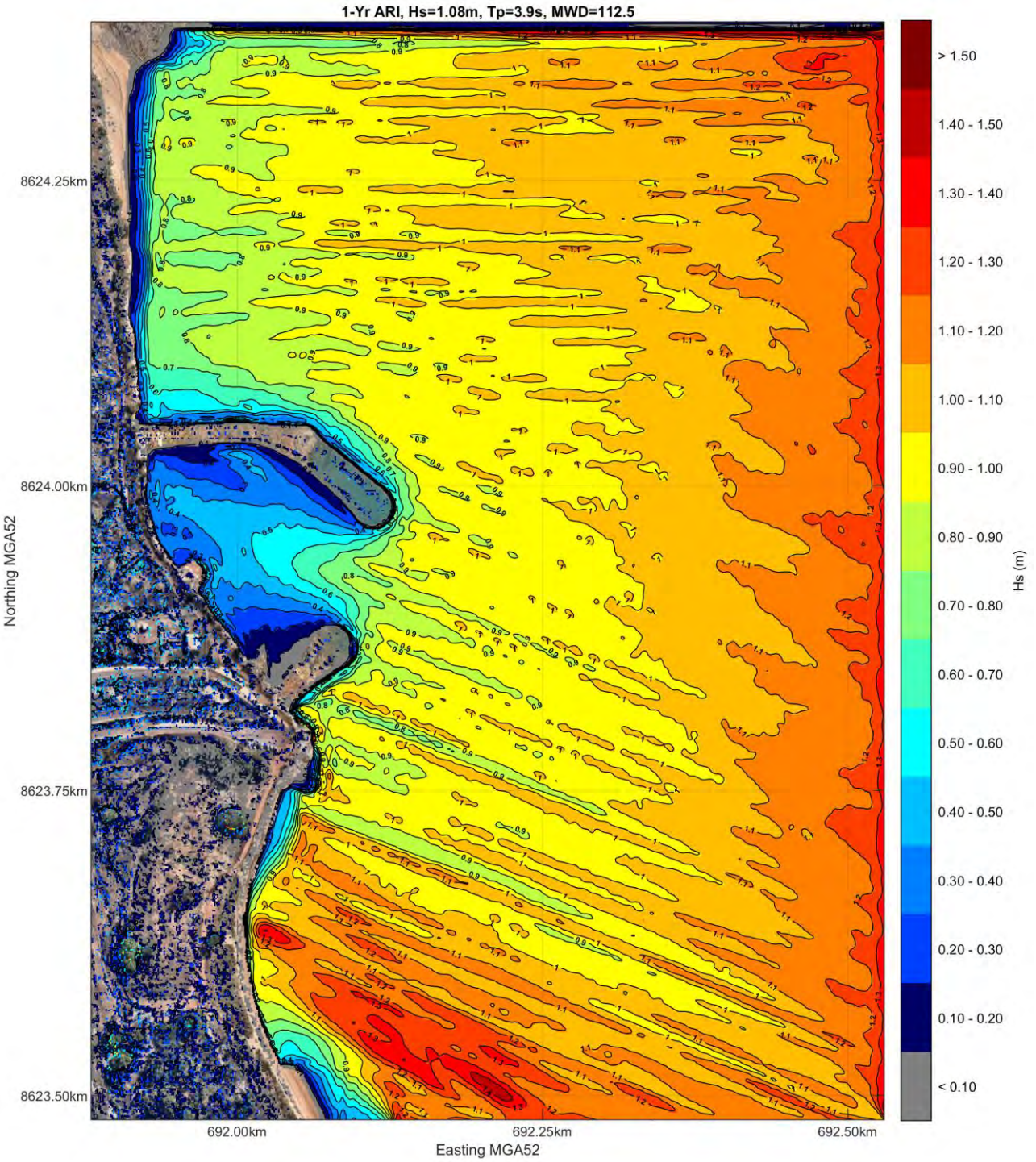


Figure 9-5 SWASH wave modelling result for 1-year ARI waves from ESE direction

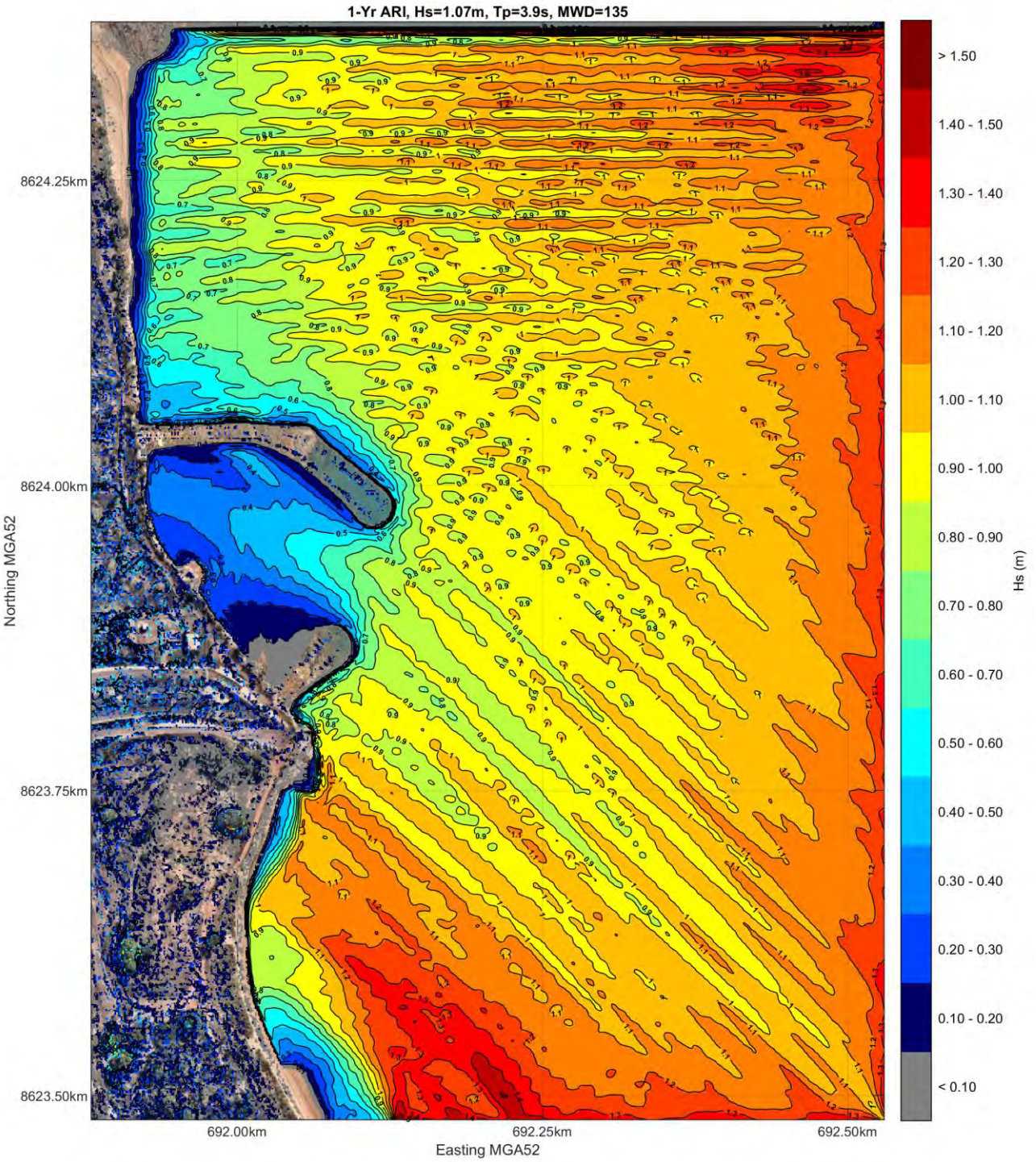


Figure 9-6 SWASH wave modelling result for 1-year ARI waves from SE direction

9.6 Marine Environmental Quality

9.6.1 Objective

"Protect the quality and productivity of water, sediment and biota so that environmental values are maintained"

9.6.2 Potential Impacts

The potential impacts associated with the environmental factor 'Marine Environmental Quality' that have been identified are:

- Dredging has the potential to release contaminants from seabed sediments into the marine environment;
- Potential water quality (turbidity) issues due to sediment plumes generated by dredging actions;
- Dredging and construction activities may release waste and pollutants to the marine environment;
- Surface water runoff from the proposed marine facilities may pick up litter, oil or grease from carpark and flow into the marine environment; and
- Siltation of the proposed marine facilities may occur due to constructed breakwaters lowering velocities within the harbour allowing the settlement of suspended particles (maintenance dredging).

9.6.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of marine environmental quality include the following:

- *Waste Management and Pollution Control Act 1998*;
- *Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory* (NT EPA, 2013);
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. (ANZECC & ARMCANZ 2000). Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra;
- *National Assessment Guidelines for Dredging 2009* (NAGD). Commonwealth of Australia, Canberra;
- *ANZECC/ARMCANZ Sediment Quality Guidelines* (2019); and
- National Acid Sulfate Soils Guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management (2018).

9.6.4 Impact Assessment

9.6.4.1 Marine Sediment Quality

Marine sediments in the dredging footprint were comprehensively sampled and analysed for physical and chemical properties as per the guidance of the National Assessment Guidelines for Dredging (NAGD, 2009). The investigation is detailed in the *SAP Implementation Report* (Cardno, 2022c). The investigation led to the following findings:

- All concentrations of metals and metalloids for the site were below all assessment criteria for offshore and onshore disposal of sediments;
- Two locations returned a concentration of Tributyltin (TBT) above the limit of reporting (LOR) – one of these was outside of the proposed dredge footprint;
- The 95% UCL for Tributyltin corrected for 1% TOC (9.5 µg/kg), for samples collected within the proposed dredge footprint, marginally exceeded the NAGD low screening level of 9 µg/kg;
- No other samples recorded concentrations of organotin compounds above the LOR;

- Additional investigations at 12 samples sites surrounding the site with elevated TBT found all to be below the LOR. This suggested the previous detection was an isolated occurrence, not representative of a contamination hotspot. The recalculated 95% UCL for TBT, incorporating the additional sampling, was well below the NAGD low screening level;
- No organic compounds were detected, with all BTEX, TRH, PAH and organochlorine pesticide concentrations were below their respective LORs in all samples; and
- Two samples were found to have Net Acidity values above the recommended management action criteria (Simpson et al., 2018) for the dredging of sands to loamy clays; > 1000 tonnes.

Given a low CSD dredge spill rate (see *Sediment Transport Report* [Cardno, 2022d]) the potential for contaminants in sediments resuspended during dredging or in the dredge return water to bio-accumulate in aquatic organisms are considered to be negligible. Additionally, only low levels of contamination were recorded, the potential for the proposed works to increase the risk to aquatic biota over a long period is considered to be very low.

Analysis shows that PASS is present at the site and likely to be present in surface-level seabed sediments rather than in those at depth. It should be conservatively assumed that all sediments within the top 0.5m contain PASS and be managed as such. It should be noted that when saturated the opportunity for oxidisation of dredged material is negligible as the available supply of oxygen necessary for a significant rate of acid formation is too low.

The required investigations into the contamination status of unconsolidated marine sediment to be dredged by the project has been undertaken, finding it suitable for offshore disposal. This, combined with the relatively small volume and proposed dispersion method, indicates that risk to marine environmental quality associated with contaminated sediment is low.

9.6.4.2 Sedimentation

Note that long-term sedimentation is discussed in *landforms* (**Section 9.2**), and siltation is discussed below. This section refers to temporary sedimentation from dredging effects. Sediment deposition thickness has been modelled for the proposed dredging program (Cardno, 2022d). **Figures 9-7** and **9-8** display the predicted deposition thickness for dredging during spring and neap tides, respectively. It demonstrates that deposition is generally negligible (in the order of mm) outside of the direct project footprint. This is due to the relatively fines sediment grain size and string tidal currents at the site.

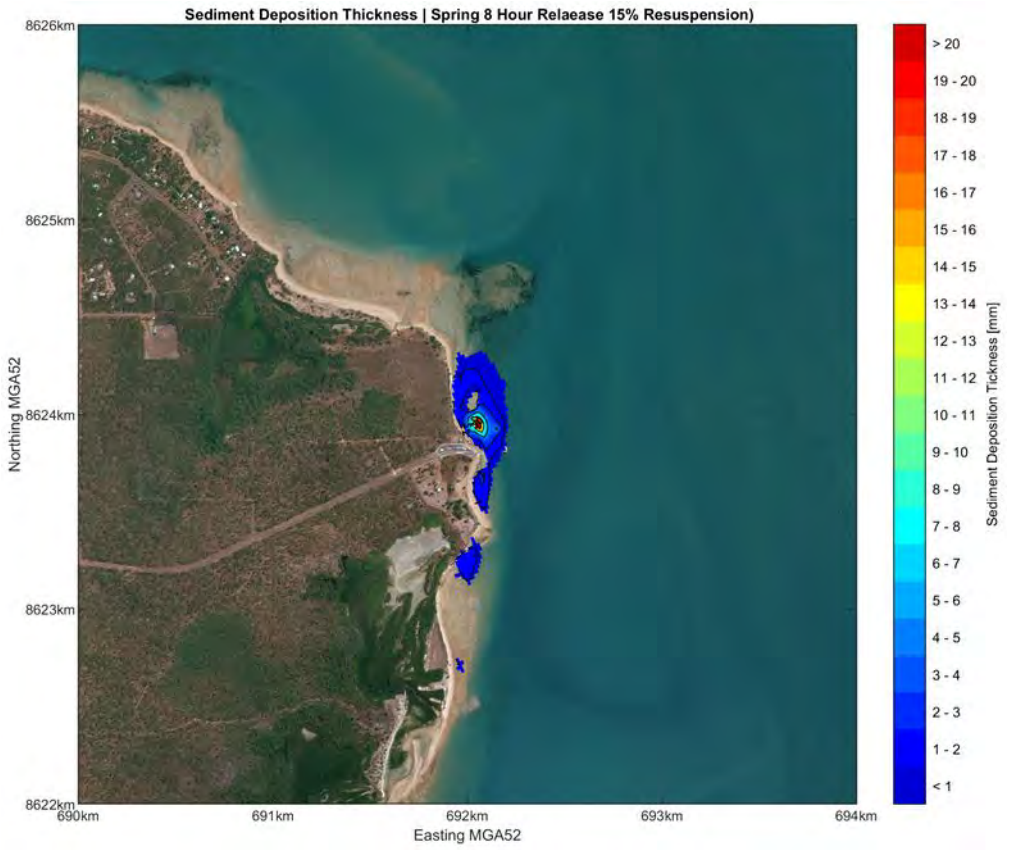


Figure 9-7 Sediment deposition thickness during dredging (Spring tide)

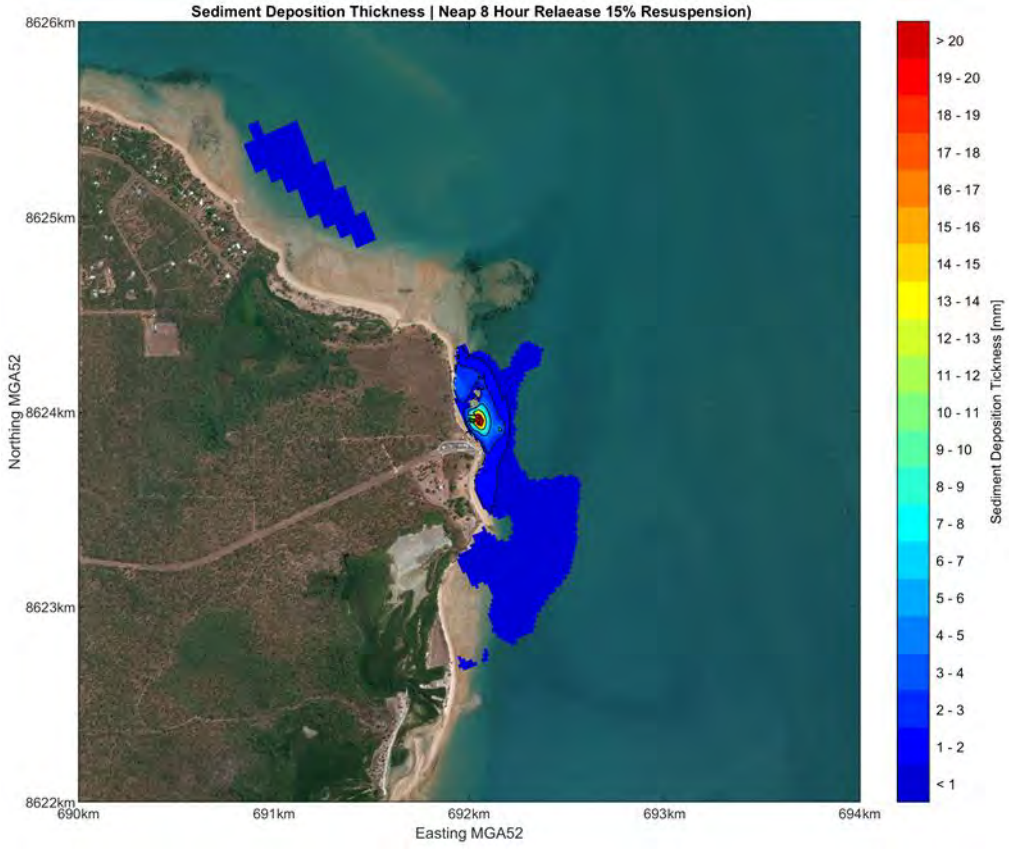


Figure 9-8 Sediment deposition thickness during dredging (Neap tide)

9.6.4.3 Long-term Sedimentation (Siltation)

The breakwaters are designed to reduce wave and current conditions for the safe navigation of vessels, leading to an unavoidable decrease in velocities and increase in siltation. To maintain desired bed levels within the proposed tolerances, maintenance dredging is likely to be required at regular temporal intervals. The sedimentation rate calculated provides an estimate of the length of maintenance dredging intervals required to keep bed levels within the siltation allowance of 0.3 m. Modelled sedimentation rates result in a maintenance dredging interval of 1.4 years.

$$Maintenance\ Interval = \frac{0.3\ m}{0.210\ m\ /yr} = 1.4\ years$$

This sedimentation rate is likely to be a conservative estimate due to the following:

- The sedimentation volume is based on a dry bulk density of 350 kg/m^3. This represents freshly deposited mud, and will consolidate over time as more sediment is deposited above it, which will double (or more) in density over time, halving the volume; and
- The passage into and out of the harbour by the ferry, and to a lesser extent, recreational vessels, will stir up freshly deposited sediment, thereby reducing the amount of sediment retained in the harbour.

