PORT OF **WEIPA**

SUMMARY REPORT

Environmental risk assessment

Port of Weipa Maintenance Dredging - Environmental Risk Assessment

North Queensland Bulk Ports Corporation

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Template 2.8.1

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Abbreviations

Abbreviation	Description
CMA	Commonwealth Marine Area
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
DAWE	Department of Agricultural, Water and the Environment
DMPA	Dredged Material Placement Area
DSITI	Department of Science, Information Technology and Innovation
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
GBRMPA	Great Barrier Reef Marine Park Authority
LAT	Lowest Astronomical Tide
MNES	Matters of National Environmental Significance
NAGD	National Assessment Guidelines for Dredging
NQBP	North Queensland Bulk Ports Corporation
PAR	Photosynthetically Active Radiation
PCS	Port and Coastal Solutions
PMST	Protected Matters Search Tool
PN	Particulate Nitrogen
RTA	Rio Tinto Alcan
SDP	Sea Dumping Permit
SSC	Suspended Sediment Concentration

Abbreviation	Description
SSMP	Sustainable Sediment Management Program
TC	Tropical Cyclone
TSHD	Trailing Suction Hopper Dredger
WRB	Wave-Rider Buoy

Executive Summary

Introduction

The Port of Weipa is located in the Gulf of Carpentaria on the north-west coast of the Cape York Peninsula, approximately 200 km from the northern tip of Australia. The Port is managed by the North Queensland Bulk Ports Corporation (NQBP).

Sedimentation within the Port of Weipa occurs naturally and is caused by the transportation of sediment from ocean currents, swell and tides. Periodic cyclonic activity can also increase sedimentation significantly. Sediment accumulation within channels and berthing areas impacts the depths necessary for safe loading, manoeuvring and transit of ships. This in turn impedes the overall operating efficiency of the Port and requires management.

A detailed study has been undertaken to understand the most sustainable way to manage accumulating sediment at the Port of Weipa – the *Sustainable Sediment Management Program*. The overall conclusion was that whilst some measures can be implemented to reduce its frequency, maintenance dredging with sea disposal of dredged material is the best method of managing accumulated sediments. NQBP are now progressing the necessary environmental approvals to facilitate maintenance dredging at the Port of Weipa. This includes the development of a Long-term Maintenance Dredging Management Plan and an application for a Long-term (10-year) Sea Dumping Permit.

This report provides a detailed assessment of the potential risks from maintenance dredging at the Port of Weipa

Planned maintenance dredging

Maintenance dredging will periodically occur across the Port, in order to return areas to their design depths and ensure the safe and efficient operation of the Port. The total dredging requirement over a 10-year timeframe is in the order of 10,810,000 m^3 including a 15% overdredge contingency spread across a series of campaigns. Future campaigns will be undertaken as required in order to ensure the safe and optimal operating efficiency of the Port, with the exact volumes varying depending on sediment accumulation and cyclonic activities. Dredge planning has been based on a need to accommodate the volumes outlined below over a ten year period.

Dredge volume requirements

Number of years	Anticipated volume	Plus 15% contingency / overdredge
5 years in 10 year period	400,000 m^3 (typical year)	460,000 m^3
3 years in 10 year period	800,000 m^3 (cyclonic year)	920,000 m^3
2 years in 10 year period	2,500,000 m^3 (multiple cyclone year)	2,875,000 m^3
TOTAL: 10 years	**9,400,000 m^3**	**10,810,000 m^3**

The full ten year volume may be in the order of **10.8 million m^3.**

Environmental values

The environmental values at the Port of Weipa are reflective of an inshore environment of the Cape York Peninsula. Water quality within the Port is naturally turbid due to sediment resuspension driven by wave energy and rainfall.

Habitats in the area include patchy coral reefs, benthic infauna communities; intertidal ephemeral seagrass communities; and coastal habitats including mangroves. There are a number of protected fauna species that are known to occur at the Port, including marine turtles, sharks (sawfish), in-shore dolphins, dugong and migratory shorebirds.

The Port and surrounding areas also have values for commercial fisheries, tourism and recreation; and heritage. Of these, of most significance is the commercial fishery operations that operate in the Weipa region.

Potential risks

The potential risks and impacts of maintenance dredging are well known. If not appropriately managed, maintenance dredging activities may interact with marine fauna and habitats both directly and indirectly. Direct effects relate predominantly to physical interactions with the dredge vessel and removal of the seabed. Indirect effects can occur in association with dredge plumes, lighting, underwater noise and introduction of marine pests. Dredge generated sediment plumes can extend over areas beyond the dredging location and alter natural sediment deposition rates and/or turbidity levels. These effects have the potential to restrict and/or inhibit ecological processes within the natural marine environment.

All potential impacts were assessed against known environmental values and data to determine the risks posed by maintenance dredging at the Port of Weipa. The key findings of this risk assessment are:

- Resuspension of sediments from maintenance dredging is comparable to natural suspended sediment concentrations (SSC). Importantly, analysis against intensity and duration thresholds indicated that dredging would not result in in impacts to sensitive environmental values under any dredging scenario
- Water quality monitoring results and numerical modelling of sediment transport demonstrates that natural SSC levels are much higher than those generated by maintenance dredging
- Risks to sensitive communities are likely to be low for seagrass and moderate for benthic communities. Seagrass communities have been shown to recover post-dredging and post large sedimentation events (e.g. tropical cyclones). Benthic communities may be temporarily impacted at the DMPA due to smothering, however studies have indicated the communities recover and restabilise.
- Other sensitive communities, such as coral and mangroves, lie outside of area predicted to be impacted by turbidity and sedimentation and the risks from maintenance dredging are negligible.
- Protected species are also unlikely to be significantly impacted by maintenance dredging. The Port of Weipa does not support important populations for marine species and disturbance to habitats (including critical habitat for some marine turtles) will be low. Indirect disturbances can

be effectively managed via best practise dredging operations. The short timeframe of each campaign will also reduce risks

- Other Port users may experience short-term disruptions to their activities, but these disruptions will not be significant.

A summary of risks is provided in in the table below. This risk assessment is based on the application of standard mitigation measures as outlined throughout this report.

Summary of key risks

Risk activity (cause)	Potential environmental receptors	Potential Impact	Consequence	Likelihood	Risk rating
Smothering from dredge material placement	Benthic macroinvertebrate communities	Temporary loss of benthic habitat	Minor	Likely	Medium
Dredging and placement generated sediment plume	Coral reef, seagrass and mangrove habitats	Changes to water quality leading to mortality or changes in coral and seagrass cover/diversity	Negligible Within the natural variation and tolerance of the system	Rare	Low
Dredging and placement generated sediment plume	Coral reef, seagrass and mangrove habitats	Sediment deposition resulting in loss of coral, seagrass or mangroves	Negligible Within the natural variation and tolerance of the system	Rare	**Low**
Movement of dredge vessel from the Port to the dredge material placement area	Transitory threatened and migratory marine animals	Potential for marine fauna vessel strike	Negligible No impact at the population or sub-population level	Unlikely	**Low**
Release of contaminants and nutrients	Marine biota	Potential for lethal and sub-lethal effects on marine biota	Negligible Material is consistently suitable for at sea disposal	Rare	**Low**
Dredging suction	Foraging marine turtles, dugongs and sawfish	Potential for marine fauna to be caught	Negligible No impact at the population or sub-population level	Unlikely	**Low**

Risk activity (cause)	Potential environmental receptors	Potential Impact	Consequence	Likelihood	Risk rating
Introduced marine pests	Marine bio	Potential competition with native species and changes to the ecosystem	High Significant impact on the environment in the Port and potentially the greater region	Possible	**High**

Individual assessments against formal guidelines have also been undertaken for Matters of National Environmental Significance (MNES). In all cases these determined that significant impacts are unlikely.

A range of measures to avoid and reduce risks have been implemented during project planning, and a further suite of measures will be implemented to minimise effects and avoid unpredicted environmental change. A comprehensive dredging environmental management plan will ensure each maintenance dredging campaign is undertaken in line with best practice, and that risks are avoided and reduced as far as possible. A key element of this is the application of ecologically relevant environmental triggers, which will be applied in real time during dredging. This is coupled with a comprehensive impact and ambient monitoring program that has been designed to detect and respond to changes in the marine environment at the Port.

Considering the scope and volumes of proposed maintenance dredging at the Port of Weipa, the levels of risk are considered low and will be effectively managed with the application of appropriate monitoring, management and mitigation measures.

1. Introduction

1.1 Background

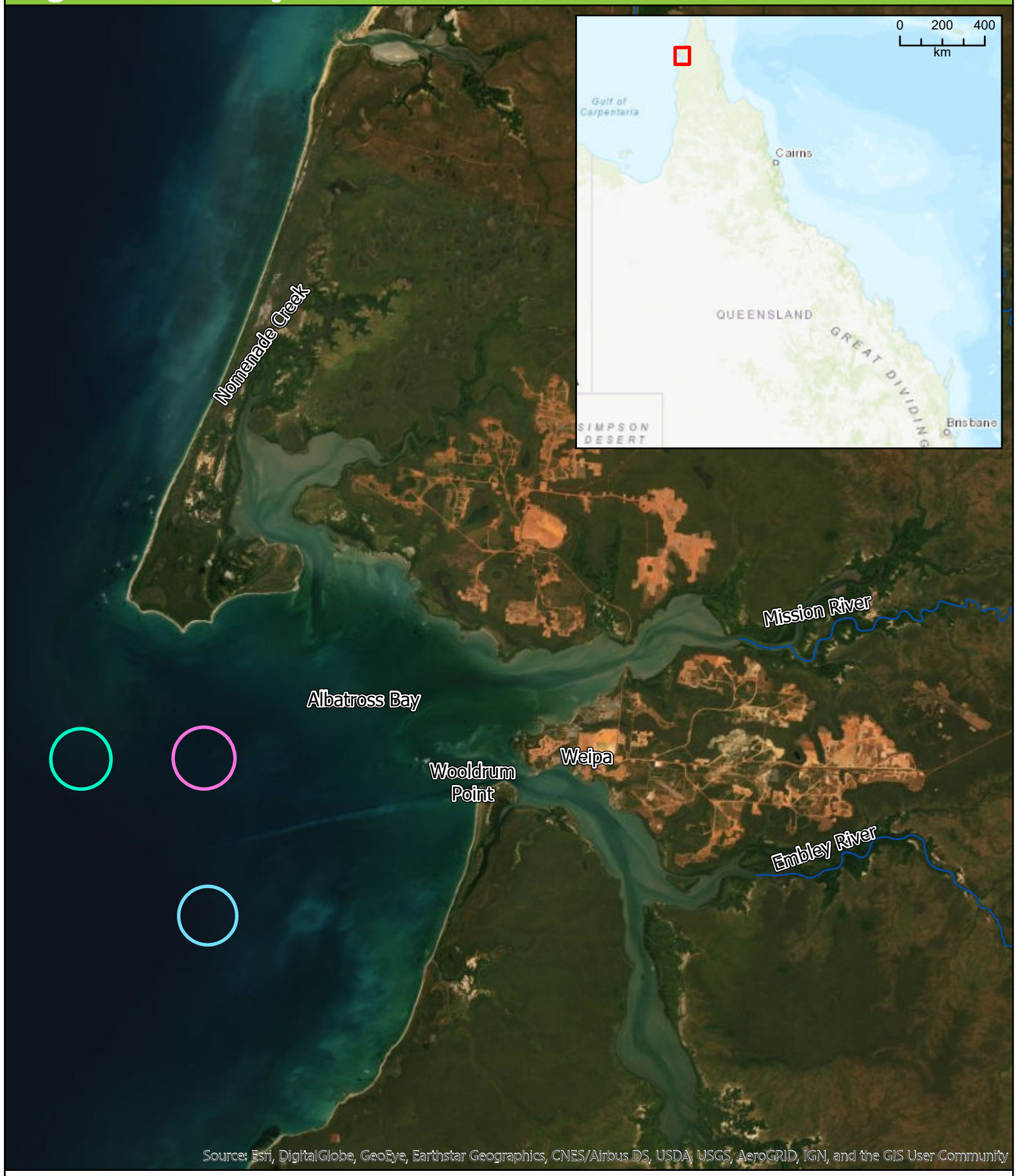
The Port of Weipa is a bulk commodities port managed by North Queensland Bulk Ports Corporation (NQBP). The Port is located in the Gulf of Carpentaria on the north-west coast of the Cape York Peninsula, approximately 200 km from the northern tip of Australia. The Port is located within Albatross Bay, a large embayment adjacent to the town of Weipa; with the wharves and berths located in the Embley River (INSERT PDF

Figure 1-1). Weipa is the largest town on the Cape York Peninsula with a population of around 4,000 people (2016 Census). The Port handles more than 30 million tonnes of product annually, with a majority of this being bauxite (aluminium ore); currently mined by Rio Tinto at the Rio Tinto Alcan (RTA) mine. The main shipping channel of the Port (South Channel) is in Albatross Bay and the inner harbour is located in the Embley River. The harbour contains approach and departure channels along with four loading berths (Lorim Point East and West, Humbug Wharf and Evans Landing), two of which are dedicated solely to bauxite export; one for importing fuel and oil; and one for importing general cargo. The annual throughput of the Port for the 2018-19 financial year was 27,338,073 tonnes (NQBP 2019).

Sedimentation within the Port of Weipa occurs naturally and is caused by the transportation of sediment from ocean currents, swell and tides. Periodic cyclonic activity can also increase sedimentation significantly. When left unmanaged, sediment accumulation within channels and berthing areas impacts the depths necessary for safe loading, manoeuvring and transit of ships. This in turn impedes the overall operating efficiency of the Port. Approximately 622 hectares of channels, swing basins and berths within the Port are currently maintained at the appropriate depths by maintenance dredging. This dredging has been undertaken annually by the Trailing Suction Hopper Dredger (TSHD) 'Brisbane' and removes between 300,000 m^3 and 2,400,000 m^3 of sediment during each dredging campaign. Maintenance dredging typically occurs immediately after the wet season due to the increased risk of sedimentation from tropical cyclones (PCS 2019a). Dredged material has historically been relocated to an offshore dredge material placement area (DMPA) located in Albatross Bay.

A Sea Dumping Permit (SDP) under the *Environment Protection (Sea Dumping) Act 1981* is currently held by NQBP for the Port of Weipa as part of the Long Term Monitoring and Management Plan for maintenance dredging. This permit allows for 5,000,000 m^3 of sediment to be removed via maintenance dredging and is due to expire on 28 September 2020. Therefore, NGBP is seeking to obtain a SDP for a further 10 years of maintenance dredging.

Figure 1-1: Locality



Legend

- Albatross DMPA Moved Region
- Albatross DMPA North (New)
- Albatross DMPA South (New)
- Major Watercourses

N

0 2.5 5 10
Kilometers

Datum/Projection:
GDA 1994 MGA Zone 54

ecological AUSTRALIA

Prepared by: SP Date: 17/01/2020

1.2 Project overview

Maintenance dredging will occur throughout the Port limits in order to return areas used for shipping to their design depths, maintain required depths for future operations and ensure the safe and efficient operation of the Port. The total dredging requirement over the 10-year timeframe is approximately 10,810,000 m^3 spread across a series of campaigns. The campaign type and dredge volumes will vary depending on sediment accumulation, but it is expected that a standard campaign will dredge approximately 400,000 m^3 of material. An additional 400,000 m^3 of sediment volume has been included as a cyclone contingency for three of the 10 years, and two large campaigns of 2,500,000 m^3 or more have been included over the 10-year period to allow for years when multiple cyclones occur. This occurred in the 2018-19 wet season when three tropical cyclones (Owen, Penny and Trevor) affected Weipa and resulted in the highest annual volume of accumulated sediment to date, approximately 2,650,000 m^3. A 400,000 m^3 will take approximately 20 days to complete and larger campaigns will take approximately 40 days to complete, with potentially two dredgers operating.

For all campaigns, dredged material will be placed at the Albatross Bay DMPA that has been re-aligned 2 km to the west of its original location, to allow access for larger dredge vessels. The previous DMPA had been used for all dredging activities at the port since 2002 and is located approximately 15 km from the mouth of the Embley River. The realigned DMPA overlaps the previous DMPA by 50% and is located in slightly deeper water to allow access by larger dredging vessels. During a standard campaign, dredging will likely be undertaken by TSHD 'Brisbane'. For very large campaigns, an additional dredge vessel may be required (TSHD Oranje was the additional vessel used during the 2019 campaign).

1.3 Scope of this report

The purpose of this report is to describe the existing environment relevant to the Port of Weipa and undertake an assessment of the potential risks from maintenance dredging over a 10-year timeframe, beginning after 28 September 2020 when the current SDP expires.

There are a number of State and Federal approvals necessary for ongoing maintenance dredging and disposal at the Port of Weipa. This report focusses on Federal approvals only.

Specifically, this report:

- Identifies environmental values that are present at the Port of Weipa
- Identifies potential environmental impacts arising from maintenance dredging, including an assessment of the impacts' extent, severity and likely significance
- Identifies impact likelihood and consequence to determine risk levels that are then used to inform the environmental management plan and related management actions
- Can be used to support environmental approvals processes; in particular application for an SDP

1.4 Legislative context

There are two Commonwealth Acts related to the regulation of ocean disposal, or more specifically dredging for the scope of this project:

- *Environment Protection (Sea Dumping) Act 1981 (the Sea Dumping Act)*; and
- *Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act).*

These Acts work under a framework to ensure a streamlined assessment process, including the possibility of assessment under a bilateral agreement between the Federal and relevant State government to minimise duplication; if approval under the EPBC Act is required.