Hydrographic survey should be regularly undertaken upon the completion of construction of the marine facilities to quantify sedimentation rates within the basin. As the predicted sedimentation rate is likely conservative, measured sedimentation rates are expected to lesser, extending the interval required between maintenance dredging campaigns.

It is more likely, due to the above, that maintenance dredging would be required approximately every 5 to 7 years. This is in line with similar facilities within Darwin Harbour, for example Cullen Bay Ferry Terminal.

9.6.4.4 Marine Water Quality

9.6.4.4.1 Physical Effects

Changes to marine water quality, in terms of elevated turbidity/SSC have been modelled based on the proposed dredging and disposal actions. The methodology and results of this are presented in detail in the *Sediment Transport Report* (Cardno, 2022d). Typically, the elevated turbidity is predicted to be short-term (temporary) and limited to the near-field at both the extraction and deposition sites. The peak total suspended solids (TSS) concentrations, above background, for dredging during spring and neap tides (95% exceedance) are presented in **Figures 9-9** and **9-10**, respectively.

Overall, magnitudes of suspended sediment concentrations are greater at the dredge site when compared to the disposal site. For all scenarios, 95th percentile suspended sediment concentrations of greater than 50 mg/L are localised within the dredge footprint. This outcome is mainly attributed to the fact that current speeds in those areas are relatively low, so the suspended fine sediment does not disperse, and remains within the project area until the dredging works stop for the day. To understand the level of environmental risk associated with modelled dredge plume dispersion, sensitive environmental receptors and their tolerance must be understood. This is discussed with respect to 'Marine Ecosystems' in **Section 9.7**.

In general, however, modelling indicates that changes to physical water quality (turbidity) associated with dredging is likely to be temporary and comparable to natural variability in background turbidity, for all areas outside of the dredge footprint and immediate point of disposal.

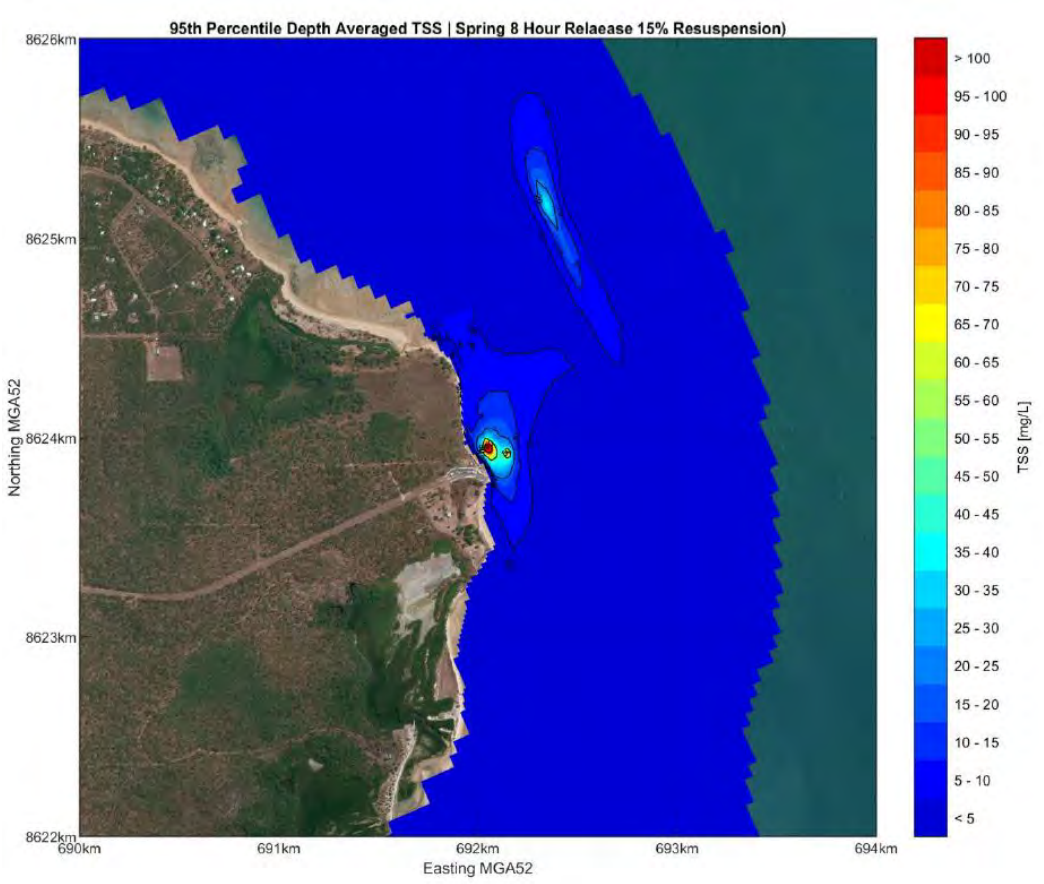


Figure 9-9 95th percentile TSS (depth-averaged) concentration (above background) – spring tides

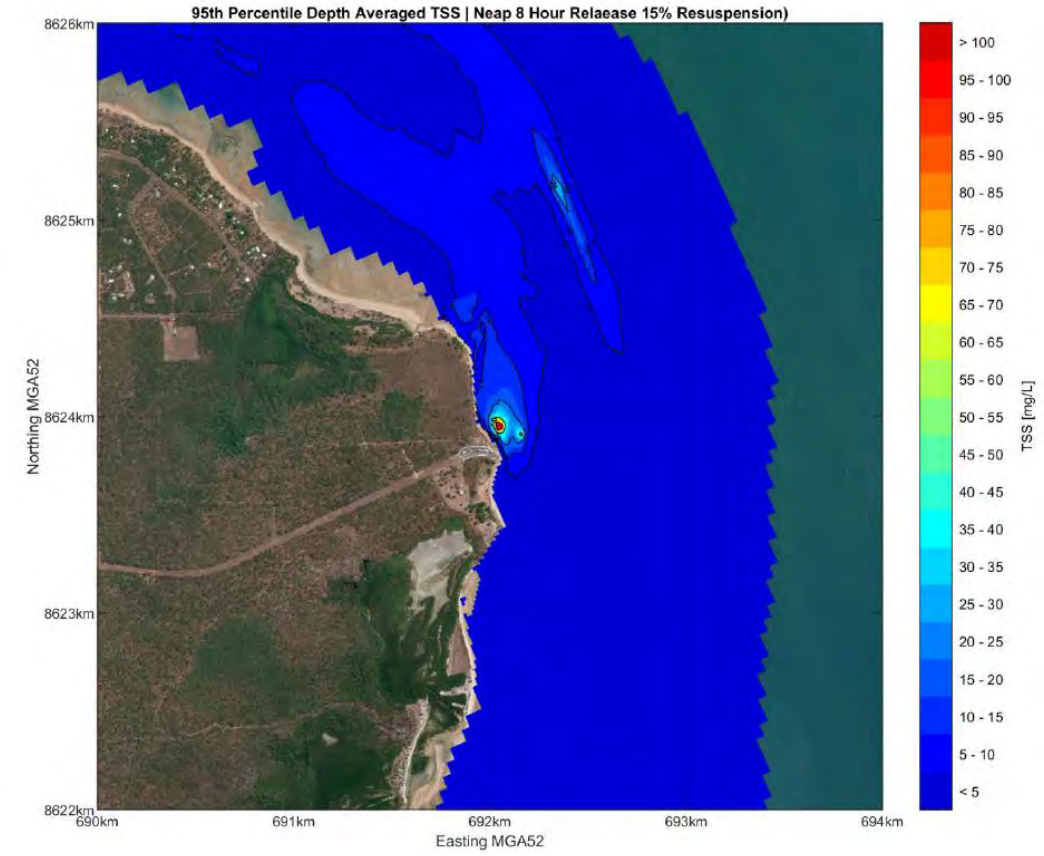


Figure 9-10 95th percentile TSS (depth-averaged) concentration (above background) – neap tides

9.6.4.5 Waste and Pollution

As construction activities will occur over and adjacent to Darwin Harbour, a risk exists that waste and pollution generated will enter the marine environment impacting marine water quality, including:

- Construction materials;
- Diesel emissions from dredger support vessels;
- Accidental hydrocarbon or chemical spills; and
- General litter.

Risk to the marine environment can be managed through adequate waste management and chemical storage protocols.

9.6.4.6 Long-term Water Quality

The capital dredging program is expected to run for approximately three months. The majority of the program will be solely dredging rock material with suspended sediment levels predicted to be much lower than for dredging of unconsolidated materials. Elevated sediment concentrations are temporary and will have no impact on long term water quality.

A maintenance dredging schedule will be developed post construction of the marine facilities, with bathymetric surveys to inform required maintenance intervals (**Section 9.6.4.3**). Maintenance programs will again elevate suspended sediment levels. Dredging will predominantly take place within the marine facilities, due to low current speeds and being enclosed by breakwaters it is expected that future sediment plumes will be largely contained within the marine facilities and be substantially less (in duration and magnitude) than those modelled for capital dredging.

9.6.5 Environmental Risk Assessment

The greatest risk to marine environmental quality is due to the disturbance of marine sediments during dredging and disposal. Modelling has shown sediment deposition to be minor and mostly limited to within the dredge footprint. High sediment concentrations are also largely restricted to the dredge footprint and disposal sites, but may still have the ability to impact the marine ecosystem, assessed in **Section 9.7**.

With appropriate controls in place, the following pose a low risk of significantly impacting marine environmental quality:

- Release of contaminants from marine sediments. The risk assessment concluded that the unconsolidated layer of soft sediments is considered to be clean and suitable for offshore disposal;
- Introduction of contaminants / pollution into the marine environment; and
- Changes to physical water quality beyond the natural range of variability.

9.6.6 Mitigation and Management

The proposed measures applicable to the management of impacts on marine environmental quality arising from dredging activities are described in detail in the Draft DSDMP (Cardno, 2022e) which outlines a framework for the environmental management of dredging activities associated with the project. The program will incorporate management systems detailing strategies, procedures and work practices, to avoid, mitigate or minimise impacts on marine environmental quality.

Management measures relating to marine environmental quality include, but are not limited to:

- Control actions during dredging to maintain water quality below appropriate thresholds;
- Characterisation of material to be disturbed and assessment against thresholds given the receiving environment;
- Inspections and audit of vessels and plant, controlled via DSDMP and CEMP;

- Waste and pollution management and control during dredging; and
- Reporting and response protocols should a spill occur.

9.6.7 Summary

The environmental risk assessment for ‘Marine Environmental Quality’ is summarised in **Table 9-4**. In general, these managed impacts are expected to pose low to medium risk to the environment The environmental risks posed to ‘Marine Ecosystems’ by the relevant changes to marine environmental quality discussed are detailed in **Section 9.7**.

Table 9-4 Summary of environmental impact and risk assessment for 'Marine Environmental Quality'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
SEA	Disturbance of marine sediments (fines)	> Dredging actions, spoil transfer and disposal, rock placement and piling	> Elevated suspended sediment concentration in marine water > Sedimentation in marine environment > Potential impact to benthic communities and other biota	High	> Model dredging and disposal actions to properly understand dredge plume dispersion > Gain an understanding of sensitive marine environmental receptors and their tolerance > Control actions to maintain water quality below appropriate thresholds (i.e. altering dredging activities [e.g. volumes, locations] to limit sediment resuspension, dredging only on certain tides etc.)	Low
	Release of contaminants from marine sediments	> As per actions above - predominantly dredging and disposal	> Toxic contaminants made available to marine ecosystem for biological uptake and bioaccumulation > Potential impact to ecosystem health	Medium	> Characterise material to be disturbed to understand locations and levels of contamination > Assess levels of contamination against appropriate thresholds, given the nature of the receiving environment > Isolate, remove and confine areas where contamination is potentially toxic to the marine environment	Low

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Introduction of contaminants/pollution to marine environment	> Construction activities - inappropriate waste disposal, accidental oil/chemical spill	> Toxic contaminants introduced to marine ecosystem for biological uptake and bioaccumulation > Potential impact to ecosystem health	**Medium**	> Inspection / audit / washdown of vessels and plant, outlined in DSDMP and CEMP > Reporting and response protocols should a spill occur - oil/chemical spill response etc.	**Low**
	Release of sediments from land	> Disturbance/stockpiling of material on land, lost due to run-off, wind etc.	> Elevated suspended sediment concentration in marine water > Sedimentation in marine environment > Potential impact to benthic communities and other biota	**Medium**	Controlled by CEMP: > Appropriate stockpiling technique and location > Prevention by bunding, erosion control etc. > Response plan for release of material	**Low**
	Disturbance of marine sediments (fines)	> Rock placement and piling	> Elevated suspended sediment concentration in marine water > Sedimentation in marine environment > Potential impact to benthic communities and other biota	**Medium**	> Model dredging and disposal actions to properly understand dredge plume dispersion > Gain an understanding of background conditions > Gain an understanding of sensitive marine environmental receptors and their tolerance > Control actions to maintain water quality below appropriate thresholds	**Low**

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Release of contaminants from marine sediments	> Rock placement and piling	> Toxic contaminants made available to marine ecosystem for biological uptake and bioaccumulation > Potential impact to ecosystem health	**Medium**	> Characterise material to be disturbed to understand locations and levels of contamination > Assess levels of contamination against appropriate thresholds, given the nature of the receiving environment > Isolate, remove and confine areas where contamination is potentially toxic to the marine environment	**Low**
	Introduction of contaminants/pollution to marine environment	> Construction activities - inappropriate waste disposal, accidental oil/chemical spill	> Toxic contaminants introduced to marine ecosystem for biological uptake and bioaccumulation > Potential impact to ecosystem health	**Medium**	> Inspection and audit of vessels and plant, outlined in DSDMP and CEMP > Reporting and response protocols should a spill occur - oil/chemical spill response etc.	**Low**
	Release of sediments from land	> Disturbance/stockpiling of material on land, lost due to run-off, wind etc.	> Elevated suspended sediment concentration in marine water > Sedimentation in marine environment > Potential impact to benthic communities and other biota	**Medium**	Controlled by CEMP: > Appropriate stockpiling technique and location > Prevention by bunding, erosion control etc. > Response plan for release of material	**Low**

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Siltation of harbour	> Proposed breakwaters lower velocities in the harbour and allow the settlement of suspended particles	> Smothering of seabed with fine particles impacting marine flora / fauna	**Medium**	> Siltation modelling undertaken to estimate rates of accumulation > Benthic habitat has already been identified and removed as part of initial dredging campaign	**Low**
	Introduction of contaminants/pollution to marine environment	> Boat ramp use - inappropriate waste disposal, accidental oil/chemical spill	> Toxic contaminants introduced to marine ecosystem for biological uptake and bioaccumulation Potential impact to ecosystem health	**Medium**	> Inspection and audit of vessels and plant, outlined in DSDMP and CEMP > Reporting and response protocols should a spill occur - oil/chemical spill response etc.	**Low**

9.7 Marine Ecosystems

9.7.1 Objective

"Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning"

9.7.2 Potential Impacts

The potential impacts associated with the environmental factor 'Marine Ecosystems' that have been identified are:

- Direct destruction of marine ecosystems within the project's construction footprint;
- Indirect impacts of dredging actions, associated with sediment transport and sedimentation, to nearby marine ecosystems;
- Interaction/impact of construction activities with marine flora and fauna; and
- Long-term changes to coastal processes and morphology impacting marine flora and fauna.

9.7.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of marine ecosystems include the following:

- *Territory Parks and Wildlife Conservation Act 1976*;
- *Fisheries Act 1988*;
- *Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory* (NT EPA, 2013);
- *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth);
- *Environmental Factor Guideline – Benthic Communities and Habitats* (WA EPA, 2016c);
- *Environmental Factor Guideline – Marine Fauna* (WA EPA, 2016d); and
- *Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals* (WA EPA, 2016e).