1.4.1 Environment Protection (Sea Dumping) Act 1981

Dumping of waste and other material from any vessel, aircraft or platform in Australian waters is prohibited under the *Environment Protection (Sea Dumping) Act 1981*, unless a permit has been issued. Permits are most commonly issued for dredging operations and the creation of artificial reefs. The Act fulfils Australia's international obligations under the London Protocol (to prevent marine pollution by controlling dumping of wastes and other matter). The Act is administered by the Department of Agriculture, Water and the Environment in this case. However, it can also be administered by the Great Barrier Reef Marine Park Authority (GBRMPA) for activities inside the Great Barrier Reef Marine Park.

1.4.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's central environmental legislation. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, wetlands and heritage places which are defined in the EPBC Act as Matters of National Environmental Significance (MNES). The EPBC Act is triggered when a development proposal has the potential to have a significant impact on MNES. Approval under this Act is not required if no significant impact to MNES will occur as a result of the proposed activity.

1.5 Relevant policy and guidance

There is also a range of State and Federal policy guidance relevant to the assessment of dredging projects, including:

- National Assessment Guidelines for Dredging (NAGD; CoA 2009)
- Numerous EPBC Act guidance documents
- Environmental Code of Practice for Dredging and Dredged Material Management (Ports Australia 2016)

1.5.1 National Assessment Guidelines for Dredging (NAGD)

The NAGD establishes a scientific assessment framework to determine if dredged material is suitable for ocean disposal in line with the *Environment Protection (Sea Dumping) Act 1981* and the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972* (the London Protocol). The Guidelines include an assessment framework that is applied to ensure the impacts of dredged material loading and disposal are adequately assessed and, when ocean disposal is permitted, that impacts are managed responsibly and effectively. The NAGD provides a suite of contamination thresholds for sediments, which determine the suitability of dredged material for ocean disposal.

1.5.2 EPBC Act guidance documents

There are a range of policy documents that guide impact assessments under the EPBC Act. Those relevant to this assessment include:

- Significant impact guidelines 1.1 – Matters of National Environmental Significance (2013)

- Industry guidelines for avoiding, assessing and mitigation impacts on EPBC Act listed migratory shorebird species (2015)
- Approved conservation advices for listed threatened species
- Threatened species recovery plans, including the Recovery Plan for Marine Turtles in Australia (2017)

1.5.3 Environmental Code of Practice for Dredging and Dredged Material Management

Whilst not a government policy, Ports Australia's *Environmental Code of Practice for Dredging and Dredged Material Management* is important to consider, as it sets out the practices that will be employed during maintenance dredging at the Port of Weipa. The Code of Practice outlines a number of environmental principles that Australian ports meet when undertaking dredging and disposal of dredged material; based on the National Strategy for Ecologically Sustainable Development (ESD)

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2. Assessment methodology

2.1 Available information

There is considerable information available to inform the assessment of maintenance dredging at the Port of Weipa. This includes previous environmental impact assessments for capital dredging programs, the results of monitoring (both baseline and that associated with dredging) and the technical reports produced as part of the Sustainable Sediment Management Project (SSM). The SSM is aimed at informing whether sedimentation can be managed to avoid or reduce the need for maintenance dredging. In addition, a range of studies have been undertaken to specifically understand the maintenance dredging requirements at the Port over the upcoming 10 years.

In this context, this risk assessment has been developed primarily based on the information and findings available in the following key documents:

- Port of Weipa Environmental Values Assessment Report (GHD 2019)
- Port of Weipa – Sustainable Sediment Management Assessment: Bathymetric Analysis (PCS 2018)
- Port of Weipa – Sustainable Sediment Management Assessment: Dredge Plume Modelling (PCS 2019a)
- Port of Weipa – Sustainable Sediment Management Assessment: Environmental Thresholds (PCS 2019b)
- Port of Weipa Post Wet Season Seagrass Habitat Update May 2019 (McKenna and Rasheed 2019)
- Port of Weipa Ambient Marine Water Quality Monitoring Program (January 2018 – July 2018) (Waltham et al 2018)
- Environmental Impact Statement – South of Embley Project (RTA 2011)
- Benthic Infauna Survey Report (Advisian 2019)
- Maintenance Dredging Sediment Characterisation Report (Advisian 2018a)
- Marine bioregional plan for the North Marine Region (DSEWPaC 2012a)

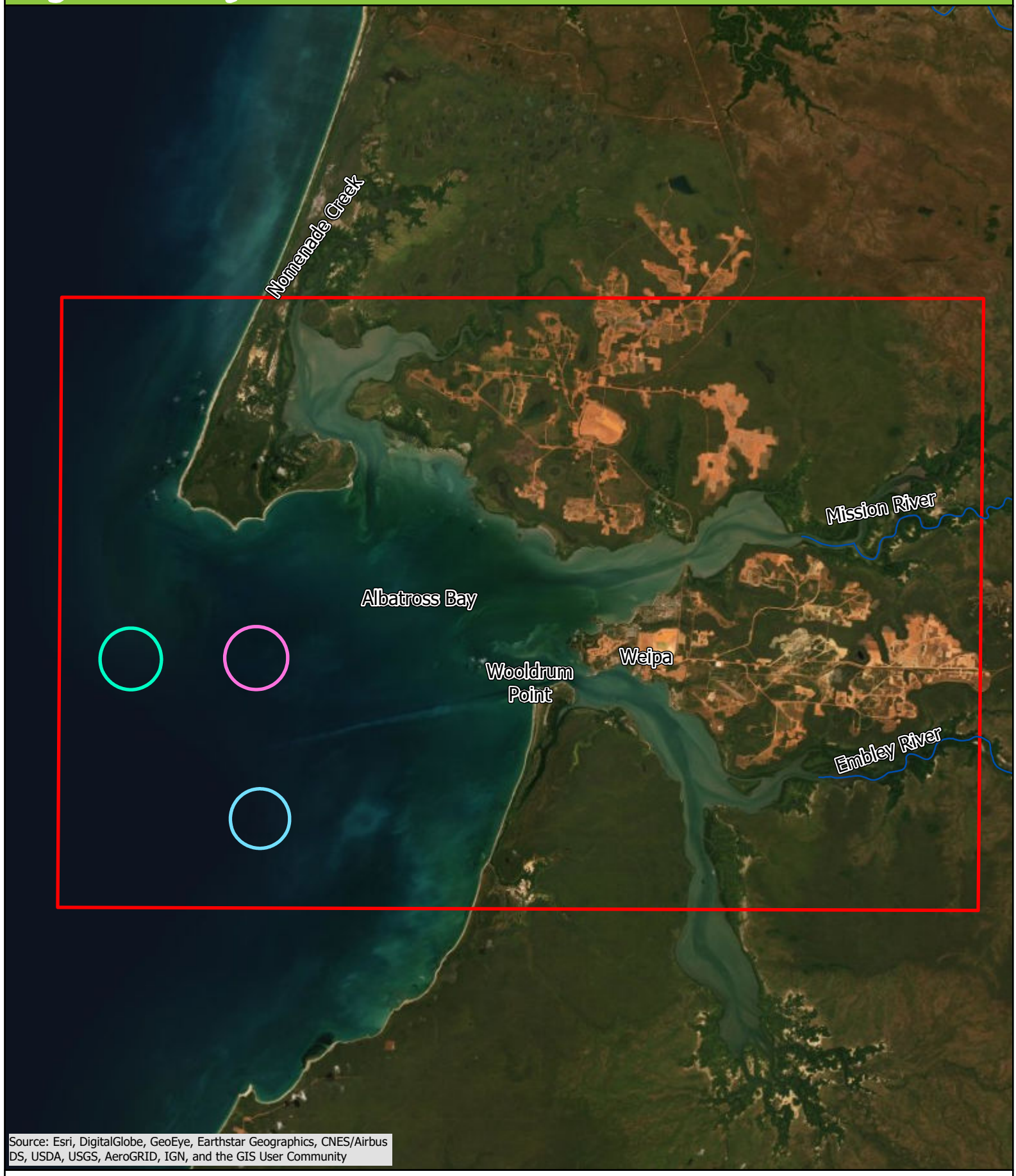
Other information sources have been used where relevant and have been referenced accordingly.

2.2 Risk assessment approach

The Project area was defined to include the Port of Weipa, the existing offshore DMPA and a surrounding area extending from Nomenade Creek to Wooldrum Point and approximately 25 km offshore from the mouth of the Embley River (INSERT PDF

Figure 2-1). This is an area that could be expected to be larger than the broadest influence of any sediment plume generated by dredging or material placement activities. The Project area includes all marine areas and near-shore coastal environments (i.e. beaches and mangrove communities). Terrestrial environments and associated environmental values will not be impacted by the proposed maintenance dredging and are therefore not considered in this assessment.

Figure 2-1: Project Area



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

Legend

- Project Area
- Albatross DMPA Moved Region
- Albatross DMPA North (New)
- Albatross DMPA South (New)
- Major Watercourses

N

0 2.5 5 10

Kilometers

Datum/Projection:
GDA 1994 MGA Zone 54

eco logical AUSTRALIA

Prepared by: SP Date: 17/01/2020

The suite of environmental values that occur in the Project area is well known and is comprehensively documented in GHD (2019). The values and their relative importance in the Weipa region are summarised in Section 4. It was determined that each of these values has the potential to be impacted by maintenance dredging to varying degrees, and would require further consideration in the risk assessment.

In order to understand the risks to environmental values, a list of potential impacts known to occur from maintenance dredging was compiled (**Section 5**). Following this step, the suite of impact avoidance and reduction measures that could be implemented at the Port of Weipa was considered (Section 6). This included consideration of the suite of recommended monitoring and associated adaptive management actions that may be implemented as required.

A further analysis of whether the potential impacts identified in **Section 5** would affect relevant MNES and if so, the severity of these impacts was undertaken (see **Section 7**). This included consideration of the effectiveness of relevant avoidance and reduction measures. This analysis was supported by in-depth investigations into dredge plume generation and movement, natural sediment resuspension and an environmental thresholds analysis. These studies are discussed as applicable in **Section 7**. Full reports are available and should be read in conjunction with this assessment.

Where appropriate, known impact thresholds were applied to determine the significance of impacts. In some instances these were derived from literature and data analysis and applied specifically to the Weipa environment (e.g. environmental thresholds for water quality). In other instances, and specifically for matters protected under the EPBC Act, relevant policy guidance was applied. The thresholds applied depended on the MNES under consideration. Some MNES (e.g. migratory shorebirds) have specific policy advice about what comprises a significant impact. For others, the more generic *EPBC Act Significant Impact Guidelines 1.1* (Commonwealth of Australia 2013) were used.

Following a detailed analysis of impacts, a formal risk assessment was undertaken and considered likelihood and consequence of each potential impact. The method applied was based on the GBRMPA risk Assessment – Permission System (GBRMPA 2017), provided at Appendix A. While the Port of Weipa is located outside of the GBRMP, NQBP has elected to apply a consistent approach to maintenance dredging across Queensland, and the framework provides a robust approach to protecting marine environmental values. Based on information contained in the impact assessment detailed in **Section 7**, the likelihood and consequence has been evaluated and a risk rating assigned to potential risk events. The risk rating levels used are outlined in Table 2-1. The results of the risk assessment are provided in **Section 8**.

Table 2-1: Risk levels (GBRMPA 2017)

Risk Level	Risk evaluation in the permission system
Low	A few low risks may be accepted. However, multiple low risks may require a broad mitigation or monitoring strategy. These risks should be recorded and monitored
Medium	Medium risks require further mitigation. Consider whether the activity could be done differently (or in a different location) to reduce the risk. Where the applicant does not propose further measures, the managing agencies may place conditions on the permission. Multiple medium risks may be grounds for refusing approval, if suitable mitigation or offset measures cannot be agreed

Risk Level	Risk evaluation in the permission system
High	If uncontrolled, a risk event at this level may have a significant impact on the Marine Parks. High risks require further mitigation and may be grounds for refusing approval. Mitigation measures need to be reliable, well-tested, and have a high likelihood of success. Mitigation and offset measures should be closely monitored
Very high	Risk events at this level have the potential to cause irreversible damage to the Marine Parks. Activities with unmitigated risks at this level should be avoided and are likely be refused permission

2.3 Approach to assessing multiple campaigns

Several dredge campaigns are proposed over the 10 year permit timeframe, with the first scheduled under the proposed new permit for mid 2021. There is good certainty about the nature of the upcoming maintenance dredging including locations, volumes and timing (see **Section 3**). The initial campaign has therefore been the focus of the risk assessment, with detailed analysis about how these works may impact environmental values. Future campaigns will mirror the initial campaign with the only variables being the volume that needs to be dredged and whether two dredgers are required.

Ports and Coastal Solutions (PCS 2019a and 2019b) have undertaken a detailed study to understand the potential effects of maintenance dredging and how these can vary across a range of scenarios and volumes (up to 2.5 million m^3). They considered variable dredge volumes, metocean conditions, seasons, placement site locations and sediment compositions. This approach has therefore accounted for a range of scenarios and has been used to inform an assessment of the risks from all potential future campaign scenarios.

In addition to the PCS (2019a and 2019b) studies and in order to ensure the risks of future campaigns are appropriately addressed prior to any dredging being undertaken, future assessments will be undertaken once the details of works are known. A process for this will be included in the Long-Term Maintenance Dredge Management Plan (LTMDMP) (Adaptive Strategies, 2020) and is summarised below.

Prior to each dredging campaign, a risk assessment of potential changes to environmental, social or cultural values will be undertaken. The assessment will help to determine the level of potential harm that environmental, social or cultural values may be exposed to from the proposed dredging program. The assessment will assist in identifying where refined management measures to avoid, reduce or mitigate impacts are needed. Identified measures can then be incorporated into revisions of the Maintenance Dredging Environmental Monitoring Plan. This process is outlined in Figure 2-2.

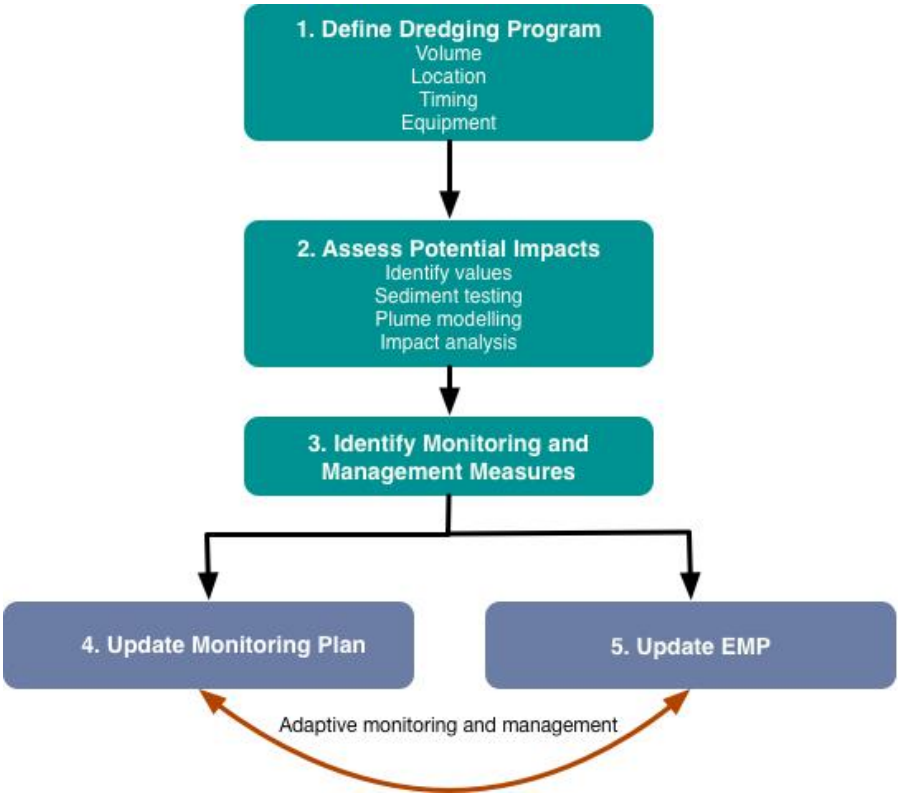


Figure 2-2: Risk assessment process for identification of potential impacts and management measures for future campaigns

Information needed to inform the risk assessment will include:

- Up to date environmental values, including data from baseline surveys of coral, seagrass, benthic infauna, mangroves, marine fauna and water quality.
- Dredging program design including: dredge type, volumes, locations, duration, seasonal timing.
- Up to date sediment characteristics: particle sizes, contamination results.
- Sediment plume modelling.

A detailed assessment of the potential impacts of the expected full dredge volume (10,810,000 m^3) has not been specifically undertaken. Campaigns will be staggered over the 10-year time frame, thereby reducing the impacts with a degree of proportionality to the size of the campaign. Dredging events will also generally be separated by at least one year and in some cases more than one year. During this time, impacts will have ceased, and recovery occurred. As such, it is considered appropriate to assess each campaign as an independent event, with little risk of cumulative impacts. However, as discussed above, plume modelling has been undertaken at a range of volumes (up to 2.5 Mm^3). A program of long-term monitoring and continual improvement will be implemented to assess and respond to any changes to environmental values over several campaigns.