9.7.4 Impact Assessment

9.7.4.1 Impacts to Benthic Communities and Habitats

9.7.4.1.1 Modelled Zones of Influence and Impact

Dredge plume modelling was interpreted with respect to the NT EPA's (2013) requirement of assessing potential impacts of dredging on the marine environment. The assessment requires a spatially-based zonation scheme described by the Western Australian (WA) EPA (2016), which acts as a common basis when describing predicted extent, severity and duration of impacts due to dredging. The three zones each represent a level of impact as outlined by WA EPA (2016) and are described below:

- Zone of High Impact (ZoHI) "is the area where impacts on benthic communities or habitats are predicted to be irreversible";
- Zone of Moderate Impact (ZoMI) "is the area within which predicted impacts on benthic organisms are recoverable within a period of five years following the completion of the dredging activities"; and
- Zone of Influence (ZoI) "is the area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota".

In order to determine the three zones of influence, thresholds for sedimentation and turbidity due to dredging activities are required. Adopted thresholds have been developed based on ambient turbidity conditions

monitored at Mandorah across a 2.5-year period, as part of the INPEX Ichthys Nearshore Environmental Monitoring Program (INPEX Browse, 2014).

Typically, dredge plume modelling calculates TSS above background concentrations, to account for this, median background concentrations from baseline data have been subtracted from thresholds, resulting in thresholds for TSS of 11 mg/L during Dry Season and 49 mg/L during Wet Season. Thresholds for real-time monitoring of dredging and disposal activities have also been derived from turbidity data at Mandorah (Cardno, 2022d).

The zones have been calculated for the project and are presented, considering seasonality, tides and the distribution of BCH, in **Figure 9-11** to **9-14**. Various plots are necessary to define zones during both Wet and Dry Season (due to very different background concentrations), as well as during neap and spring tide (due to different hydrodynamic dispersion). Full details of the calculation of these zones are detailed in the *Sediment Transport Report* (Cardno, 2022d).

Sediment deposition has also been modelled, with results indicating negligible deposition (< 2.5mm) outside of the direct project footprint. As such, the key potential impacts to BCH due to dredge plume dispersion are those associated with elevated suspended sediment concentrations (turbidity). While the zones of impact are overlayed on varying benthic habitat types, they apply predominantly to seagrass and coral and also assume an adequate duration for the impacts to take effect. In reality, the dredging program is unlikely to be long enough to lead to permanent impacts.

9.7.4.1.2 Impact to Benthic Communities and Habitats

There are two key factors that determine the potential scale of plume dispersion impact to BCH from dredging and disposal actions. As can be seen in **Figures 4-3** to **4-6**, these are:

- The seasonal timing of the dredging and disposal actions - wet season or dry season. This is due to the substantially different natural/background turbidity during these two seasons; and
- Whether or not the actions occur during neap tides or spring tides. This is due to the strength of currents and their ability to disperse suspended sediment. This factor is significant at the dredging site, but does not have a strong influence on zones of impact at the disposal site.

Seasonality has the most significant influence on these zones of impact and, as such, environmental risk is discussed separately in the sub-sections below.

Dry Season

As the ZoIs are calculated against average background suspended sediment concentrations, their extents and severities are highest during the dry season, when ambient turbidity levels are low. For dredging and disposal actions during neap tides, ZoIs are centred around the dredging and disposal areas, as expected, and also develop in the nearshore areas to the north of the site. The lower tidal current speeds during neap tides lead to elevated suspended sediment concentrations in these shallow areas, compared to during spring tides.

During both tidal cycles, substantial ZoHI and ZoMI develop at the dredging and disposal sites, which pose a risk to sensitive receptors that have been identified in the vicinity of the project, such as seagrasses (*Halodule* and/or *Halophila*) and corals. However, the zones do not intersect significant portions of these benthic communities, as identified in BCH mapping. The impact is distributed primarily across areas identified as ‘sponges’, ‘bare ground’ and ‘macro algae’. There is a small portion of seagrass directly to the north of the direct project footprint (northern breakwater) that is predicted to be impacted by the ZoMI during both spring and neap tides.

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend

- Breakwater
- Project Footprint
- Offshore Disposal Area (sediments)
- >2.5mm Sediment Deposition Zone
- ZoHI (Project Footprint & Buffer)
- ZoHI
- ZoMI
- ZoI

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
16/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

IMPACT MAP - NEAPTIDE & DRY SEASON

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL
FIGURE 9-11

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S

NORTH

Legend

- Breakwater
- Project Footprint
- Offshore Disposal Area (sediments)
- >2.5mm Sediment Deposition Zone
- ZoHI (Project Footprint & Buffer)
- ZoHI
- ZoMI
- ZoI

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
16/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

IMPACT MAP - NEAPTIDE & WET SEASON

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL
FIGURE 9-12

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend

- Breakwater
- Project Footprint
- Offshore Disposal Area (sediments)
- >2.5mm Sediment Deposition Zone
- ZoHI (Project Footprint & Buffer)
- ZoHI
- ZoMI
- ZoI

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
16/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

IMPACT MAP - SPRING TIDE & DRY SEASON

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL
FIGURE 9-13

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S

NORTH

Legend

- Breakwater
- Project Footprint
- Offshore Disposal Area (sediments)
- >2.5mm Sediment Deposition Zone
- ZoHI (Project Footprint & Buffer)
- ZoHI
- ZoMI
- ZoI

Benthic Habitats

- Sponges
- Bare Ground
- Mixed Filter Feeders/Octocorals
- Corals
- Macro Algae
- Seagrasses (Halodule & Halophila)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno

Darwin, Northern Territory

Date
16/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

IMPACT MAP - SPRING TIDE & WET SEASON

MANDORAH MARINE FACILITIES
ENVIRONMENTAL REFERRAL
FIGURE 9-14

As the dispersion modelling predicts ZoHI and ZoMI to be generated by the dredging and disposal actions, and sensitive environmental receptors such as corals and seagrass are known to be present at the site, environmental risk is initially considered to be high. Given that BCH investigations have demonstrated the majority of the ZoI does not intersect sensitive environmental receptors (owing also to the careful selection of the disposal site) and the relatively short duration of CSD dredging and disposal (≈10 days), residual environmental risk is considered moderate. With additional controls, such as water quality monitoring with appropriate thresholds for reactive changes to dredging and disposal activities, the risk from these actions may be considered low.

Wet Season

During the Wet Season, the ZoI for dredging and disposal actions undertaken in either neap or spring tides is predicted to be fully contained within the direct project footprint. The concentrations of suspended sediment expected to be generated by the project actions during the wet season, outside of the dredge footprint, are small relevant to background concentrations. The perception of the changes to water quality by sensitive receptors outside of the dredge area and at the disposal site are, therefore, predicted to be negligible. As such, risk to BCH from dredging and disposal plume dispersion undertaken during Wet Season, outside of the direct impact footprint (where removal of BCH is expected), is predicted to be low.

Undertaking dredging and disposal activities during the Wet Season only may be considered as a control to significantly minimise environmental risk from these actions.

9.7.4.2 Marine Fauna

Potential impacts to marine fauna from dredging and disposal actions are described in the following sub-sections.

9.7.4.2.1 Underwater noise impacts

Sounds and vibrations emitted from vessels and piling activities are transmitted through seabed sediments and the water column, and they might be perceived by marine fauna within a certain distance from the construction site.

Based on the existing information, underwater noise can effect marine animals in a number of ways, including (i) behavioural responses, (ii) masking, (iii) stress and physiological responses, (iv) hearing loss and damage to auditory tissues, (v) structural and cellular damage of non-auditory tissues and total mortality, (vi) impairment of lateral line functions and (vii) particle motion-based effects on eggs and larvae (Popper and Hastings, 2009; Popper et al., 2014).

Death and injury can result from exposure to very high amplitude sounds. In addition, the effects of changes in pressure (barotrauma) must also be considered, especially for impulsive sounds (e.g. Stephenson et al., 2010; Halvorsen et al., 2011, 2012a, 2012b). Rapid changes in pressure can cause blood gases to come out of solution. In fish, rapid pressure changes can also cause gas volumes (i.e. swim bladders) to expand and contract rapidly, thereby damaging surrounding tissues and organs, and sometimes causing rupture of the swim bladder itself.

Piling is considered to be a much higher risk in terms of underwater noise than dredging and disposal activities. As such, risk management associated with piling is considered sufficient to mitigate underwater noise risk associated with dredging also (refer to *Draft CEMP* ([Cardno, 2022f]). Risk of underwater noise to marine fauna from dredging and disposal actions, with appropriate monitoring and management, is considered low.

9.7.4.2.2 Direct impact/collision from vessel plant and equipment

There is a risk of impact to marine fauna, such as dugong and turtles (dolphins being unlikely) during the movement and operation of dredging plant and support vessels. The risk of such impacts is generally minimised by observation and avoidance procedures. E.g. any marine mammal or reptile observed within 100 metres of the dredging operations (high-risk area) would trigger the stop-work procedure until the animal has moved at least 200 metres away from the high-risk area or has not been seen for at least 20 minutes.

It should be noted that dredging plant and their actions are relatively slow, lowering the risk of impact in comparison to fast moving vessels. Risk of direct impact to marine fauna from dredging and disposal actions, with appropriate monitoring and management, is considered low.

9.7.4.2.3 Impacts of turbid water

Although species show variable responses to elevated turbidity that are species-dependent and that fish may avoid the area during construction, the mechanical or abrasive action of elevated turbidity may be harmful to suspension feeders, clogging their feeding apparatus and impairing respiratory and excretory function. However, given that natural levels of turbidity are also very high, plumes would be expected to affect a very small area of soft sediment infauna and epifauna relative to the extent of these habitats in Darwin Harbour. Further, any affected soft sediment biota would recover through natural recruitment of biota within months once construction had finished. Hence, any losses of biota would be temporary and amount to a minor localised impact.

Impacts to marine mammals and reptiles can be avoided with the inclusion of a marine mammal and reptile spotting program during dredging that includes a stop-work procedure upon sighting marine mammal and reptile activity (as described above). Risk of impact to marine fauna from changes to water quality is considered low.

9.7.4.3 Invasive Marine Species

The potential for introduction of invasive marine species arises when marine vessel and plant are imported from other areas where such species exist. These risks may or may not be present for the project, depending on the plant to be used.

Management of such risks is also not generally the responsibility of the project, but is covered by relevant territory inspection and quarantine requirements. Nevertheless, the project should be aware of such risks and ensure proper import procedures have been adhered to by all equipment operating on the project. The environmental risk associated with invasive marine species for the project is likely to be low.

9.7.5 Environmental Risk Assessment

9.7.5.1 Risk assessment for Benthic Communities and Habitats

The potential impact and risk to sensitive receptors in the area, coral and seagrass, have been mapped in **Figures 9-15** to **9-18**. The demonstrate maximum extents (spring or neap tide) of zones of influence during both Wet and Dry Season, underlain by mapped percentage cover of coral and seagrass.

The maps demonstrate that significant loss of these sensitive receptors is not expected due to dredge plume dispersion, beyond the project footprint. The greatest risk to marine ecosystems, therefore, is the direct removal of BCH within the dredge footprint. Whilst the dredge footprint has been minimised, dredging activities will permanently remove benthic habitat without opportunity for regrowth, due to the presence of rock structures, changed hydrodynamics and ongoing siltation. The portions of seagrass, coral and sponge to be cleared as part of dredging and construction of the breakwaters has been calculated as a portion of their total coverage along the east side of Darwin Harbour (as predicted by Geoscience Australia, AIMS and DEPaWS, 2021). **Table 9-5** lists the percentage cover within the ZoHI which may be lost if dredging was to be undertaken in dry season, where modelling shows broader potential impact (conservative assumption).

Table 9-5 Potential portion of benthic habitat loss along east side of Darwin Harbour

Habitat	Percentage of East Darwin Harbour habitat loss
Coral	0.009%
Sponges	0.04%
Seagrass	0.02%

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend
- ZoI
- ZoMI
- ZoHI
- ZoHI (Project Footprint Buffer)
- Project Footprint
- Breakwater
- Offshore Disposal Area (Sediments)
- >2.5mm Sediment Deposition Zone

Coral Coverage (%)
High : 100
Low : 0

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno
Darwin, Northern Territory

Date
21/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

ZONES OF IMPACT AND INFLUENCE DRY SEASON & CORAL COVERAGE

MANDORAH MARINE FACILITIES
REFERRAL REPORT
FIGURE 9-15

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend
- ZoI
- ZoMI
- ZoHI
- ZoHI (Project Footprint Buffer)
- Project Footprint
- Breakwater
- Offshore Disposal Area (Sediments)
- >2.5mm Sediment Deposition Zone

Coral Coverage (%)
High : 100
Low : 0

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno
Darwin, Northern Territory

Date
21/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

ZONES OF IMPACT AND INFLUENCE WET SEASON & CORAL COVERAGE

MANDORAH MARINE FACILITIES
REFERRAL REPORT
FIGURE 9-16

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend
- ZoI
- ZoMI
- ZoHI
- ZoHI (Project Footprint Buffer)
- Project Footprint
- Breakwater
- Offshore Disposal Area (Sediments)
- >2.5mm Sediment Deposition Zone

Seagrass Coverage (%)
High : 100
Low : 0

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno
Darwin, Northern Territory

Date
21/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200Meters

ZONES OF IMPACT AND INFLUENCE DRY SEASON & SEAGRASS COVERAGE

MANDORAH MARINE FACILITIES
REFERRAL REPORT
FIGURE 9-17

130°45'45"E
130°46'0"E
130°46'15"E
12°25'45"S
12°26'0"S
12°26'15"S
12°26'30"S
NORTH

Legend
- ZoI
- ZoMI
- ZoHI
- ZoHI (Project Footprint Buffer)
- Project Footprint
- Breakwater
- Offshore Disposal Area (Sediments)
- >2.5mm Sediment Deposition Zone

Seagrass Coverage (%)
High : 100
Low : 0

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cardno
Darwin, Northern Territory

Date
21/12/2021

Size
A3

Scale
1:5,000

0 50 100 150 200 Meters

ZONES OF IMPACT AND INFLUENCE WET SEASON & SEAGRASS COVERAGE

MANDORAH MARINE FACILITIES
REFERRAL REPORT
FIGURE 9-18

9.7.5.2 Risk to Marine Fauna

Risk to marine fauna from project actions is detailed in the EPBC Act 'self-assessment' (**Section 10**) for several priority marine species with potential to be impacted by the project.

9.7.6 Mitigation and Management

The proposed measures applicable to the management of impacts on marine ecosystems arising from dredging activities are described in detail in the Draft DSDMP (Cardno, 2022e) and Draft CEMP (Cardno, 2022f) which outline frameworks for the environmental management of dredging and marine construction activities, respectively, associated with the Project. The plans incorporate management systems detailing strategies, procedures and work practices, to avoid, mitigate or minimise impacts on marine ecosystems.

Management measures proposed to minimise impacts to benthic communities include, but are not limited to:

- Characterisation of BCH and minimisation of footprint;
- Characterisation of dredge plume dispersion to understand changes to water quality with respect to tolerance of BCH/fauna;
- Implementation of dredging controls and reactive monitoring to maintain levels below thresholds; and
- Disposal location chosen to optimise dispersion and minimise impact to sensitive receptors.

Management measures proposed relating to marine fauna include, but are not limited to:

- Control of vessel movements, speeds and no-go zones;
- Marine Fauna Observer (MFO) to be present during dredging activities; and
- Soft start protocols to allow fauna to leave area.

9.7.7 Summary

The environmental risk assessment for 'Marine Ecosystems' is summarised in **Table 9-6**. Overall, risk to Marine Ecosystems beyond the direct impacts of the project footprint is considered low to moderate.