3. Project Description

3.1 Areas and volumes

Maintenance dredging will occur across the Port, in order to return areas to their design depth. The total dredging requirement over a 10-year timeframe is in the order of 10,810,000 m^3 spread across a series of campaigns as shown in Table 3-1. Exact volumes will vary depending on sediment accumulation and cyclonic activities and an upper limit of 10,000,000 m^3 is being requested in the permit application.

Table 3-1: Dredge volume requirements

Number of years	Anticipated volume	Plus 15% contingency / overdredge
5 years in 10 year period	400,000 m^3 (typical year)	460,000 m^3
3 years in 10 year period	800,000 m^3 (cyclonic year)	920,000 m^3
2 years in 10 year period	2,500,000 m^3 (multiple cyclone year)	2,875,000 m^3
TOTAL: 10 years	**9,400,000 m^3**	**10,810,000 m^3**

The areas of the Port that have the most regular need for maintenance dredging are:

- South Channel, particularly the mid- to outer-sections where the sediment is predominantly fine-grained silt and clay
- Inner Harbour and inner areas of South Channel, particularly areas that do not experience localised erosion from propeller wash. Sediments in these areas comprise a higher proportion of sand

Specific requirements will be determined prior to each campaign based on hydrographic survey. However, it is anticipated that South Channel will require annual maintenance dredging to ensure the entire channel remains below design depth and dredging within the Inner Harbour will be less frequent, with one campaign every two to five years.

Port areas are shown on Figure 2-1.

3.2 Material to be dredged

Sediment sampling was most recently undertaken in 2018, as part of the implementation of the current Long-term Dredge Management Plan, which is due to expire in 2020 (Advisian 2018a; Advisian 2018b). The expectation is that sediments currently, and in the future, will have a similar particle size composition and contamination status as those previously sampled, and this risk assessment has proceeded with this assumption.

Previous sampling has indicated that sediments across the Port of Weipa and shipping channels are highly variable. The outer sections of South Channel are dominated by fine fraction silts (70%) and clays (20%), with areas of South Channel within 5 km of the Embley River mouth, approach channels and departure channels dominated by coarse-grained sand (75%) and gravel (14%). Across the Port, berths are also dominated by coarse-grained sand and gravels in varying proportions, with the exception of the tug berths, which are comprised of predominantly silts and clays. Previous testing has also indicated that

sediments across all Port areas can be considered uncontaminated and suitable for ocean disposal (Advisian 2018a). Further details of sediment composition, movement and suitability for ocean disposal is provided in **Section 4.2** and in Advisian (2018a & b).

3.3 Dredged material placement area

Each campaign will utilise the Albatross Bay DMPA, that has been re-aligned 2 km to the west to enable access for larger dredge vessels. The Albatross Bay DMPA is located approximately 15 km from the mouth of the Embley River with centre coordinates MGA Zone 54 569396, 8600375 (Figure 2-1). The DMPA has been used for capital and maintenance dredging campaigns since 2002.

The existing DMPA covers an area of approximately 13 km^2 within Albatross Bay; with water depths of 8 – 11 m below the level of lowest astronomical tide (LAT). The seabed of the DMPA slopes with shallower areas in the north-eastern edge, which slopes to deeper areas along the south-western boundary. The geomorphic features of the seabed have been altered through its historical use for dredged material placement, with a number of mounds clearly defined in bathymetric models (PCS 2018). The seabed sediments are dominated by sand (Advisian 2018a), with highly variable benthic infauna communities (Advisian 2019). **Section 4** provides additional information on the existing environment of the Port.

3.4 Dredging methods, timing and duration

Since 2000, the majority of maintenance dredging in Queensland has been undertaken by the TSHD 'Brisbane'. The TSHD 'Brisbane' was specifically designed and built to operate in Queensland and the vessel has numerous environmental management mechanisms to ensure any environmental risks are minimised. It is likely that the TSHD 'Brisbane', or a similar vessel, would undertake future maintenance dredging at the Port of Weipa. For very large campaigns, two dredge vessels may be required.

Dredging at the Port of Weipa, since 2012 has occurred during the dry season, typically between June and September. It is envisaged that future campaigns are also most likely to occur around this time of year. The length of future campaigns will be proportional to the volumes required, with a 400,000 m^3 campaign lasting approximately 20 days and larger campaigns lasting approximately 40 days, with either one or two dredgers operating.

As indicated above, the schedule of dredging will be comprised of an annual campaign, each year over 10 years. It is envisaged that half of these campaigns would be standard and require the smallest dredge volume. It is expected that the remaining campaigns would be large (3) or very large (2) and the timing of these will depend on cyclonic activity and associated sediment deposition.

4. Existing environment

4.1 Climate and marine conditions

The climate of the Cape York Peninsula is tropical and monsoonal with a distinct wet season and dry season.

4.1.1 Rainfall

The average annual rainfall for Weipa is 1,911.4 mm, most of which occurs during the wet season. Monthly and annual rainfall measurements are provided in Table 4-1. The monsoonal climate varies from year to year regarding start, duration and intensity of rainfall during the wet season. However, rainfall in the region can be summarised as follows:

- The wet season occurs between November and April and a significant proportion of the annual rainfall occurs during this period (over 95%)
- The dry season occurs between May and October
- The highest rainfall occurs between January and March while the lowest rainfall occurs between June and September

Table 4-1: Long-term mean and median rainfall since 1990 (BoM weather station Weipa Aero)

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	481.1	502.7	409.9	97	20.3	3.4	1.4	5.1	1.5	19.6	97.9	273.8	1911.4
Highest	909.8	932.6	986.4	328	137.8	23.6	9.2	59.2	16.6	132.6	339.6	876	2719.4
Lowest	0	127.2	149	0.2	0	0	0	0	0	0	2.6	59.2	1206.2

4.1.2 Wind

Wind data from the Bureau of Meteorology (BoM) Weipa Aero Automatic Weather Station is presented in **Figure 4-1** for both the annual and seasonal winds. The Weipa region experiences wind predominantly from the east to south-east (55% of the time). During the dry season, winds are light to moderate from the east to southeast. Winds are more variable during the wet season, most commonly light tending moderate westerly or easterly. This variability is diurnal with easterly morning winds and westerly winds in the afternoon. The westerly winds during wet season occur due to the monsoonal trough moving south of the region (PCS 2018). Fresh winds occur more frequently during summer months with the potential for gale force winds during a tropical cyclone (**Section 4.1.6**).

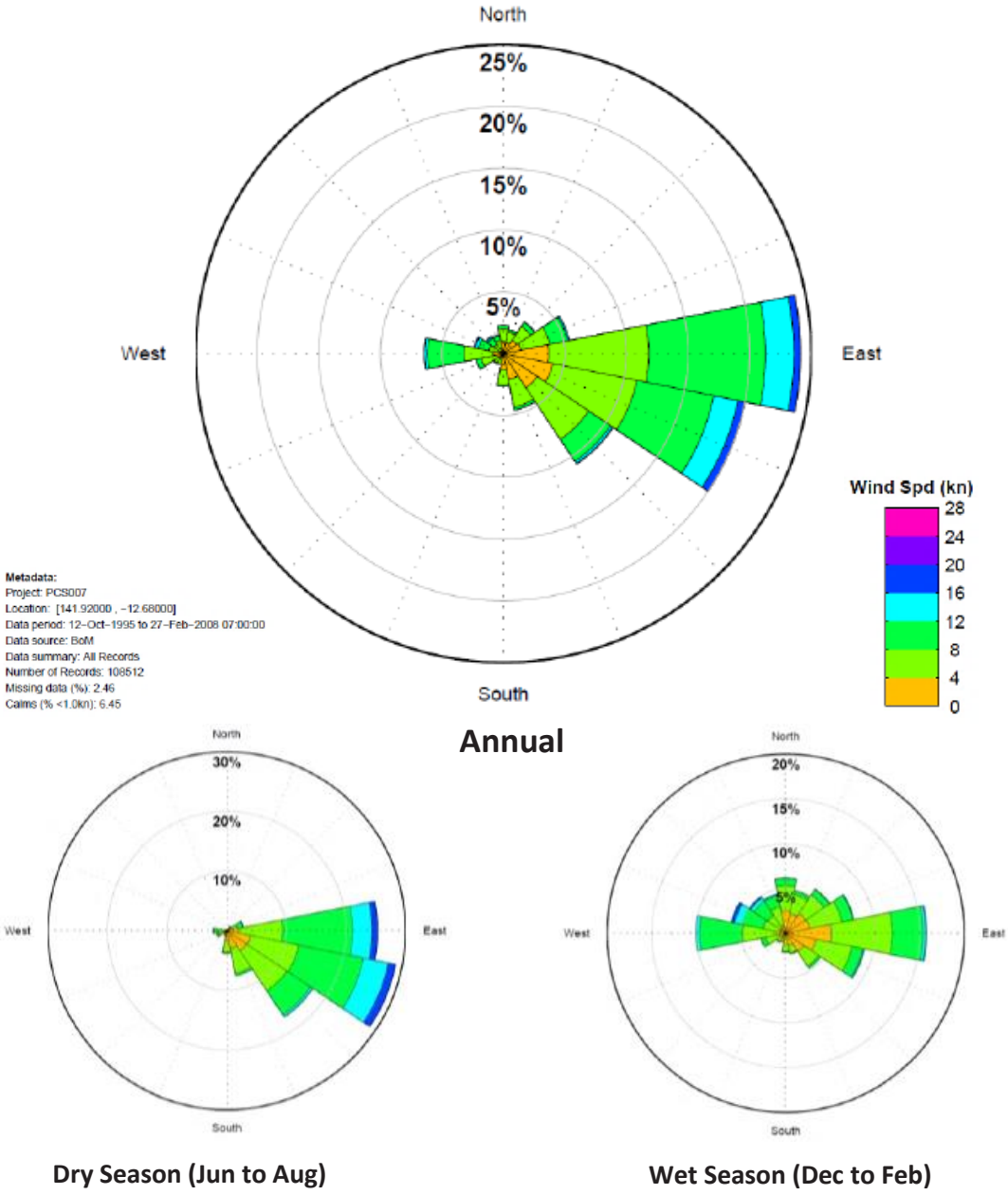


Figure 4-1: Wind roses for measured wind data at the BoM Weipa Aero AWS (1995 to 2008)