Table 9-6 Summary of environmental impact and risk assessment for 'Marine Ecosystems'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
SEA	Dredger/vessel movement	> Vessel strike of marine fauna such as dugongs, turtle, dolphins > Underwater noise impacts due to dredging and piling > Direct impact to seabed - marine ecosystems	> Vessel strike of marine fauna > Injury to marine fauna > Damage to ecosystems	Medium	> Vessel movement controls, speed limits, no-go zones > Marine fauna observation and avoidance > Piling controls (soft start) to allow fauna to leave area	Low
	Dredging	> Direct removal of benthic communities and habitat	> Permanent removal/destruction of BCH such as seagrass and coral	Very High	> Characterise BCH in direct impact footprint > Minimise footprint and avoid sensitive receptors/important BCH where possible	High
	Dredging	> Elevated suspended sediment concentration (turbidity) in vicinity of project	> Impact to sensitive BCH such as coral and seagrass (blocking of light) > Impact to marine fauna due to ingestion/dermal contact	High	> Characterise BCH in vicinity of project > Characterise dredge plume dispersion to understand changes to water quality with respect to tolerance of BCH/fauna > Implement dredging controls and reactive monitoring to maintain levels below thresholds	Low

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Dredging	> Sedimentation of seabed in vicinity of project	> Impact to sensitive BCH such as coral and seagrass (smothering)	High	> Characterise BCH in vicinity of project > Characterise dredge plume dispersion to understand sedimentation levels with respect to tolerance of BCH/fauna > Implement dredging controls and reactive monitoring to maintain levels below thresholds (i.e. altering dredging activities [e.g. volumes, locations] to limit sediment resuspension, dredging only on certain tides etc.).	Low
	Dredge spoil disposal	> Elevated suspended sediment concentration (turbidity) at disposal site	> Impact to sensitive BCH such as coral and seagrass (blocking of light) > Impact to marine fauna due to ingestion/dermal contact	High	> Select disposal area for optimum dispersion and minimum sensitive receptors > Characterise disposal dispersion to understand changes to water quality with respect to tolerance of BCH/fauna > Implement dredging disposal controls and reactive monitoring to maintain levels below thresholds (i.e. altering dredging activities [e.g. volumes, locations] to limit sediment resuspension, dredging only on certain tides etc.).	Low
	Dredge spoil disposal	> Sedimentation of seabed at disposal site	> Impact to sensitive BCH such as coral and seagrass (smothering)	High	> Select disposal area for optimum dispersion and minimum sensitive receptors > Characterise disposal dispersion to understand sedimentation levels with respect to tolerance of BCH/fauna > Implement dredging controls and reactive monitoring to maintain levels	Low

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
					below thresholds (i.e. altering dredging activities [e.g. volumes, locations] to limit sediment resuspension, dredging only on certain tides etc.).	
	Dredger/vessel movement during operations (maintenance dredging)	> Vessel strike of marine fauna such as dugongs, turtle, dolphin > Underwater noise impacts due to dredging and piling > Direct impact to seabed - marine ecosystems	> Vessel strike of marine fauna > Injury to marine fauna > Damage to ecosystems	**Medium**	> Vessel movement controls, speed limits, no-go zones > Marine fauna observation and avoidance > Piling controls (soft start) to allow fauna to leave area	**Low**
	Construction activities including earthworks, building works and transport to site	> Construction materials and /or general litter entering marine environment	> Ingestion/injury of waste by marine fauna > Damage to marine ecosystems	**Medium**	> Control of waste as per CEMP > Reporting and response to pollution events > Control of construction access/activities	**Low**
	Rock placement and piling	> Direct removal of benthic communities and habitat	> Permanent removal/destruction of BCH such as seagrass and coral	**High**	> Characterise BCH in direct impact footprint > Minimise footprint and avoid sensitive receptors/important BCH where possible	**Medium**
	Rock placement and piling	> Elevated suspended sediment concentration	> Impact to sensitive BCH such as coral and seagrass (blocking of light)	**High**	> Characterise BCH in vicinity of project > Characterise dredge plume dispersion to understand changes to water quality with respect to tolerance of BCH/fauna	**Low**

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
		(turbidity) in vicinity of project	> Impact to marine fauna due to ingestion/dermal contact		> Implement dredging controls and reactive monitoring to maintain levels below thresholds	
	Rock placement and piling	> Sedimentation of seabed in vicinity of project	> > Impact to sensitive BCH such as coral and seagrass (smothering)	**High**	> Characterise BCH in vicinity of project > Characterise dredge plume dispersion to understand sedimentation levels with respect to tolerance of BCH/fauna > Implement dredging controls and reactive monitoring to maintain levels below thresholds	**Low**

9.8 Air Quality

9.8.1 Objective

"Protect air quality and minimise emissions and their impact so that environmental values are maintained"

9.8.2 Potential Impacts

The potential impacts associated with the environmental factor 'Air Quality' that have been identified are:

- Dust deposition on vegetation reducing photosynthetic potential, diversity of ecosystems and human health; and
- Exhaust emissions during construction and operation of the facility.

9.8.3 Guidance and Legislation

In setting ambient air quality standards and goals the NT EPA adheres to standards set out by the National Environmental Protection Council (NEPC) which are specified within the *Ambient Air Quality National Environmental Protection Measure* (Ambient Air Quality NEPM) Variation 2021, effective 15 April 2021. The Ambient Air Quality NEPM provides guidance relating to air in the external environment and does not include air inside buildings or structures.

The Ambient Air Quality NEPM outlines monitoring, assessment and reporting procedures for the following pollutants:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Particulate matter (PM10 and PM2.5)
- Sulfur dioxide (SO_2)
- Carbon monoxide
- Ozone

Air quality standards are contained within the *National Environment Protection Measure for Ambient Air Quality* (NEPC, 2021) relevant to the project are summarised in **Table 9-7**.

Table 9-7 Criteria for relevant air pollutants (NEPC, 2021)

Pollutant	Averaging period	Maximum concentration standard
Nitrogen dioxide (NO_2)	1 hour	164 micrograms per cubic metre ($\mu g/m^3$)
	1 year	30.75$\mu g/m^3$
Particulate matter (PM_{10})	1 day	50$\mu g/m^3$
	1 year	25$\mu g/m^3$
Particulate matter ($PM_{2.5}$)	1 day	25$\mu g/m^3$
	1 year	8$\mu g/m^3$
Carbon monoxide (CO)	8 hours	11.25 milligrams per cubic metre (mg/m^3)

9.8.4 Impact Assessment

Construction is anticipated to take between one and three years with the majority of the construction work expected to occur between 2022 and 2025. Emissions of air pollutants may occur in relation to construction activities associated with the development of the marine infrastructure and civil construction within the terrestrial footprint.

The main pollutant of concern during construction will be the generation of dust associated with heavy vehicle movements, land clearing and wind erosion of stockpiles and the liberation of asbestos fibres associated with construction on Lot 50. Small amounts of other pollutants may be released in association with the combustion of diesel fuel by plant and equipment.

The assessment of the potential impact of the proposal has therefore considered the impact related to the emission of the following Ambient Air Quality NEPM pollutants:

- Particulate matter (PM_{10})
- Deposited dust
- Asbestos fibres
- NO_2
- Total suspended particulates.

9.8.5 Environmental Risk Assessment

Current guidance states that on-site plant and site traffic is unlikely to impact local air quality, and therefore they do not need to be qualitatively assessed (Holman et al, 2014). Therefore, NO_2 and other exhaust emissions generated by on-site plant and site traffic have not been considered further in this assessment. The presence of ACMs in subsoils has not yet been determined and quantified (if detected) and must be considered further following intrusive soil investigation of Lot 50 (**Section 5.5**).

As detailed in **Section 5.9** the existing air quality at the study area is generally considered to be good. Existing air quality at the site is mainly influenced by local road traffic and seasonal bushfires. Dust generated during land clearing and wind erosion of stockpiles has the potential to impact humans and local fauna in the vicinity of the site. A ‘sensitive receptor’ refers to any location where a person or property may experience the adverse effects of airborne dust or dust settlement, or exposure to PM_{10} over the averaging time period presented in **Table 9-7**.

Following completion of construction, air quality is expected to return to its current high quality justified in **Section 5.9**.

9.8.6 Mitigation and Management

The proposed measures applicable to the management of impacts on air quality arising from the construction and operation of the landside development portion are described in detail in the Draft CEMP (Cardno, 2022f) which outlines a framework for the environmental management of the terrestrial construction activities associated with the Project. The plan incorporates air quality management systems detailing strategies, procedures and work practices, to avoid, mitigate or minimise impacts resulting from dust generation.

Management measures proposed include, but are not limited to:

- Identification of potential risks/impacts due to work/activities such as dust or asbestos fibre generating activities;
- Management measures (such as watering of haul roads and stockpiles, reduced onsite speed limits) to minimise risk of dust generation associated with earthworks and other construction activities;
- Progressive rehabilitation of disturbed areas will be carried out where feasible and reasonable to minimise soil exposure and dust emissions;
- Dust and air quality complaints will inform implementation of further appropriate corrective actions to reduce emissions in a timely manner and will include processes for monitoring dust on-site; and

> In the event friable asbestos is detected in the sub soils of Lot 50, a licenced asbestos assessor and removalist will conduct air monitoring, remove and dispose of ACM soils, issue the clearance inspection and to issue the clearance certificate.

9.8.7 Summary

The environmental risk assessment for ‘Air Quality’ is summarised in **Table 9-8**. The managed risk remains moderate and will require ongoing monitoring and management during construction.

Table 9-8 Summary of environmental impact and risk assessment for 'Air Quality'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
Air	Dust generated by construction activities including earthworks, building works and transport to site.	> Decrease in local air quality	> Impacts to local fauna and human health through inhalation of particles	**Medium**	Integration of dust management measures in construction management plan including: > Watering of temporary roads and stockpile areas; > Use of dust suppression equipment; and > Speed limits on site roads.	**Low**
	Mobile plant at site and trucking of materials to site	> Carbon dioxide emissions	> Impacts to local fauna and human health through inhalation of emissions	**Medium**	Integration of air quality measures in construction management plan including: > Isolating plant from workers where possible; and > PPE	**Low**

9.9 Atmospheric Processes

9.9.1 Objective

"Minimise greenhouse gas emissions so as to contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050"

9.9.2 Potential Impacts

The potential impacts associated with the environmental factor 'Atmospheric Processes' that have been identified are:

- Construction of the marine facilities will contribute to NT emissions overall; and
- Operation of the marine facilities will contribute to overall NT emissions. Potential small increase in electricity use compared to existing.

9.9.3 Guidance and Legislation

- *Northern Territory Climate Change Response: Towards 2050* (NTG, 2020); and
- *Appendix A NT Environmental Impact Assessment Guide: Greenhouse Gas Emissions* (NT EPA, 2019).

9.9.4 Impact Assessment

Emissions relating to the construction phase of the project will be dominated by the trucking of large volumes of rock to the project site for use in breakwaters. Rock will likely be sourced from a quarry approximately 150 km from Mandorah equating to a ~300 km round trip. Due to the high quantities to be imported (45,000 m^3) hundreds of round trips will need to be completed during the construction of the breakwaters over a period of approximately six months. This will release approximately 6,100 T of CO_2 to the atmosphere.

Dredging sediment, particularly rock, requires large quantities of energy and will also be a significant contributor to the emissions generated by the project. It is estimated that dredging the required volumes will result in approximately 1,800 T of CO_2 to the atmosphere.

The operation of the expanded marine facilities is also expected to require slightly more power than the existing facilities due to the operation of a terminal, increased lighting associated with extended carpark, breakwaters, jetty and boat ramp. Incorporation of solar power is likely to offset or even reduce this current energy need however.

9.9.5 Environmental Risk Assessment

Emissions related to the construction of the facilities can be minimised through mitigation measures, but cannot be eliminated. However, emissions generated by trucking of rock (~0.03%) and dredging activities (~0.009%) make up a minor percentage of the annual CO_2 emissions of the Territory. In the long term, the upgraded maritime facilities are expected to reduce the number of cars commuting between the Cox Peninsula from Darwin due to the higher operability of ferry services, helping offset construction emissions.

The increase in power for the operations phase of the marine facilities makes a negligible contribution to the Northern Territory's net emissions and could be offset by installing solar cells or through mitigation measures (**Section 9.9.6**).

9.9.6 Mitigation and Management

The following measures shall be implemented to reduce emissions relating to the construction phase of the marine facilities:

- Design of breakwaters to minimise the volume of rock required whilst maintaining structural integrity;
- Materials transported to site using the minimal number of vehicles;
- Reuse of existing building at site for the ferry terminal; and
- Reuse of dredged rock as core in breakwaters.

The following measures shall be implemented to reduce emissions during the operation of the marine facilities:

- Energy saving devices; and
- Consideration of alternative energy sources where possible such as solar power and batteries.

9.9.7 Summary

The environmental risk assessment for ‘Atmospheric Processes’ is summarised in **Table 9-9**.

Table 9-9 Summary of environmental impact and risk assessment for 'Atmospheric processes'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
AIR	Energy usage during construction of facilities	> Direct emissions from mobile plant, dredger, generators etc.	> Cumulative impact of carbon emissions to global climate change	**Medium**	> Efficiency in design to minimise quantity of rock needed in breakwaters, causeway and boat ramp; > Materials should be transported to site with the minimum number of vehicles required; and > Reuse of existing building onsite for ferry terminal to reduce new materials required;	**Low**
	Future power usage at the ferry terminal	> Indirect emissions from use of electricity	> Cumulative impact of carbon emissions to global climate change	**Medium**	> Integration of electricity reduction measures in construction management plan including: > Energy saving devices; and > Consideration of alternative energy sources where possible	**Low**

9.10 Community and the Economy

9.10.1 Objective

"Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians"

9.10.2 Potential impacts

The potential impacts associated with the environmental factor 'Community and the Economy' that have been identified are:

- Interruption and inconvenience to the community during construction;
- Economic stimulation from the project's construction;
- It is expected that this project will improve accessibility to the area and increase economic opportunities for residents and visitors to the area; and
- Increase in accessibility for residents of the Cox Peninsula to jobs, businesses, education and healthcare services.

9.10.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of impact to the community and economy include the following:

- *Consultation Framework* (International Association of Public Participation, 2019); and
- *Remote Engagement and Coordination (REC) Strategy 2015* (NTG, 2015).

9.10.4 Impact Assessment

Construction is anticipated to take between one and three years with the majority of the construction work expected to occur between 2022-2025. Potential negative impacts on the local community are likely to include:

- Ongoing noise from construction activities, predominantly attributed to heavy vehicles entering and exiting the site as well as general construction activities. It is expected that heavy vehicles will be required to access the site consistently throughout the construction of the breakwaters. Access will be via Charles Point Road which is over 100 m from the nearest residence to the south; and
- Increases in traffic along the Cox Peninsula Road and Charles Point Road due to heavy vehicles is also expected. Both roads are single lane and connect residents at Wagait Beach, Mandorah and the Belyuen to the Sturt Highway and south west of the peninsula. The number of heavy vehicles has the potential to slow transit times and increase overtaking risk.

9.10.5 Environmental Risk Assessment

Noise generated by construction works is likely to be dominated by trucks transiting to and from the site. The closest residences at Mandorah are set back approximately 120 m from Charles Point Road. Due to the residence's close proximity to the site, heavy trucks will have already significantly reduced speed when passing, this coupled with the mitigation measures outlined in the Draft CEMP, will result in a low risk of construction activities having significant impact on the community.

Traffic disruption along Cox Peninsula Road and Charles Point Road is expected to be minimal given the current numbers of road users coupled with the mitigation measures outlined in the Draft CEMP.

9.10.6 Mitigation and Management

Proposed measures relating to the management of impacts on the local community and economy from the construction of the landside development portion are described in detail in the Draft CEMP which include, but are not limited to:

- Restricting working hours to 7am to 7pm Monday to Saturday and between 9am to 1pm on Sundays or public holidays;
- Traffic management plan to manage any disruptions to local traffic, including staggering heavy vehicles throughout the day to minimise congestion; and
- Prior warning given to residents and ferry users regarding times where increased noise pollution is expected or of any changes to access of facilities i.e. temporary reduction in available parking.

Management of the expected positive impacts of the new facilities is also required through the following measures:

- Detailed analysis to determine the number of extra visitors and job opportunities in the region; and
- Heavy stakeholder engagement to prepare for the anticipated increase in number of visitors to the peninsula and economic opportunities.

9.10.7 Summary

The environmental risk assessment for 'Community and Economy' is summarised in **Table 9-10**.

Table 9-10 Summary of environmental impact and risk assessment for 'Community and Economy'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
PEOPLE	Construction activities including earthworks and building works	> Noise generated	> Decrease in liveability for nearby residents, ferry users or tourists	Medium	> Integrate noise management measures within the construction management plan	Low
	Trucking in of construction materials	> Increase in traffic along Cox Peninsula Road and Charles Point Road	> Traffic delays and increased risk of accident for local residents of the Cox Peninsula	Medium	> Traffic management plan to be implemented to manage any disruptions to local traffic > Staggering of heavy vehicles throughout the day to minimise congestion	Low
	Construction activities including earthworks and building works	> Loss of access to existing carpark	> Decrease in liveability for users of existing boat ramp or carpark	Medium	> Stakeholder engagement with current uses of facilities to inform of access issues during construction	Medium

9.11 Culture and Heritage

9.11.1 Objective

"Protect sacred sites, culture and heritage"

9.11.2 Potential Impacts

The potential impacts associated with the environmental factor 'Culture and Heritage' that have been identified are:

- Impact to known or unknown Aboriginal sacred sites during construction; and
- Impact to unknown heritage objects or sites (e.g. WWII) during construction.

9.11.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of impacts to cultural heritage include the following:

- *Aboriginal Land Rights (Northern Territory) Act 1976*;
- *Northern Territory Aboriginal Sacred Sites Act 1989*;
- *Planning Act 1999*; and
- *Heritage Act 2011*.

9.11.4 Impact Assessment

Sites of known Aboriginal cultural heritage and significance have been identified for the project and permissible work areas (including the dredging footprint, have been captured in an Aboriginal Areas Protection Authority (AAPA) Certificate, provided in **Appendix A**. No works are to be undertaken within known sites of Aboriginal heritage and have been defined as Restricted Work Areas (RWAs).

There is a risk of encountering an object or area of significance as part of the dredging works. Items or areas may be of significance to Aboriginal people or from World War Two. If object or areas are not identified there exists the risk of destroying its entirety.

9.11.5 Environmental Risk Assessment

Strict avoidance of the restricted work areas (RWA) and exclusion zone will minimise the risk of impact. Only one of the sacred sites is in the marine environment (nearshore area to the north of the project site), with the potential to be impacted by dredging and disposal actions. Sedimentation at this site has been modelled as minimal (less than 2.5 mm) and predicted changes to suspended sediment concertation in the vicinity of the sacred site is expected to be isolated and temporary (i.e. during outgoing tide). Risk to known sacred sites associated with dredging and disposal actions is considered to be low.

Likelihood of encountering an object or area of cultural significance is low as the dredging area is known to be predominantly rock, with a thin layer of sediment overlain. Nevertheless, appropriate response and reporting of any such encounter is required to minimise risk.

9.11.6 Mitigation and Management

The proposed measures applicable to the management of impact on known or unknown Aboriginal sacred sites or unknown heritage sites are listed below:

- Design footprint maintains buffer between works and RWAs. Access to site via Charles Point Road will does not impact RWAs;
- Adequate training of anyone entering site is to be provided to ensure no works impact identified RWAs;

- Response and reporting are required of any heritage site or object encountered (or suspected site or object) during earthworks and dredging; and
- Signage and fencing may be erected to deter any increase in road users mistakenly entering areas to the south of the facilities.

9.11.7 Summary

The environmental risk assessment for ‘Culture and Heritage’ is summarised in **Table 9-11**.

Table 9-11 Summary of environmental impact and risk assessment for 'Culture and Heritage'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
PEOPLE	Aboriginal sacred sites	> Construction activities disturbing or destroying Aboriginal Sacred Sites south of the works	> Permanent or temporary damage or contamination of Sites	Medium	> Response and reporting procedures should a site or object be encountered	Low
	Cultural heritage sites / artefacts	> Dredging, disposal and associated actions	> Disturbance of known or unknown cultural heritage areas during dredging	Medium	> Gain understanding of cultural heritage of the site and establish no work areas around heritage sites > Response and reporting procedures should a site or object be encountered	Medium
	Increased patronage in the area due to upgraded marine facilities	> Disturbance or destruction of Aboriginal Sacred Sites south of the works	> Permanent or temporary damage or contamination of Sites	Medium	> Signage to alert the public of private driveways and land to the south of the carpark	Low

9.12 Human Health

9.12.1 Objective

"Protect the health of the Northern Territory population"

9.12.2 Potential impacts

The potential impacts associated with the environmental factor 'Human Health' that have been identified are:

- Contaminants and dust released during construction could impact nearby users of the area, such as ferry passengers;
- Emissions from construction plant acting as irritant to humans;
- Dredging activities releasing contaminants that could enter the food chain; and
- General health and safety to workers and patrons during construction, and the general public during operations.

9.12.3 Guidance and Legislation

Relevant policy, guidance and industry standards that have been used in the assessment of impact to human health include the following:

- *Public and Environmental Health Act 2011*; and
- *National Environment Protection Council Act 1994* (Commonwealth).

9.12.4 Impact Assessment

The highest risk to human health is due to the release of both fine sediments and contaminated sediments through earthworks, building and/or dredging activities. These can impact humans through primary contact and inhalation, or secondary uptake through bioaccumulation in the food chain.

It is expected that construction plant will predominantly run on diesel fuel exposing ferry users to diesel exhaust. Short term effects of exposure include irritation of eyes, nose, throat and lungs as well as light headaches.

9.12.5 Environmental Risk Assessment

The risk to human health through inhalation or through bioaccumulation of contaminated sediments is considered low, due to the following factors:

- Contaminant levels were found to be low and below relevant thresholds for human health risk;
- Fines will be released by dredging but these are to remain waterborne and be dispersed to low concentration rapidly by tidal currents; and
- The work areas are not expected to be in close proximity to the general public (although workers may be exposed).

Risk to human health through exposure to diesel exhaust is low due to the following:

- Construction plant will be located in an open-air environment; and
- Construction plant are not expected to be in close proximity to the general public.

9.12.6 Mitigation and Management

The proposed measures applicable to the management of impacts to human health due to fine / contaminated sediments or diesel exhaust are:

- Isolation and removal of areas where contamination is potentially toxic to humans;

- Appropriate stock piling and erosion control;
- Use of alternative power sources where possible;
- Isolation of diesel plant from public and workers;
- Use of appropriate PPE if required to work near diesel exhaust;
- Safety in Design process to minimise safety risk associated with operation and use of the facility; and
- Health and safety planning to accompany construction works.

9.12.7 Summary

The environmental risk assessment for ‘Human Health’ is summarised in **Table 9-12**.

Table 9-12 Summary of environmental impact and risk assessment for 'Human Health'

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
PEOPLE	Asbestos contamination encountered on Lot 50	> Inhalation of airborne asbestos	> Adverse health impacts to site workers and users of facility	Medium	> Staff to have sufficient training in handling asbestos > Appropriate PPE provided to all staff working with, or suspected to be working with asbestos	Low
	Personnel working outside	> Exposure	> Sunburn and heat stress > Injury due to cyclone or storm whilst on site	High	> Staff to have appropriate PPE (long sleeved shirt, pants, hats, sunscreen etc.) to minimise risk of sunburn and heat stress > First aid kits located around site for initial response > Development of a cyclone response plan and regular monitoring of local news channels	Medium
	Personnel working outside	> Biting insects, snakes, crocodiles	> Injury due to bite/attack > Disease transmitted by biting insect	Medium	> Staff to have appropriate PPE (long sleeved shirt, pants, repellent etc.) to minimise risk of biting insects > Staff to have sufficient training on the identification of reptiles likely to be encountered on site > If a problem crocodile is encountered it should be reported to (08) 8983 2475 > First aid kits located around worksite to provide initial response to incidents	Medium

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Construction activities including earthworks and building works	> Open fire ignited by construction activities	> Minor, serious or fatal burns to personnel > Smoke inhalation	Medium	> Staff to have sufficient training in fire management > Fire extinguishers located around site > Smoking and hot works in permitted areas only	Medium
	Proximity to vegetation	> Exposure to bushfire	> Minor, serious or fatal burns to personnel > Smoke inhalation	Medium	> Creation of a bushfire evacuation plan > Staff to have sufficient training in fire management > Regular monitoring of local news channels	Low
	Public accessing breakwaters and / or jetty during construction	> Slip, trip or fall into water above head height	> Accidental entry to deeper water leading to drowning hazard	Medium	> Fencing and signage to prevent public access to breakwater and jetty	Medium
	Dredging and disposal of contaminated sediments	> Disturbance/release during extraction, transport and placement stages > Release to the marine environment following placement, then bioaccumulation and biomagnification in the food chain	> Dermal contact > Inhalation > Ingestion	Medium	> See management measures relating to marine environmental quality. These apply to risk to humans also, with risk to human health considered a lower risk.	Low

Theme	Environment Aspect	Risk Pathway(s)	Potential Impacts	Inherent Risk Rating	Risk Management / Mitigation	Residual Risk Rating
	Dredging and disposal of fine sediments	> Disturbance/release during extraction, transport and placement stages	> Dermal contact > Inhalation	Medium	> Sediments to remain wet or be contained as part of disposal > Segregation of work area and material from general public	Low
	Public accessing breakwaters and / or jetty during construction	> Slip, trip or fall into water above head height	> Accidental entry to deeper water leading to drowning hazard	Medium	> Fencing and signage to prevent public access to breakwater and jetty	Medium
	Emissions from construction plant	> Exposure of workers to emissions	> Irritation to workers	Medium	> Avoiding idling of construction plant > Isolating workers from fumes > PPE such as masks and faceshields > Alternative power source	Low
	Public access to breakwaters and jetty	> Slip, trip or fall into water above head height	> Accidental entry to deeper water leading to drowning hazard	High	> Signage to notify public of dangers and that the breakwaters should not be accessed during dangerous conditions	Medium

10 EPBC Act Self-Assessment

10.1 Overview of the EPBC Act

The EPBC Act is the Australian Government's key piece of environmental legislation which commenced 16 July 2000. The EPBC Act enables the Australian Government to join with the states and territories in providing a truly national scheme of environment and heritage protection and biodiversity conservation. The EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance (MNES), with the states and territories having responsibility for matters of state and local significance. The Australian Government Department of Agriculture, Water and Environment (DAWE) administers the EPBC Act.

The objectives of the EPBC Act are to:

- Provide for the protection of the environment, especially MNES;
- Conserve Australian biodiversity;
- Provide a streamlined national environmental assessment and approvals process;
- Enhance the protection and management of important natural and cultural places;
- Control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife;
- Promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;
- Recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and
- Promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

The nine MNES are:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- Nationally threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mining); and
- A water resource, in relation to coal seam gas development and large coal mining development.

10.2 Relevant MNES

DAWE's PMST was queried on 11 November 2021, applying a 10km buffer radius around the project site (**Appendix B**). The results of the search, in relation to MNES, included:

- No World Heritage Properties;
- No National Heritage Places;

- No Wetlands of International Importance;
- No Commonwealth Marine Areas;
- No Listed Threatened Ecological Communities;
- 39 Listed Threatened Species;
- 70 Listed Migratory Species;

Other matters identified by the search included:

- 109 Listed Marine Species;
- 12 Whales and Other Cetaceans;
- 30 Invasive Species; and
- 1 Nationally Important Wetland (Port Darwin).

The search identified that the MNES to be assessed for this project are potential impacts to listed threatened and migratory fauna species.

10.3 Likelihood of Occurrence Assessment

For all listed threatened and migratory fauna identified by the PMST, their likelihood of occurrence in the Project Area has been assessed, based on the criteria in **Table 10-1**. The Project Area in this context is defined as the area where project activities and impacts may occur. The Study Area is the broader surrounding the area, defined by the search radius.

Table 10-1 Likelihood of occurrence criteria for listed species with potential to occur in the Project Area

Likelihood of Occurrence	Criteria
Unlikely	Species that fit into one or more of the following criteria: ▪ Species highly restricted to certain geographical areas not overlapping the Study Area. ▪ Species that have specific habitat requirements that are not present in the Study Area.
Low	Species that fit into one or more of the following criteria: ▪ Have not been recorded previously in the Study Area and for which the Study Area is beyond the current distribution range. ▪ Use specific habitats or resources not present in the Project Area.
Moderate	Species that fit one or more of the following criteria: ▪ Have infrequently been recorded previously in the Study Area. ▪ Use specific habitats or resources present in the Study Area, but in a poor or modified condition. ▪ Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
High	Species that fit one or more of the following criteria: ▪ Have frequently been recorded previously in the Study Area. ▪ Use habitat types or resources that are present in the Study Area, that are abundant and/or in good condition within the Project Area. ▪ Are known to, or likely to, maintain resident populations surrounding the Project Area. ▪ Are known to, or likely to, visit the Project Area during regular seasonal movements or migration.

The species (or species types) that are considered for EPBC Act 'self-assessment' for the project are those that are listed as Threatened or Migratory and have moderate to high likelihood of occurring in the Study Area ('species of concern'). **Tables 10-2** and **10-3** list marine and terrestrial species, respectively, and the justification for their likelihood assignment. The full likelihood of occurrence assessment table, including all listed species is provided in **Appendix E**.

10.3.2 Marine Species

Listed marine species of concern include:

- 20 species of Migratory marine bird, seven of which are Threatened;
- The Green Sawfish (*Pristis zijsron*), listed as Threatened and Migratory;
- The Dugong (*Dugong dugon*), listed as Migratory;
- Three Migratory species of dolphin;
- Four species of Threatened and Migratory turtle; and
- The Saltwater Crocodile (*Crocodylus porosus*), listed as Migratory.

Table 10-2 Marine species of concern with moderate to high likelihood of occurrence in the study area

Scientific name	Common name	EPBC Act	TPWC Act	Likelihood of occurrence in Study Area	Justification
Birds					
Actitis hypoleucos (M)	Common Sandpiper	-	-	High	Have frequently been recorded previously in the Study Area. Study site habitat area is suitable for the species, with known breeding grounds around the Darwin area - fly by likely to occur.
Arenaria interpres (M)	Ruddy Turnstone	-	-	High	Have frequently been recorded previously in the Study Area. Potential foraging area. Known breeding site (Bynoe Harbour) located south of Study Area, therefore may also fly through.
Calidris acuminata (M)	Sharp-tailed Sandpiper	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Calidris alba (M)	Sanderling	-	-	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Calidris canutus (T, M)	Red Knot	E	V	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration. Migration patterns may see presence of Red Knots, generally during September and October. Numbers reduce in December.
Calidris ferruginea (T, M)	Curlew Sandpiper	C	V	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Calidris melanotos (M)	Pectoral Sandpiper	-	-	Moderate	Are unlikely to maintain sedentary populations, however may

Scientific name	Common name	EPBC Act	TPWC Act	Likelihood of occurrence in Study Area	Justification
					seasonally use resources within the Project Area, opportunistically or during migration.
Calidris tenuirostris (T, M)	Great Knot	C	V	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Charadrius leschenaultia (T, M)	Greater Sand Plover, Larger Sand Plover	V	V	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Charadrius mongolus (T, M)	Lesser Sand Plover, Mongolian Plover	E	V	High	Have frequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Charadrius veredus (M)	Oriental Plover, Oriental Dotterel	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Fregata ariel (M)	Lesser Frigatebird, Least Frigatebird	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Hirundo rustica (M)	Barn Swallow	-	-	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Limosa lapponica baueri (M)	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed	V	V	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Limosa limosa (M)	Black-tailed Godwit	-	-	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Numenius madagascariensis (T, M)	Eastern Curlew, Far Eastern Curlew	C	V	High	Have frequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may

Scientific name	Common name	EPBC Act	TPWC Act	Likelihood of occurrence in Study Area	Justification
					seasonally use resources within the Project Area, opportunistically or during migration.
Numenius phaeopus (M)	Whimbrel	-	-	High	Have frequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Pandion haliaetus (M)	Osprey	-	-	Moderate	Species and habitat known Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Pluvialis squatarola (M)	Grey Plover	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Sternula albifrons (M)	Little Tern	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Tringa nebularia (M)	Common Greenshank, Greenshank	-	-	High	Have frequently been recorded previously in the Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Fish, Sharks & Rays					
Pristis zijsron (T, M)	Green Sawfish, Dindagubba, Narrowsnout Sawfish	V	V	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration.
Mammals and Cetaceans					
Dugong dugon (M)	Dugong	-	-	Moderate	Have infrequently been recorded previously in the Study Area. Potential for dugongs to be foraging or passing through the study site is likely. Transient, has the potential to swim through the Study Locality, albeit widespread. Known species habitat present in Study area.
Orcaella heinsohni / brevirostris (M, C)	Australian Snubfin Dolphin, Irrawaddy Dolphin	-	-	Moderate	Have infrequently been recorded previously in the Study Area.

Scientific name	Common name	EPBC Act	TPWC Act	Likelihood of occurrence in Study Area	Justification
					Transient, has the potential to swim through the Study Locality, albeit widespread.
Sousa chinensis (M, C)	Indo-Pacific Humpback Dolphin	-	-	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration. Transient, has the potential to swim through the Study Locality, albeit widespread.
Tursiops aduncus (M, C)	Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	-	-	Moderate	Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically or during migration. Transient, has the potential to swim through the Study Locality, albeit widespread.
Reptiles					
Chelonia mydas (T, M)	Green Turtle	V	-	Moderate	Use specific habitats or resources present in the Study Area. Therefore, potential for foraging.
Crocodylus porosus (M)	Salt-water Crocodile, Estuarine Crocodile	-	LC		Known to inhabit surrounding area of study site. However, capture and removal of any entering Darwin Harbour occurs regularly.
Eretmochelys imbricata (T, M)	Hawksbill Turtle	V	V	Moderate	Have infrequently been recorded previously in the Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition. May seasonally use resources within the Project Area, opportunistically or during migration.
Lepidochelys olivacea (T, M)	Olive Ridley Turtle, Pacific Ridley Turtle	E	V	Moderate	Have infrequently been recorded previously in the Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition. May seasonally use resources within the Project Area, opportunistically or during migration.
Natator depressus (T, M)	Flatback Turtle	V	DD	Moderate	Have infrequently been recorded previously in the Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition. May seasonally use resources within the Project Area, opportunistically or during migration.

Key:

C = Critically endangered, DD = Data deficient, E = Endangered, LC = Least concern, N = Near Threatened, V = Vulnerable, *EPBC Act:* M = Migratory, T = Threatened

10.3.3 Terrestrial Species

Listed terrestrial species of concern include:

> One Migratory bird and five Threatened birds; and

> Five Threatened mammals (marsupials).

Table 10-3 Terrestrial species of concern with moderate to high likelihood of occurrence in the study area

Scientific name	Common name	EPBC Act	TPWC Act	Likelihood of occurrence in Study Area	Justification
Birds					
Cuculus optatus (M)	Oriental Cuckoo	-	-	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition. Previously recorded in Study Area.
Erythrotriorchis radiatus (T)	Red Goshawk	V	V	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Erythrura gouldiae (T)	Gouldian Finch	E	E	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Falco hypoleucos (T)	Grey Falcon	V	V	Moderate	Species or species habitat likely to occur within Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically.
Geophaps smithii smithii (T)	Partridge Pigeon (eastern)	V	-	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Tyto novaehollandiae Kimberli (T)	Masked Owl (northern)	V	V	Moderate	Species or species habitat likely to occur within Study Area. Are unlikely to maintain sedentary populations, however may seasonally use resources within the Project Area, opportunistically.