Source: PCS 2018

4.1.3 Tides

Port of Weipa has predominantly diurnal tides with shorter periods of semi-diurnal tides during the neap tidal phase. The tidal planes for Weipa (Humbug Point) relative to LAT and Australian Height Datum (AHD) are shown in **Table 4-2**. Within the Gulf of Carpentaria there are seasonal fluctuations in sea level due to trade winds and forcing from the Arafura Sea, adjacent to the north-western entrance of the Gulf. This results in elevated predicted water levels during the wet season compared with the dry season (PCS 2018). Tropical cyclones can cause storm surges and strong wind-induced currents. This is discussed further in **Section 4.1.6**.

Table 4-2: Weipa Tidal Planes (PCS 2018)

Tidal Plane	Elevation (m LAT)	Elevation (m AHD)
Highest Astronomical Tide (HAT)	3.38	1.63
Mean High High-Water (MHHW)	2.95	1.20
Mean Low High-Water (MLHW)	2.21	0.46
Mean Sea Level (MSL)	1.83	0.08
Mean High Low-Water (MHLW)	1.46	-0.29
Mean Low Low-Water (MLLW)	0.72	-1.03

4.1.4 Waves

Wave data are available from the Department of Science, Information Technology and Innovation (DSITI) wave-rider buoy (WRB) deployed in Albatross Bay which has been measuring wave conditions since 2008. A summary of this data is provided in Figure 4-2. Generally, the wave climate of Weipa is relatively calm with wave heights of less than 0.5 m occurring 80% of the time and only exceeding 1 m less than 15% of the time. The larger waves are commonly produced by either monsoons or tropical cyclones during the wet season. There are three dominant wave conditions at Weipa:

- Waves from the east travelling away from Weipa;
- Waves from the west to north-west, travelling towards Weipa and generated by either onshore sea breezes, monsoonal winds or cyclonic winds (during the wet season); and
- Waves from the south-west which do not corelate to wind conditions and are likely generated by waves in the Gulf of Carpentaria, south of the Weipa region.

Locally at areas of the Port, larger waves occur on the northern side of the Southern Channel compared to the southern side due to the sudden change in depth (caused by the channel) producing a slight sheltering effect. At the entrance to the Embley River, wave height is less than 0.5 m and limited wave energy is able to penetrate the Inner Harbour (PCS 2019b).

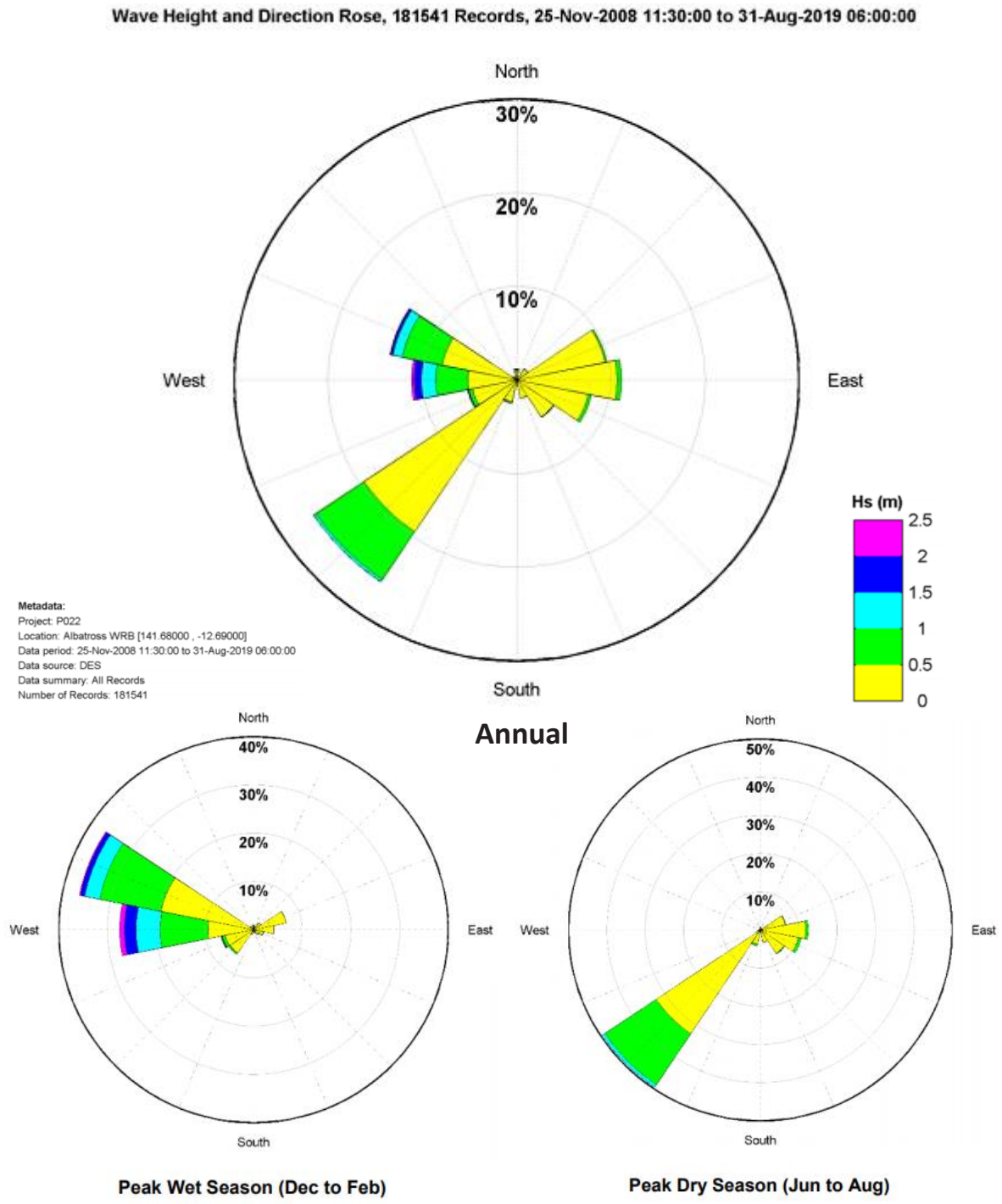


Figure 4-2: Wave roses for measured wave data at Albatross Bay DSITI WRB (2008 to 2019)

Source: PCS 2019b

4.1.5 Currents

Current data in this report have been collected from two beacons (SC20 and SC24) located within the South Channel of the Port and supplemented with results of a numerical model of the Weipa region, outlined in PCS (2018). Peak ebb current speeds range from 0.6 to 1.4 m/s and peak flood current speeds range from 0.3 to 0.6 m/s. Ebb currents are dominant in all channels and high current speeds occur within the South Channel, within approximately 4 km of the mouth of the Embley River (peak ebb

current speeds from 0.9 to 1.3 m/s and peak flood current speeds from 0.6 to 0.8 m/s). These high current speeds suggest that limited deposition of fine-grain sediment would occur at the eastern end of the South Channel and within parts of the Inner Harbour (PCS 2018). Tidal asymmetry indicates that estuaries with ebb dominant currents are net exporters of sediment and therefore sediment is transported off-shore (Dronkers 1986; Winterwerp 2011).

4.1.6 Tropical cyclones

Weipa is vulnerable to the effects of severe tropical cyclones (TCs) during the summer months. Between 1969 and 2016, 21 TCs have passed within 100 km of the Port of Weipa and historically, the region is influenced by a TC every second year. TCs that are located to the south of Weipa commonly result in large waves and strong onshore winds due to the clockwise rotation of TCs. Recent notable cyclones which have affected the Port include TC Trevor (March 2019), TC Nora (March 2018), TC Oswald (January 2013), TC Olga (January 2010) and TC Charlotte (2009). TCs can result in gale force winds and large wave heights along the Weipa coast including at the Port. The largest measured wave height of 6.7 m occurred during TC Oswald.