Mammals					
Antechinus bellus (T)	Fawn Antechinus	V	E	Moderate	Species or species habitat likely to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Conilurus penicillatus (T)	Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	V	E	Moderate	Species or species habitat may occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Dasyurus hallucatus (T)	Northern Quoll [Dambimangari], Wiminji [Martu]	E	C	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.
Mesembriomys gouldii (T)	Black-footed Tree-rat, Djintamoonga, Manbul	E	V	Moderate	Species or species habitat known to occur within Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition. Previously recorded in Study Area.
Trichosurus vulpecula arnhemensis (T)	Northern Brushtail Possum	V	E	Moderate	Species or species habitat known to occur in Study Area. Use specific habitats or resources present in the Project Area, but in a poor or modified condition.

Key:

C = Critically endangered, DD = Data deficient, E = Endangered, LC = Least concern, N = Near Threatened, V = Vulnerable, *EPBC Act:* M = Migratory, T = Threatened

10.4 Significant Impact Assessment

10.4.1 Criteria

Criteria used to assess whether proposed project actions could result in 'significant impact' to species of concern have been derived from *Matters of National Environmental Significance: Significant impact guidelines 1.1* (Commonwealth of Australia, 2013). The criteria are listed in the sub-sections below.

10.4.1.1 Critically Endangered and Endangered Species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of a population;

- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere with the recovery of the species.

10.4.1.2 Vulnerable Species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species;
- Reduce the area of occupancy of an important population;
- Fragment an existing important population into two or more populations;
- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of an important population;
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere substantially with the recovery of the species.

10.4.1.3 Migratory Species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

10.4.2 Marine Birds

10.4.2.1 Migratory species

The assessment has identified 21 marine bird species with moderate to high likelihood of occurrence in the project area, listed as Migratory under the EPBC Act.

10.4.2.1.1 Modification of Important Habitat

The assignments of 'High' and (predominantly) 'Moderate' likelihood of occurrence of these migratory bird species in the project area is due to their high mobility and is primarily associated with fly-by and temporary site use (e.g. foraging), rather than attendance at the site as important habitat. The likelihood of fly-by is due to known sources of food, breeding and nesting areas in the vicinity of the project area. DEPWS natural resource mapping does not identify any Waterbird or Seabird Colonies in close proximity to the project site, with the closest colonies being within Middle Arm and in Bynoe Harbour.

The project area itself is not considered to be important habitat for any migratory bird species. The project is expected to clear a very small portion of Eucalypt woodland and Eucalypt open woodland, both of which are abundant habitat inland and along the coast of the Cox Peninsula.

10.4.2.1.2 Introduction of Invasive Species

There is considered to be a low likelihood that project actions would introduce invasive species, let alone those that may pose a threat to migratory birds. The site has already been exposed to most of the common invasive plant species in the Darwin Region.

10.4.2.1.3 Disruption of Lifecycle

Important lifecycle factors that could be impacted by the project for migratory birds would be related to feeding and nesting behaviour. Breeding is not known to occur at the project site. Migratory birds may rest in the nearshore footprint of the project site or feed in nearshore areas, that will be impacted both temporarily and permanently to various extents. These areas do not contain specific features that are likely to be unique or of high value for such activities. The intertidal habitat is relatively sparse (bare reef), beaches are small compared to surrounding areas and no mangroves or wetlands are present. There is considered to be abundant suitable foraging and resting habitat in areas adjacent the project and its impacts, such that migratory bird species can avoid being affected. All species are highly mobile, with the ability to avoid project impacts.

10.4.2.2 Threatened species

Of the Migratory marine bird species listed, seven are also listed as Threatened under the EPBC Act:

- Red Knot (*Calidris canutus*) – Endangered;
- Curlew Sandpiper (*Calidris ferruginea*) – Critically Endangered;
- Great Knot (*Calidris tenuirostris*) – Critically Endangered;
- Greater Sand Plover (*Charadrius leschenaultia*) – Vulnerable;
- Lesser Sand Plover (*Charadrius mongolus*) – Endangered;
- Nunivak Bar-tailed Godwit (*Limosa lapponica baueri*) – Vulnerable; and
- Eastern Curlew (*Numenius madagascariensis*) – Critically Endangered.

All of these species of bird are listed as Vulnerable under the TPWC Act, due to their relative abundance in the NT with respect to Australia overall.

10.4.2.2.1 Fragmentation or Reduction of Population

The project, through its anticipated change of coastal geomorphology and impact to marine and terrestrial habitat, is not expect to lead to tangible fragmentation or reduction of populations of Threatened marine bird species. As described above, the areas to be affected are not of high habitat value (e.g. breeding or nesting) to any of the listed species. Furthermore, the habitat at the site is not particularly unique, lacking wetlands, mangroves and complex nearshore ecosystems. Substantial similar habitat is available on Cox Peninsula and in adjacent Bynoe and Darwin Harbours, with the species being capable of avoiding project actions and seeking this out.

10.4.2.3 Mitigation Measures

Mitigation measures proposed in the Draft CEMP will further reduce risk to marine birds, to the point of protecting individuals of each species. The plan will require visual survey of all areas to be impacted, allowing identification of presence and nests. Identification will require further investigation prior to proceeding with construction works, with nests and birds to be relocated if required ('spotter-catcher' services).

10.4.2.4 Conclusion

The project actions are considered unlikely to result in significant impacts to listed marine bird species under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.3 Sawfish

The Green Sawfish (*Pristis zijsron*) is listed as Migratory and Vulnerable under the EPBC Act and is considered to have a 'Moderate' likelihood of being present in the study area. The 'Moderate' likelihood has been assigned given the long duration of the project actions in the nearshore area (i.e. dredging and breakwater construction) and the general suitability of nearshore habitat for the species. In reality, observations of the species are extremely rare in Darwin Harbour and their population and behaviour is poorly understood. The two official records of the species were within Buffalo Creek.

10.4.3.1 Modification of Important Habitat

The project will modify a small portion of nearshore habitat by the installation of the harbour breakwaters. This includes soft bottom habitat that is believed to be an important habitat type for the species (Peverell et al. 2004; Stevens et al. 2005; Thorburn et al. 2004). However, given the nature of coastal processes and geomorphology, the same amount of similar habitat (shallow, soft bottom etc.) will eventually reform and be redistributed around the coastal structures – i.e. the habitat modification is predicted to be temporary, rather than permanent. Similar shallow, soft bottom habitat is also abundant throughout Darwin Harbour (Galaiduk et al, 2019), so it is highly unlikely that the project site is specifically important habitat for the species.

10.4.3.2 Introduction of Invasive Species

There is considered to be a low likelihood that project actions would introduce invasive species to the marine environment, with equipment to be used not expected to be imported from outside of Australia waters. Standard inspection and quarantine processes are also in place to reduce this risk. Invasive species are not listed as a potential threat to sawfish by DAWE.

10.4.3.3 Disruption of Lifecycle

Green Sawfish are long lived, produce few young and mature late in life (Walker, 1998). The low fecundity and late maturation of Green Sawfish render the species highly susceptible to anthropogenic mortality and limits the ability of the species to recover from other listed threats (Stevens et al., 2005; Stobutzki el al., 2002). As such, impact of the project to an individual species, particularly given their scarcity within Darwin Harbour, could constitute lifecycle disruption at a local scale. Such an impact is considered unlikely, however. As discussed, the project site is unlikely to be particularly unique or valuable to the species, with abundant similar habitat nearby. The project's major marine actions, dredging and rock placement, are relatively slow and loud, which should allow the species to avoid impact. It is likely that the species already avoids the area (or is not present) due to regular ferry movements and general long-term anthropologic presence (including fishing activities).

10.4.3.4 Fragmentation or Reduction of Population

The Green Sawfish has been known to inhabit a range of coastal environments and water depths (Stevens et al., 2005). As such, the installation of the harbour in the nearshore environment is not an action that would be considered to fragment Sawfish populations, if present. Impact to an individual of the species may constitute a noticeable reduction in local population, given their perceived scarcity in Darwin Harbour. As discussed above, it is considered unlikely that the project actions will have such a direct impact.

10.4.3.5 Impact to Species Recovery

The primary threats to the species, listed by DAWE, are habitat degradation and impacts related to fishing. As discussed above, the project is not expected to noticeably degrade available habitat for the species. Mandorah is already fished heavily by recreational anglers. It is possible that this threat to the species has already had an impact at the site (and throughout Darwin Harbour). The project is not planned to increase fishing pressure at Mandorah, though improved accessibility associated with the new facilities may have this effect. In general,

long-term fisheries management within Darwin Harbour, and how this relates to Sawfish species recovery, is not considered to be within the control of this project.

10.4.3.6 Mitigation Measures

Marine fauna observation and avoidance will be incorporated as a mitigation measure for the project, as described in the Draft DSDMP. This is unlikely to identify the presence of Sawfish, however, which are usually found at the seabed. Controls on marine construction actions, in particular 'soft-start' for dredging and piling will improve the species ability to avoid direct impact, if present in the area.

10.4.3.7 Conclusion

The project actions are considered unlikely to result in significant impacts to Sawfish under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.4 Dugong

The Dugong (*Dugong dugon*) is listed as Migratory under the EPBC Act and is considered to have a Moderate likelihood of occurring in the project area.

10.4.4.1 Modification of Important Habitat

The site contains habitat that is known to be attended by Dugong. It is likely that the relatively sparse seagrass assemblage present at the site, that was observed during BCH surveys for the project, can provide foraging for the species. The results of the surveys found two individual sightings of Dugong in the nearshore vicinity of the project site. This was likely to be associated with foraging on seagrass in the area or resting. The majority of sightings were on the western and outer edges of the harbour, where significant seagrass assemblages are known to exist. **Figure 10-1** depicts all sightings for the three-year monitoring program (INPEX Browse, 2014).

10.4.4.2 Introduction of Invasive Species

There is considered to be a low likelihood that project actions would introduce invasive species to the marine environment, with equipment to be used not expected to be imported from outside of Australia waters. Standard inspection and quarantine processes are also in place to reduce this risk. Invasive species are not listed as a potential threat to the species by DAWE.

10.4.4.3 Disruption of Lifecycle

Potential threats to Dugong lifecycle elements that could arise from the project actions include:

- Habitat degradation;
- Pollution;
- Vessel strike; and
- Underwater noise.

As discussed above, the project is not anticipated to impact high-value habitat or cause significant degradation of this habitat. Pollution of the marine environment from dredging vessels and land-based equipment is possible, but unlikely to be of a nature and scale that would impact the Dugong. Vessel strike is a realistic threat, however vessel movement for the project will be associated with dredgers and barges, which are large and move slowly. Underwater noise will arise from rock work and piling. These can pose a threat of injury to the species, but are unlikely to disrupt the species lifecycle.

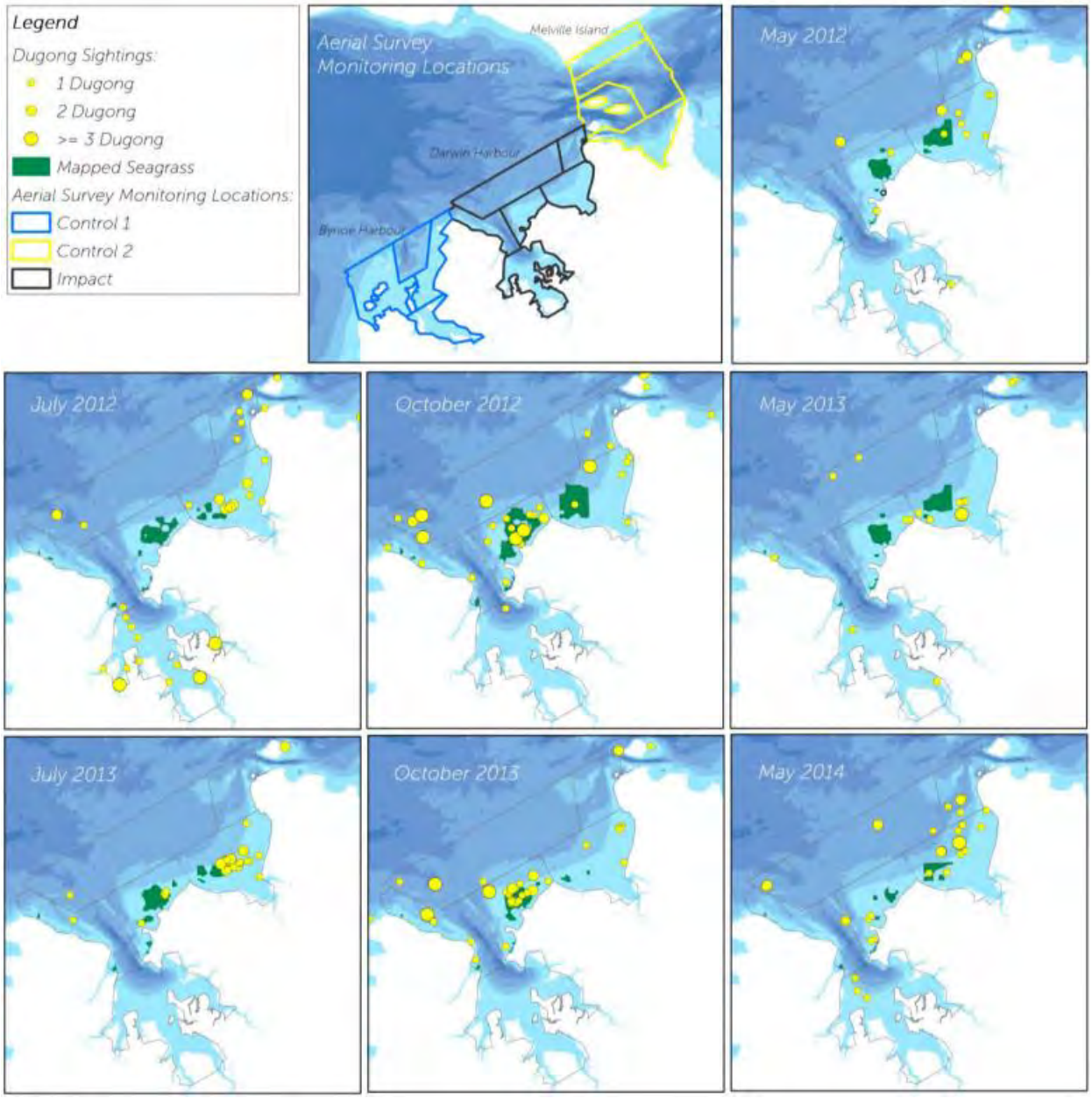


Figure 10-1 Dugong sightings around the Darwin region during aerial surveys from May 2012 to May 2014 (INPEX Browse, 2014)

10.4.4.4 Mitigation Measures

Mitigation measures will be enforced for the project via the Draft DSDMP. Those specific to managing risk to Dugong include:

- Marine fauna observation and avoidance, requiring work to stop if a Dugong is in proximity to construction activities;
- Oil spill and pollution prevention and response procedures;
- Control of movement of vessels, including speed and allowable areas; and
- 'Soft-start' of construction activities, in particular piling, to allow marine fauna to leave the area prior to underwater noise reaching levels that could pose a risk of injury.

10.4.4.5 Conclusion

The project actions are considered unlikely to result in significant impacts to Dugong under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.5 Dolphins

Three species of dolphin listed as Migratory have been identified:

- Australian Snubfin Dolphin (*Orcaella heinsohni*);
- Indo-Pacific Humpback Dolphin (*Sousa chinensis*); and
- Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*).

These species are considered to have a 'Moderate' likelihood of occurrence in the project area, due to the project's duration and their high mobility.

Monitoring of these dolphin populations in Darwin harbour was undertaken for almost 10 years (2011 to 2019) and the findings of the monitoring were reported in Griffiths et al (2020). The program identified small, mobile and variable coastal dolphin populations in the Darwin region. All three species were shown to occur at relatively low densities compared to other coastal areas in Australia. They were found to exhibit substantial temporary emigration and have fluctuating population size. The bottlenose dolphin population was the smallest, had high levels of temporary emigration and a significant negative trend in abundance. The snubfin dolphin population was also small, had the most variation in population size, the highest levels of temporary emigration and a significant negative trend in abundance. The humpback dolphin population was the largest, showed the least amount of temporary emigration and a significant negative trend in abundance.

10.4.5.1 Modification of Important Habitat

Seagrass assemblages are important habitat for dolphins, due to associated foraging (Parra, 2006). A small and relatively sparse seagrass assemblage is expected to be modified by the project. As discussed above, this assemblage is unlikely to be of high importance along Cox Peninsula, where more abundant seagrass is present to the north and south of the project site. Furthermore, the highest abundance of seagrass in Darwin Harbour is associated with meadows along its east. Dolphins, being highly mobile, also have the ability to travel and forage outside of the harbour, as they have been recorded to do (Griffiths et al., 2020).

10.4.5.2 Introduction of Invasive Species

There is considered to be a low likelihood that project actions would introduce invasive species to the marine environment, with equipment to be used not expected to be imported from outside of Australia waters. Standard inspection and quarantine processes are also in place to reduce this risk. Invasive species are not listed as a potential threat to the species by DAWE.

10.4.5.3 Disruption of Lifecycle

Threats to the lifecycle of dolphins include:

- Habitat destruction and degradation (discussed above);
- Habitat pollution;
- Interaction with vessels; and
- Pathogens.

There is potential for pollution associated with the project during and post-construction. The risk of pollution is expected to be low during construction, managed by appropriate vessel/equipment survey standards, waste control and pollution/spill response. The receiving environment is also an open coastline, allowing dolphins to easily evacuate the area.

Interaction with vessels is considered a very low risk, given the slow-moving nature of the vessels involved, and the highly mobile and intelligent nature of dolphins.

Marine mammals are very susceptible to pathogen-induced mass mortalities (Bannister et al, 1996), suggesting that an epizootic event could threaten the dolphin species in Darwin Harbour, with their small population size and restricted coastal range (Griffiths et al., 2020). Pathogens such as *Toxoplasmosis gondii* are of concern for the conservation of dolphins (Parra, 2006), particularly the Snubfin and Bottlenose with their small population sizes. The project is not expected to increase the risk of release of such pathogens to the marine environment. The harbour design and its location mean it will be regularly and well flushed, unlike many of the locked marinas in the Harbour. Ablutions will be installed (not present currently) but these will include appropriate treatment of waste prior to any release to the environment.

10.4.5.4 Mitigation Measures

Mitigation measures will be enforced for the project via the Draft DSDMP. Those specific to managing risk to dolphins include:

- Marine fauna observation and avoidance, requiring work to stop if dolphins are in proximity to construction activities;
- Oil spill and pollution prevention and response procedures;
- Control of movement of vessels, including speed and allowable areas; and
- 'Soft-start' of construction activities, in particular piling, to allow marine fauna to leave the area prior to underwater noise reaching levels that could pose a risk of injury.

Appropriate waste management for the ongoing operation of the facility will be incorporated, such that the new facilities are not expected to impact on marine environmental quality.

10.4.5.5 Conclusion

The project actions are considered unlikely to result in significant impacts to listed dolphins under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.6 Turtles

Four species of turtle listed as Threatened and Migratory have been identified with 'Moderate' likelihood of occurrence in the project area:

- Green Turtle (Chelonia mydas) - Vulnerable;
- Hawksbill Turtle (Eretmochelys imbricata) - Vulnerable;
- Olive Ridley Turtle (Lepidochelys olivacea) - Endangered; and
- Flatback Turtle (*Natator depressus*) – Vulnerable.

Turtles were monitored before, during and after Inpex Ichthys nearshore dredging program by aerial and land-based surveys (INPEX Browse, 2014). During the monitoring program, observations from aerial surveys were undertaken three times a year during the dry season, when conditions were most favourable, with approximately 3,500 linear kilometres flown over a 40-hour period during each survey.

Turtles were sighted throughout the harbour over the monitoring period, with several observations in the nearshore area at Mandorah (**Figure 10-2**). There appeared to be a higher concentration of sightings along the Cox Peninsula during October, with the majority of observations to the north of the project site.

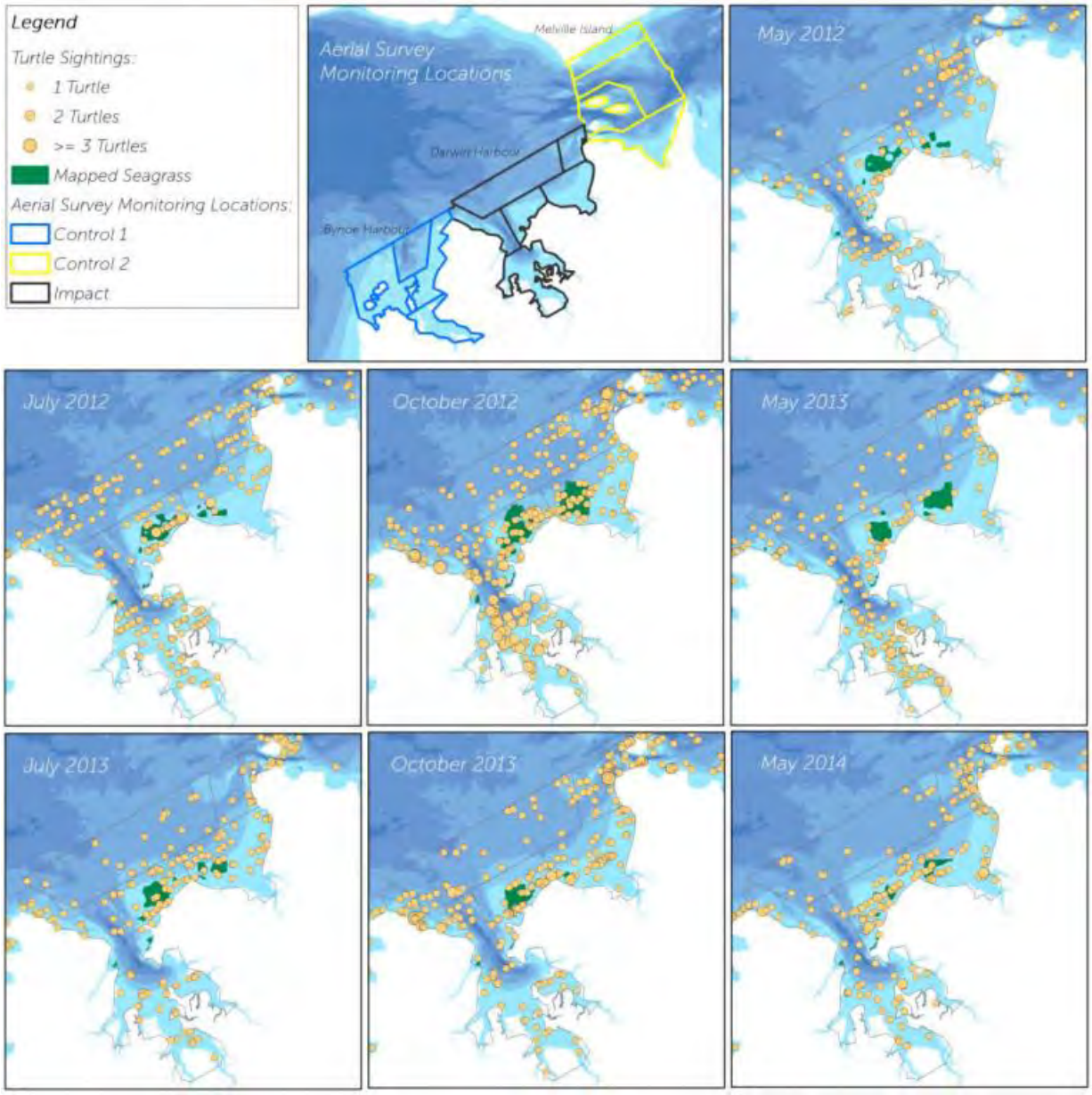


Figure 10-2 Turtle sightings around the Darwin region during aerial surveys from May 2012 to May 2014 (INPEX Browse, 2014)

10.4.6.2 Modification of Important Habitat

The nearshore area adjacent the project site is likely to provide suitable foraging habitat for turtles, in the form of seagrass, soft corals and sponges. A portion of sparse seagrass assemblage is expected to be modified (removed) by the project. Other nearby benthic habitats are not expected to be significantly impacted by temporary dredging impacts. This habitat is not considered to be of high importance for turtles, with higher quality examples of the habitat present to the north and south along Cox Peninsula and, more notably, on the western side of Darwin Harbour. This is demonstrated by the preferred visitation areas observed during surveys (**Figure 10-2**).

The site is not considered to have unique features that would endear it to turtle breeding. The site does not comprise nesting habitat and nesting has not been recorded at the site.

10.4.6.3 Introduction of Invasive Species

There is considered to be a low likelihood that project actions would introduce invasive species to the marine environment, with equipment to be used not expected to be imported from outside of Australia waters. Standard inspection and quarantine processes are also in place to reduce this risk. Invasive species are not listed as a potential threat to turtles by DAWE.

Invasive species that might interfere with turtle nesting, such as wild pigs, are not expected to be introduced (already present) or increased by the project.

10.4.6.4 Disruption of Lifecycle

Turtle nesting is very unlikely to occur at the project site and is rare in Darwin Harbour (Chatto & Baker, 2008). It is also highly unlikely that the project site is a specific breeding area for any of the species of turtle identified. Visitation at the site is likely to be temporary and for the purpose of foraging and/or resting. It is, therefore, considered unlikely that the project actions will disrupt the species' lifecycle, except through potential direct impact to the animals, discussed below.

10.4.6.5 Fragmentation or Reduction of Population

All turtle species are known to inhabit a range of coastal environments and water depths. As such, the installation of the harbour in the nearshore environment is not an action that would be considered to fragment turtle populations, which are transient anyhow.

Impacts to several individuals of a turtle species may constitute a noticeable reduction in local population, given the threatened listing status of the species and particular scarcity of some species in Darwin Harbour (e.g. Olive Ridley Turtle). As discussed above, it is considered unlikely that the project actions will have such a direct impact.

10.4.6.6 Impact to Species Recovery

The main threats to turtle species identified by DAWE, that could be associated with the project, include:

- Habitat degradation (discussed above);
- Boat strike;
- Light pollution;
- Marine pollution and debris; and
- Disturbance of nesting and hatching (not expected to occur in the project area).

Boat strike is a realistic threat to turtles, which have poor awareness and can be slow moving. For this project, the risk would be considered lower due to relatively large, slow-moving vessels – barges and dredgers. Marine fauna observation and avoidance will be required and turtles are generally easy to observe due to their size and presence at the surface.

Light pollution can disorient turtles and impact their behaviour. This is primarily a risk for nesting and hatching activities. The restriction of operations to daytime will prevent impacts in this regard during construction. Some increased lighting is expected for expanded onshore facilities once established, although substantial lighting is already in place at the site.

There is potential for pollution associated with the project during and post-construction. The risk of pollution is expected to be low during construction, managed by appropriate vessel/equipment survey standards, waste control and pollution/spill response. The receiving environment is also an open coastline, allowing turtles to easily evacuate the area. Usage of the onshore site, and associated litter/pollution, may increase for the new facilities. Ingestion by turtles of debris, such as plastic waste, is an ongoing issue to be managed, not specific to this project.

10.4.6.7 Mitigation Measures

Mitigation measures will be enforced for the project via the Draft DSDMP. Those specific to managing risk to turtles include:

- Marine fauna observation and avoidance, requiring work to stop if turtles are in proximity to construction activities;
- Oil spill and pollution prevention and response procedures;

- Control of movement of vessels, including speed and allowable areas; and
- 'Soft-start' of construction activities, in particular piling, to allow marine fauna to leave the area prior to underwater noise reaching levels that could pose a risk of injury.

Terrestrial fauna observations will have the potential to identify and mitigate risk to any turtles coming onshore at the site, though this is unlikely.

10.4.6.8 Conclusion

The project actions are considered unlikely to result in significant impacts to listed turtles under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.7 Terrestrial Birds

One species of Migratory bird has been identified with Moderate likelihood of occurrence in the project area, the Oriental Cuckoo (*Cuculus optatus*).

Five species of terrestrial bird that are listed as Threatened have been identified as having Moderate likelihood of occurrence in the project area:

- Red Goshawk (*Erythrotriorchis radiatus*) – Vulnerable;
- Gouldian Finch (*Erythrura gouldiae*) – Endangered;
- Grey Falcon (*Falco hypoleucos*) – Vulnerable;
- Partridge Pigeon (*Geophaps smithii smithii*) – Vulnerable; and
- Masked Owl (Tyto novaehollandiae Kimberli) – Vulnerable.

The assignment of 'Moderate' likelihood accounts for the duration of the project and the potential for fly-by. It does not necessarily indicate a moderate likelihood that the species permanently reside in the project area.

10.4.7.1 Modification of Important Habitat

All bird species have been known to use the type of natural habitat present at the site, comprising Eucalypt woodland and Eucalypt open woodland, in addition to cleared land. The project site has relatively low coverage of trees, significant presence of invasive flora species and represents a degraded and very small portion of the region's Eucalypt woodland, which is abundant inland and along the coast of the Cox Peninsula. It is unlikely that the habitat to be modified by the project is of high importance to the listed birds at a species level, though individuals may reside in the area. The direct footprint of modification is relatively small and lies predominantly within land that has already been cleared or degraded.

10.4.7.2 Introduction of Invasive Species

The project is not anticipated to introduce any invasive terrestrial fauna species, with local (Darwin) based plant and equipment to be used and the project area not being isolated from areas already inhabited by invasive species. Invasive flora species could be introduced that may degrade natural habitat for the birds over time. The likelihood of this is also considered low and can be mitigated through appropriate controls.

Invasive grasses such as Mission Grass (*Pennisetum polystachion*) and Gamba Grass (*Andropogon gayanus*) are already present at the site and can pose threats to bird species by reducing native grass used for foraging and also increasing bushfire loads. The project is not expected to exacerbate the existing presence of these species.

10.4.7.3 Disruption of Lifecycle

Given the relatively sparse vegetation to be cleared at the site, it is unlikely that the project will disrupt nesting of the listed birds on a large scale. Individual nests may be present in the project area and mitigation measures will need to be in place to prevent impact to these. The site does not exhibit features that would make it an important breeding area for bird species.

10.4.7.4 Fragmentation or Reduction of Population

The location of the proposed development at the land/coast interface, and its small relative scale, is such that it will not fragment populations of bird species, if present.

10.4.7.5 Impact to Species Recovery

Preventing impact to species recovery for threatened birds is generally focused on reducing the impact of invasive predators and preventing large scale loss of habitat attributed to changed fire patterns, clearing and invasive flora species. The project is considered unlikely to add significantly to these existing threats, with mitigation measures to be put in place where any risk of impact to species recovery does exist.

10.4.7.6 Mitigation Measures

Mitigation measures proposed in the Draft CEMP will further reduce risk to birds, to the point of protecting individuals of the species. The plan will require visual survey of all areas to be impacted, allowing identification of presence and nests. Identification will require further investigation prior to proceeding with construction works, with nests and birds to be relocated if required ('spotter-catcher').

The plan will also incorporate mitigation measures for potential large-scale impacts, such as the creation of bushfires or degradation of environmental quality (e.g. erosion). These risks are typical for rural construction projects and it is expected that they can be adequately mitigated.

10.4.7.7 Conclusion

The project actions are considered unlikely to result in significant impacts to listed terrestrial birds under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.4.8 Terrestrial Mammals

Five species of terrestrial mammal that are listed as Threatened have been identified with Moderate likelihood of occurrence at the project site:

- Fawn Antechinus (*Antechinus bellus*) – Vulnerable;
- Brush-tailed rabbit-rat (*Conilurus penicillatus*) – Vulnerable;
- Northern Quoll (*Dasyurus hallucatus*) – Endangered;
- Black-footed tree-rat (*Mesembriomys gouldii*) – Endangered; and
- Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*) – Vulnerable.

The likelihood assignment is predominantly based on the habitat available at the site, with none of the species having previously been recorded at the project site.

10.4.8.1 Modification of Important Habitat

All mammal species have been known to use the type of natural habitat present at the site, comprising Eucalypt woodland and Eucalypt open woodland, in addition to cleared land. The project site has relatively low coverage of trees, significant presence of invasive flora species and represents a degraded and very small portion of the region's overall Eucalypt woodland, which is abundant inland and along the coast of the Cox Peninsula. It is unlikely that the habitat to be modified by the project is of high importance to the mammals at a species level, though individuals may reside in the area. The direct footprint of modification is relatively small and lies predominantly within land that has already been cleared or degraded.

10.4.8.2 Introduction of Invasive Species

The project is not anticipated to introduce any invasive terrestrial fauna species, with local (Darwin) based plant and equipment to be used and the project area not being isolated from areas already inhabited by invasive species. Invasive flora species could be introduced that may degrade natural habitat for the mammals over time. The likelihood of this is also considered low and can be mitigated through appropriate controls.

10.4.8.3 Disruption of Lifecycle

Given the relatively small project footprint and degraded/sparse natural habitat, it is unlikely that it provides particular value to key lifecycle stages of any of the listed terrestrial mammals. Individual animals may be present in the project area and mitigation measures will need to be in place to prevent impact to these, particularly when clearing vegetation.

10.4.8.4 Fragmentation or Reduction of Population

The location of the proposed development at the land/coast interface, and its small relative scale, is such that it is very unlikely to fragment populations of mammals, if present.

10.4.8.5 Impact to Species Recovery

Preventing impact to species recovery for threatened mammals is generally focused on reducing the impact of invasive predators and preventing large scale loss of habitat attributed to changed fire patterns, clearing and invasive flora species. The project is considered unlikely to add significantly to these existing threats, with mitigation measures to be put in place where any risk of impact to species recovery does exist.

10.4.8.6 Mitigation Measures

Mitigation measures proposed in the Draft CEMP will further reduce risk to mammals, to the point of protecting individuals of the species. The plan will require visual survey of all areas to be impacted, allowing identification of presence and burrows/nests. Identification will require further investigation prior to proceeding with construction works, with animals to be relocated if required ('spotter-catcher' services).

The plan will also incorporate mitigation measures for potential large-scale impacts, such as the creation of wildfires or degradation of environmental quality (e.g. erosion). These risks are typical for rural construction projects and it is expected that they can be adequately mitigated.

10.4.8.7 Conclusion

The project actions are considered unlikely to result in significant impacts to listed terrestrial mammals under the criteria outlined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

10.5 Summary

The project lies at the land/sea interface, with proposed project actions impacting both the terrestrial and marine environment. MNES that may be impacted by the project include both threatened and migratory species with potential to occur in the project area.