Tropical cyclones and other extreme weather events can cause significant increases in sedimentation and the requirement for maintenance dredging. To ensure efficient and safe operation of the Port, maintenance dredging is usually undertaken immediately after the wet season. Three TCs affected Weipa during the 2018/19 wet season; TC Owen, TC Penny and TC Trevor. This resulted in the highest annual accumulation of sediment in channels and berths of the Port (2,650,000 m^3).

4.2 Sediments

4.2.1 Characterisation

As part of NQBP's LTMDMP, sediment characterisation assessments are undertaken to ensure that sediment remains suitable for placement in the DMPA. The 2013 and 2018 assessments are the most recent and were used to inform the study conducted by PCS, summarised in this report (PaCE 2013b; Advisian 2018b; PCS 2018).

Sediment characterisation in each area of the Port is provided in Figure 4-3. These data highlight the variability of sediment across the Port including variation within channels. For example, the sediment in the South Channel towards the Embley River mouth is predominantly composed of sand (75%) and gravel (14%), yet further offshore sediment is predominantly composed of silt (70%) and clay (20%).

Sediment composition in the Inner Harbour varies depending on location, but sand is usually the most abundant sediment type. The DMPA was predominantly composed of sand (65%) with smaller amounts of silt (18%) and clay (16%). The reference sites are located in Albatross Bay, 2 km north-west of the site and suggest that the natural seabed is composed of mostly silt (36%) and sand (34%) with smaller amounts of clay (18%) and gravel (12%). Across all areas to be dredged, sand is the most

common sediment type (48.6%), followed by silt (21.7%) and then similar levels of gravel (14.8%) and clay (14.7%).

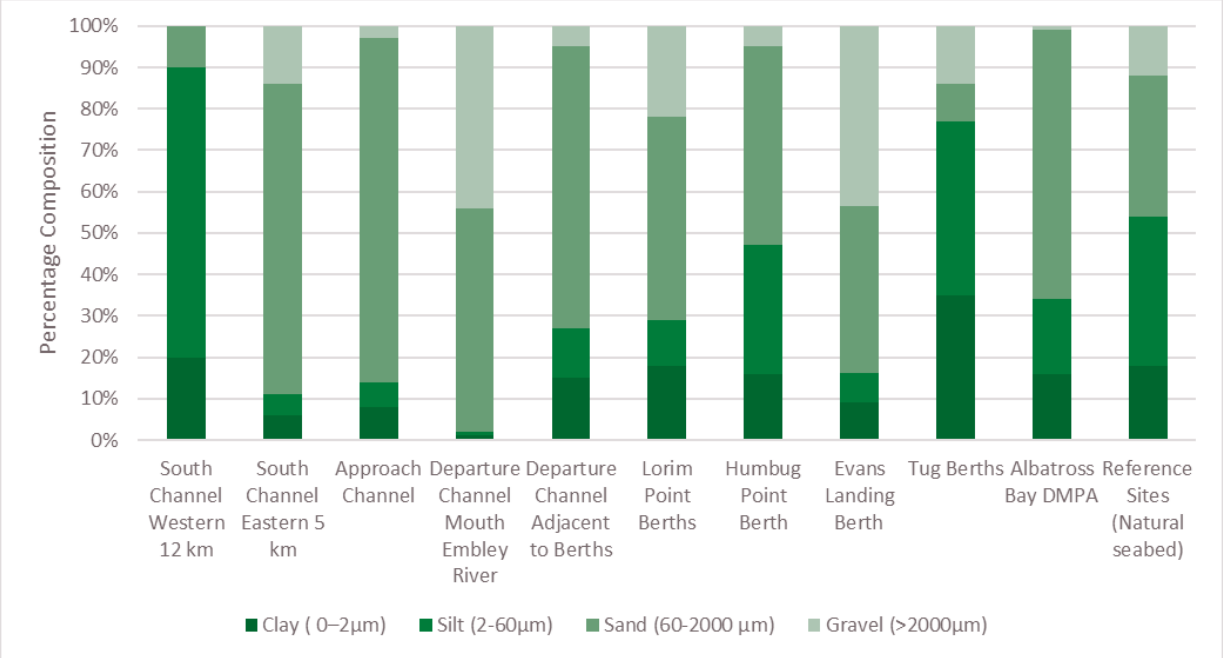


Figure 4-3: Summary of sediment characteristics
Data from PCS 2018

Sediment quality has been regularly assessed at the Port of Weipa to ensure suitability for ocean disposal in accordance with the approach provided in the NAGD. These previous assessments have shown that the sediment in the Port has been suitable for ocean disposal. The 2018 survey found no concentrations of contaminants (including TBT, metals, hydrocarbons, BTEXN and PAHs) to be above screening level and therefore the sediment has been deemed suitable for ocean disposal (Advisian 2018a).

4.2.2 Movement

Drivers of sediment resuspension and suspended sediment concentration (SSC) vary depending on the location at the Port of Weipa. Figure 4-4 shows the relationship between SSC and wave height in both Albatross Bay and the Inner Harbour, with SSC in both locations increasing rapidly at wave heights >2 m. In Albatross Bay, where the South Channel and DMPA are located, sediment resuspension is primarily driven by wave action. Both silt and clay are present within the surface sediment in Albatross Bay and this surface layer is resuspended by waves, transported by tidal currents and then deposited.

Movement of the sediment occurs more during the wet season compared to the dry as a result of larger waves. TCs also occur during the wet season, causing even larger waves and more sediment resuspension and transport. Three TCs affected Weipa during the 2018/19 wet season, resulting in the highest annual sedimentation for the Port (> 2 Mm^3). At the mouth of the Embley River there are strong tidal currents which prevent the build-up of fine grain sediment. Further offshore, these currents weaken, and sediment is able to be deposited. Therefore, as the South Channel moves further from the mouth of the river, sediment build-up increases (PCS 2018).

Within the Inner Harbour wave action is minimal and tidal currents resuspend and transport the sediment. As discussed, the sediment in the Inner Harbour is mostly sand and gravel which suggests that

the currents prevent build-up of fine-grained sediment (silt and clay) throughout most of the harbour and will only be deposited in sheltered locations such as the deep berth pockets or the banks of the Embley River. The fine-grained sediment that is present in the Inner Harbour has predominantly been resuspended from intertidal and subtidal muddy deposits present in the Hey and Embley Rivers, with only minimal sediment coming from Albatross Bay during flood tides, and river catchments during periods of heavy rain (PCS 2018).

As a result of the sediment movement throughout the Port, the mid to outer sections of the South Channel have the highest requirement for maintenance dredging due to the build-up of fine-grain sediment (PCS 2018).