The project's terrestrial footprint is relatively small and the habitat to be modified is already in a degraded condition and not considered to represent high biodiversity or habitat value. There is substantial similar and better-quality habitat in the surrounding areas of Cox Peninsula.

Marine impacts are expected to be confined primarily to the direct project footprint (breakwaters and dredging) due to the majority of dredge volume being rock. The impacted area consists of bare ground and a portion of relatively sparse seagrass assemblage. There is higher density and more abundant seagrass available throughout Darwin Harbour, which has been shown to be preferred habitat for migratory marine species such as Dolphins, Dugong and Turtles (Griffiths et al, 2020; INPEX Browse, 2014).

The project area has already been influenced by previous and ongoing anthropogenic activity. There are frequent ferry movements and significant infrastructure and human activity on land. This activity has potentially already reduced the likelihood of many listed species residing at the site permanently or for extended periods of time.

The project involves significant actions and will highly modify a small area of marine and terrestrial environment. However, based on the existing habitat and it's condition at the proposed location, the nature of the migratory and threatened species with potential to occur there and the type of construction actions, it is considered unlikely that it will impact on any MNES as defined in the *Significant impact guidelines 1.1* (Commonwealth of Australia, 2013).

11 Application of the Principles of Environment Protection and Management

11.1 Overview

Section 43 of the EP Act sets out the general duty for proponents of proposed actions, under an environmental impact assessment process, as:

- *To provide communities that may be affected by a proposed action with information and opportunities for consultation to assist each community's understanding of the proposed action and its potential impacts and benefits;*
- *To consult with affected communities, including Aboriginal communities, in a culturally appropriate manner;*
- *To seek and document community knowledge and understanding (including scientific and traditional knowledge and understanding) of the natural and cultural values of areas that may be impacted by the proposed action;*
- *To address Aboriginal values and the rights and interests of Aboriginal communities in relation to areas that may be impacted by the proposed action;*
- *To consider the principles of ecologically sustainable development in the design of the proposed action;*
- *To apply the environmental decision-making hierarchy in the design of the proposed action;* and
- *To consider the waste management hierarchy in the design of the proposed action.*

The following sections, aligned with Part 2 of EP Act, have been incorporated to describe how these duties have been upheld by DIPL in planning, development and design of the proposed project.

11.2 Principles of Ecologically Sustainable Development

11.2.1 Decision-making principle

The decision-making principle has been exercised in considering both the short-term and long-term equity implications associated with the marine facilities. By stipulating a design life of 50 years, the project aims to improve accessibility to and from Cox Peninsula across multiple generations, for all Territorians and visitors. Its goal of improving the safety and accessibility of ferry services seeks to improve equitable access to essential services and lifestyle for the persons of all abilities and in all regions of the NT.

As presented in **Section 9**, environmental implications have been considered in the short-term, with respect to the construction actions required to develop the facilities. In the long-term, the operational and cumulative impacts have been considered and risk assessed.

The decision-making process for the facilities has included community and stakeholder engagement, with incorporation of feedback, at all stages of planning and design to date, as described in **Section 7**. This has included dedicated engagement with the Belyuen Aboriginal Community, as well as the Northern Land Council and Kenby Rangers.

11.2.2 Precautionary principle

The precautionary principle has been applied extensively in environmental assessment of the project, owing to the scarcity of environmental data (particularly relating to presence of fauna) at the project site. Appropriate data gap analysis and subsequent field investigations have been undertaken to properly characterise the existing habitat at the site. When assessing potential impacts to fauna, such as through the EPBC Act self-assessment (**Section 10**), a lack of data has not allowed a perceived reduction in potential risk. Furthermore, where potential environmental impacts have been quantified through best-practice techniques (such as dredge plume dispersion modelling), monitoring of the actions has still been proposed to ensure risk can be mitigated in response to actual risk and impact during construction.

11.2.3 Principle of evidence-based decision-making

To inform decision making for the project and assessment of environmental risk, the following steps were undertaken:

- Collation of desktop and database information relevant to the site's environment (Cardno, 2019);
- Assessment of data gaps preventing proper quantification of potential impacts and environmental risk assessment (Cardno, 2019);
- Collection of field data to fill identified gaps (Cardno, 2022a, 2022b & 2022c); and
- Application of modelling and data analysis, with appropriate input data, to predict potential impacts (Cardno, 2022d).

This structured approach to characterising the environment at the site and risks to it from the project is considered to properly demonstrate application of evidence-based decision-making. The desktop and field investigations undertaken to inform environmental risk assessment are documented in relevant chapter reports accompanying this *Environmental Referral Report*. Where risk remains with a level of uncertainty, best-practice field monitoring has been recommended to ensure intolerable risk or impacts do not develop during construction.

11.2.4 Principle of intergenerational and intragenerational equity

Intergenerational equity is demonstrated in the project purpose itself, by effectively creating a permanent public access facility to be used by multiple generations of Territorians. The project is not considered to compromise intragenerational equity, given that it will improve accessibility and connectedness between all potential users. Stakeholder engagement has reached various existing generations, with a range of vested interests in the project. The potential environmental impacts have been assessed as unlikely to be significant during construction (short-term), and the legacy of the facility (long-term) is not expected to degrade the surrounding environment.

11.2.5 Principle of sustainable use

The primary materials used for the project are natural rock, derived from nearby quarries and the reuse of dredged material. This is a once-off extraction of natural materials that have low ecological value while in situ. The proposed facility is not intended to use natural resources on an ongoing basis, with the exception of potential minor rainwater harvesting to service ablutions in the terminal building.

11.2.6 Principle of conservation of biological diversity and ecological integrity

Application of this principle has been demonstrated through the environmental risk assessment and EPBC Act self-assessment outlined in **Sections 9** and **10**, respectively. Further to this, the project has sought to minimise its environmental footprint throughout the planning and design process, while still achieving its functional aims. The proposed project is not anticipated to reduce the biological diversity or reduce the ecological integrity of its surrounding environment. Further monitoring and management during construction and operations are expected to ensure this principle is upheld.

11.2.7 Principle of improved valuation, pricing and incentive mechanisms

DIPL plans to uphold this principle by taking responsibility for the ongoing management, maintenance and operation of the facility, once constructed. Other benefitting stakeholders, such as the ferry operator (currently Sealink) and Wagait community will be expected to be involved in general upkeep, security and waste management at the facility.

11.3 Management Hierarchies

11.3.1 Environmental decision-making hierarchy

The project aims to avoid adverse impacts on the environment by developing adjacent to existing built infrastructure (where the environment has already been, or is already being, disturbed) and minimising major

project actions where possible, such as dredging and disposal volumes, nearshore construction footprints and terrestrial land clearing footprints. Management options have then been defined to effectively limit environmental impact to the direct construction footprint and its immediate vicinity. Based on the habitat to be impacted by the project, it is not considered appropriate to allocate offsets, given the relatively small project footprint and abundant similar and better-quality habitat in the surrounding terrestrial and marine environment.

The project does not specifically aim to enhance or restore environmental quality at the site. However, the introduction of coastal rock structures may diversify local habitat and ecology, and the interruption of strong nearshore currents may increase stable deposits of soft sediment that are suitable for seagrass assemblages.

11.3.2 Waste management hierarchy

The design process has incorporated the hierarchy of waste management approaches specified in Section 27.2 of the EP Act, in order of priority:

a) *Avoidance of the production of waste;*

b) *Minimisation of the production of waste;*

c) *Re-use of waste;*

d) *Recycling of waste;*

e) *Recovery of energy and other resources from waste;*

f) *Treatment of waste to reduce potentially adverse impacts; and*

g) *Disposal of waste in an environmentally sound manner.*

11.3.2.1 Dredged materials

The largest source of waste from the proposed construction works is expected to be material extracted from the seabed during dredging. Whilst the design has been refined to minimise the dredging footprint and volume (approach b) it is expected that approximately 85,000 m^3 of dredged material will be extracted during construction. Approximately 70,000 m^3 of this is considered natural geological material and is proposed to be reused in the breakwater cores and project fill (≈ 35,000 m^3) and in other Darwin construction projects (≈ 35,000 m^3) (approach c). Approximately 15,000 m^3 of unconsolidated material is not suitable for reuse and is planned to be disposed offshore by dispersal in the water column.

11.3.2.2 Other waste produced during construction

The project is expected to produce waste typical of a civil and maritime construction project. This includes the risk of accidental waste production such as hydrocarbon spills. Through its design and construction (D&C) stage, the project will seek to construct the facilities as efficiently as possible (approach b). Waste would then be controlled for the project via typical controls outlined in the CEMP and DSDMP. These plans will put management measures in place to minimise the risk of the release of waste to the environment, to dispose of waste appropriately and to respond to any accidental waste production.

11.3.2.3 Waste produced during operation

Toilet facilities at the ferry terminal will produce sewage. This waste cannot be avoided, minimised, reused or recycled (feasibly). It is proposed that chemical toilets are used as no sewer services are currently available at the site and due to high level of bedrock layer any absorption trench facility has a risk of contamination into the ocean or nearby swamplands. This solution uses approaches f) and g) from the waste management hierarchy. Operational waste management will be detailed through the D&C process and will follow best-practice management approaches.

11.4 Climate Change Considerations

Due to the proposal's coastal location, it is critical to consider the impact of climate change over the asset's design life. Assets on the northern Australian coastline will experience significant challenges associated with rising sea levels and the intensification of cyclones leading to increase in storm surge and wave action. Based

on the most up to date IPCC studies (2013) and RCP8.5 scenario, the Sea Level Rise (SLR) allowance of 0.43 metres (from 2020 to 2075) and the effect of cyclone intensification on storm surge have been considered in the design of all elements of the proposal.

12 References

AECOM (2017) Site Audit Report – Section 262 Cox Peninsula, Northern Territory. Prepared for Department of Finance, September 2017.

Australian Government (2018) *Disability Discrimination Act 1992*, Prepared by the Office of Legislative Drafting and Publishing, Attorney-General's Department, Canberra

Bannister, J.L., C.M. Kemper & R.M. Warneke (1996). *The Action Plan for Australian Cetaceans. Canberra: Australian Nature Conservation Agency*. Available from: http://www.environment.gov.au/resource/action-plan-australian-cetaceans.

Cardno (2015a) *Seagrass monitoring post-dredging report.* Prepared for INPEX Browse Pty Ltd.

Cardno (2015b) *Turtle and dugong monitoring post-dredging report.* Prepared for INPEX Browse Pty Ltd.

Cardno (2022a) *Terrestrial Environment Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2021) *Asbestos Asset Survey: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022b) *Marine Environment Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022c) *SAP Implementation Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022d) *Sediment Transport Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022e) *Draft Dredging and Disposal Management Plan: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022f) *Draft Construction Environmental Management Plan: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022g) *Design Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022h) *Geotechnical Investigations Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Cardno (2022i) *Metocean Investigations Report: New Marine Facilities to Service Mandorah and Cox Peninsula.* Prepared for DIPL.

Chatto, R. & Baker, B. (2008) *The Distribution and Status of Marine Turtle Nesting in the Northern Territory*. Technical Report No. 77. Parks and Wildlife Service Department of Natural Resources, Environment, The Arts and Sport.

DENR (2003). *The application of Landsat Imagery to Land Cover Mapping in the Greater Darwin Region. Technical report number 74,* ISBN 1 9207 7217 0. Biodiversity Unit, Department of Infrastructure, Planning and Environment, Darwin.

Commonwealth of Australia (2013) *Matters of National Environmental Significance: Significant impact guidelines 1.1*. Australian Government Department of the Environment.

Galaiduk R, Radford B, Harries S, Case M, Williams D, Low Choy D, Smit N (2019) Technical Report: Darwin - Bynoe Harbours predictive mapping of benthic communities. Australian Institute of Marine Science, Perth. pp 42.

Griffiths, A.D., Groom, R.A, Low Choy, D., Mackarous, K. and Brooks, L. (2020). *Darwin Region Coastal Dolphin Monitoring Program: Final Report – 2011 to 2019*. Department of Environment, Parks and Water Security, Northern Territory Government

Groom RA, Dunshea GJ, Griffiths AD, and Mackarous K (2017). *The distribution and abundance of Dugong and other marine megafauna in Northern Territory*, November 2015. Department of Environment and Natural Resources, Darwin.

Halvorsen, M. B., Casper, B. M., Woodley, C. M., Carlson, T. J., & Popper, A. N. (2011). Predicting and mitigating hydroacoustic impacts on fish from pile installations. *National Cooperative Highway Research Program Research Results Digest*, *363*, 2011.

Halvorsen, M. B., Casper, B. M., Carlson, T. J., Woodley, C. M., & Popper, A. N. 2012a. Assessment of barotrauma injury and cumulative sound exposure level in salmon after exposure to impulsive sound. In *The Effects of Noise on Aquatic Life* (pp. 235-237). Springer, New York, NY.

Halvorsen, M. B., Zeddies, D. G., Ellison, W. T., Chicoine, D. R., & Popper, A. N. 2012b. Effects of mid-frequency active sonar on hearing in fish. *The Journal of the Acoustical Society of America*, *131*(1), 599-607.

Holman et al (2014). *IAQM Guidance on the assessment of dust from demolition and construction*, Institute of Air Quality Management, London. www.iaqm.co.uk/ text/guidance/construction-dust-2014.pdf.

IPCC (2013) *Climate Change 2013: The Physical Science Basis – Summary for Policymakers, Technical Summary and Frequently Asked Questions*. Working Group 1 Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

INPEX Browse, Ltd. (2011) *Ichthys Gas Field Development Project Draft Environmental Impact Statement*. Report prepared by INPEX Browse, Ltd., Perth, Western Australia, for the Commonwealth Government, Canberra, ACT, and the Northern Territory Government, Darwin, Northern Territory.

Jacobs (2016) *Mandorah Jetty and Boat Ramp - Assessment and Upgrade Concept Study Department of Infrastructure* (IW103400-ESO-RP-0001, T15-1406), prepared for DIPL on 15 September 2016.

Jacobs (2019) *Mandorah Jetty and Boat Ramp Engineering Studies, Coastal Modelling and Preliminary Design Report* (IW163900-003-CM-RPT-001, T17-1448), prepared for DIPL on 27 February 2019.

NT EPA (2013a) *Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory*

NT EPA (2013b) *Guidelines for Assessment of Impacts of Terrestrial Biodiversity*

NT EPA (2021) *Referring a proposal to the NT EPA: Environmental impact assessment – Guidance for proponents*

NTG (2015) *Darwin Regional Land Use Plan 2015*, Department of Lands, Planning and the Environment.

NTG (2019) *Environment Protection Act 2019*, Department of Environment, Parks and Water Security.

Parra, G.J. (2006) *Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins*. Journal of Animal Ecology. 75:862-874.

Peverell, S., N. Gribble & H. Larson (2004). 'Sawfish'. In: National Oceans Office, Description of Key Species Groups in the Northern Planning Area. Hobart, Tasmania: Commonwealth of Australia. Available from: http://www.environment.gov.au/coasts/mbp/publications/north/pubs/n-key-species.pdf.

Popper, A.N., Hastings, M.C., (2009), *The effects of anthropogenic sources of sound on fishes*. Journal of Fish Biology. Available from: https://doi.org/10.1111/j.1095-8649.2009.02319.x

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J. & Løkkeborg, S. (2014). Sound exposure guidelines. In *ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI* (pp. 33-51). Springer, Cham.

Simpson, SL, Mosley, L, Batley, GE and Shand, P (2018) *National Acid sulfate soils guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management*, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

Stephenson, J. R., Gingerich, A. J., Brown, R. S., Pflugrath, B. D., Deng, Z., Carlson, T. J. & Seaburg, A. G. (2010). Assessing barotrauma in neutrally and negatively buoyant juvenile salmonids exposed to simulated hydro-turbine passage using a mobile aquatic barotrauma laboratory. *Fisheries Research*, *106*(3), 271-278.

Stevens, J.D., R.D. Pillans & J. Salini (2005). *Conservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), Pristis microdon (Freshwater Sawfish) and Pristis zijsron (Green Sawfish).* Hobart, Tasmania: CSIRO Marine Research. Available from: http://www.environment.gov.au/coasts/publications/pubs/assessment-glyphis.pdf.

Stobutzki, I.C., J.M. Miller, D.S. Heales & D.T. Brewer (2002). *Sustainability of Elasmobranches Caught as By-catch in a Tropical Prawn (Shrimp) Fishery.* Fishery Bulletin. 100:800-821.

Thorburn, D.C., S. Peverell, S. Stevens, J.D. Last & A.J. Rowland (2004a). Status of Freshwater and Estuarine Elasmobranches in Northern Australia. Report to Natural Heritage Trust. Canberra, ACT: Natural Heritage Trust. Available from: http://www.environment.gov.au/coasts/publications/elasmo-north.html. [Accessed: 04-Jul-2009].

WA EPA (2016a) *Environmental Factor Guideline – Landforms*

WA EPA (2016b) *Environmental Factor Guideline – Coastal Processes*

WA EPA (2016c) *Environmental Factor Guideline – Marine Fauna*

WA EPA (2016d) *Environmental Factor Guideline – Terrestrial Environmental Quality*

WA EPA (2016e) *Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals*

Walker, T.I. (1998). *Can shark resources be harvested sustainably? A question revisited with a review of shark fisheries.* Marine and Freshwater Research. 49:553-572.