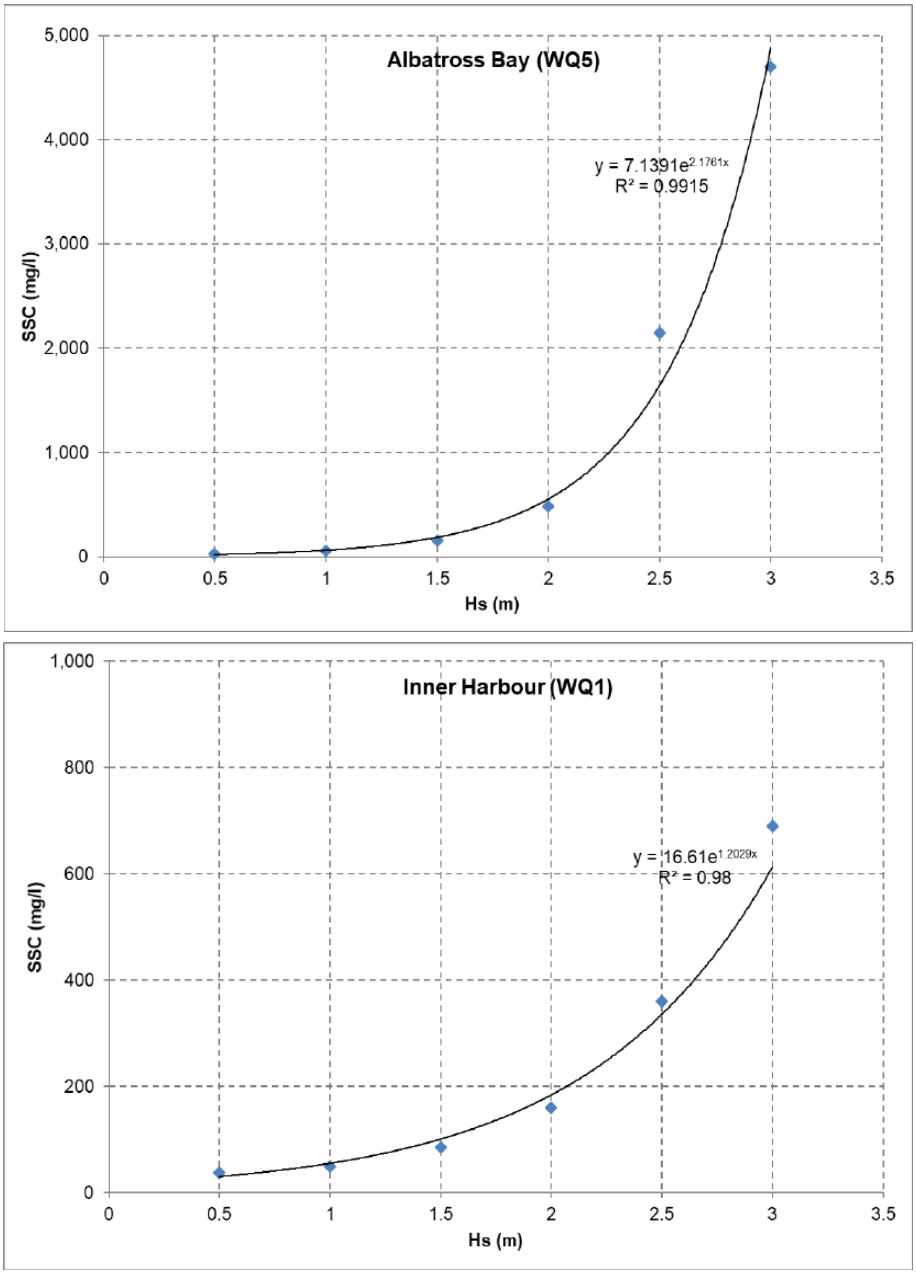


Figure 4-4: Relationship between Hs and SSC in Albatross Bay and in the Inner Harbor.

Source: PCS 2019b

4.3 Bathymetry

A detailed bathymetric analysis for the Port of Weipa and Albatross Bay has been conducted by Ports and Coastal Solutions (PCS 2018). This analysis utilised data collected by Maritime Safety Queensland, including survey data from 2002 to 2018 for the Port and DMPA. The key findings are summarised below.

4.3.1 Port of Weipa

Change in bathymetry is variable from year to year in the Port, with areas of both net sedimentation and net erosion. Propeller wash of vessels utilising the channels causes significant erosion, shown by the presence of a deeper line along the middle of some channels, particularly the South Channel. The mean change of the whole Port over the 16-year period of surveys is sedimentation of approximately 360,000 m^3/yr. Sediment volume above design depths is also variable being between 1.15 M m^3 and 415,000 m^3. Much of the sedimentation occurs in the South Channel, particularly in the Mid and Mid Outer regions which have the largest differences between natural seabed depth and Port design depths (between 7 and 11 m). The Mid Inner and Inner regions of the Channel have smaller differences between the natural seabed depth and design depth (around 1 m). These inner regions also have a different spatial distribution of sediment (uneven on either side of the channel) which suggests that sedimentation is the result of a different process compared with the outer regions. In naturally deep areas on both sides of the Embley River mouth there are sand waves present. These are up to 3 m high and are slowly migrating into the river mouth.

Bathymetry within the Inner Harbour is similar to the natural state, with deeper areas at the mouth where flow is constrained and shallower areas away from the mouth. The Inner Harbour has experienced net erosion over the survey period with limited areas above design depth. Dredged areas of the harbor are only visible in some locations due to the natural bathymetry complementing many of the dredged channels. In the Approach Channel, a deeper channel has been formed where propeller wash has eroded the seabed. This is located along the eastern side of Cora Bank. Deep scour holes can also be caused by erosion due to propeller wash of berthed vessels. This is evident at Lorim Point berths and is likely due to the activities of tugs as well as the berthed vessels. Areas within the Harbour that have been subject to net sedimentation include Approach 3 and the eastern end of Cora bank, as well as areas of accretion along the side of berths and the end of berths where the influence of propeller wash is limited.

4.3.2 Albatross Bay DMPA

Sediment from both capital dredging and maintenance dredging campaigns has been placed in the Albatross Bay DMPA, and the first bathymetric survey of this site was undertaken in 2006. Around 8.5 M m^3 of sediment has been placed at the site between 2006 and 2017, of which, 3 M m^3 was placed solely from the 2006 maintenance dredging and capital dredging (deepening and widening of the channel). Placement of sediment in 2006 created shallower mounds on areas of the site which have remained in place with some localised erosion of the higher points and deposition in the deeper areas. It is likely that the erosion of sediment has occurred predominantly during large wave events given that the bed elevation in this area is around 10 m below LAT.

The net increase in sediment at the DMPA is approximately 3.7 M m^3 (total increase of 6.25 M m^3 and total loss of 2.5 M m^3) which indicates that the site has retained approximately 60% of the sediment from capital and maintenance dredging since the main capital dredging campaign in 2006. The site is therefore considered to be a partially retentive DMPA.

4.4 Water quality

The Port of Weipa Ambient Marine Water Quality Monitoring Program was recently established by NQBP to identify potential impacts of the port and its operations on water quality and to characterise the natural variability in key water quality parameters within the adjacent sensitive habitats. The first survey as part of this program was conducted in 2018 and once data are collected for multiple years, interpretations regarding natural variability in water quality will be made. Information presented in this section has been sourced from Waltham *et al.* (2018) and referenced therein.

4.4.1 Overview

The water column is well mixed with relatively consistent temperature, dissolved oxygen and pH throughout. The exception to this trend is the turbid bottom layer caused by sediment resuspension, with water turbidity and suspended solids driven predominately by wave energy. Rainfall can also influence water quality within the Port as a result of catchment flow into the rivers and estuaries in the Weipa region.

Particulate nitrogen (PN) levels exceeded Water Quality Guidelines for the Great Barrier Marine Park (GBRMPA 2010). These guidelines were used to provide context to NQBP other Ports in the Great Barrier Reef Region. The high PN levels are likely due to nutrient loading into local rivers but could also be influenced by the municipal waste treatment at Weipa or the PN concentrations could be naturally high due to regional soil conditions. Particulate phosphorus concentrations also generally exceeded the guidelines as did chlorophyll-α concentrations. The survey was conducted following the summer months and the wet season may be driver for elevated chlorophyll-α concentrations.

Herbicide and pesticide concentrations were detected in very low levels and all heavy metal concentrations, except for arsenic, were below the thresholds outlined in the ANZECC and ARMCANZ water quality guidelines. Arsenic can be released into the environment by weathering of arsenic-containing rocks and is toxic to marine organisms at high concentrations. The concentrations in the Port of Weipa are considered to be below those levels that cause toxic effects to biota.

A total of 45 phytoplankton species and 18 zooplankton species were recorded. The community composition is thought to be seasonally influenced, which will be confirmed by future surveys.

4.4.2 Suspended sediment concentrations

SSC was measured in the Port of Weipa during the wet season of 2018. During this period included a low-pressure system moved across the region, resulting in heavy rainfall (530 mm over five days) and large waves in Albatross Bay. Also, TC Nora affected the region and resulted in heavy rain and large waves. Monitoring during this period therefore provides data for a time when wave energy and inflow from nearby rivers was high. There was found to be a strong correlation between SSC and the wave conditions in Albatross Bay, but increased SSC from river influx was minimal in comparison (PCS 2018). SSC and sediment movement are discussed further in **Section 4.2.2**.

Photosynthetically active radiation (PAR) is largely influenced by SSC but acts as an additional measure of water quality in relation to photosynthetic benthic habitats. PAR was variable across the port and was primarily driven by tidal cycles. It was found that as SSC increases, light levels decrease, although this correlation is not always strong and other factors are likely to influence PAR.

4.5 Coral

Patchy areas of coral reef occur in Albatross Bay and the mouth of the Embley River. These reefs are minimal in extent compared with sandy habitats and seagrass in the area, but still provide habitat for species of both hard and soft coral as well as algae, sponges and other benthos. Hard coral genera present in the area include:

- *Porites;*
- *Acropora* (branching species);
- *Turbinaria;*
- *Montipora;*
- *Lobophylia;*
- *Platygyra;*
- *Pavona;* and
- *Favia.*

The species commonly observed in the area are those typically found in environments of high turbidity and temperature. Some species have also been observed undergoing more flattened growth, with less branching, indicating an adaption to low light conditions (Advisian, 2016a).

Coral monitoring surveys were conducted pre and post dredging in 2016 at Amrun-Boyd Point, south of the Port of Weipa, where coral is more abundant. These surveys found no difference in hard coral cover between pre and post dredging surveys (Advisian, 2016a). The coral within the port of Weipa are not considered regionally-significant due to their patchy occurrence and their representation in the broader region. However, the bioregional plan for the North Marine Region highlights the importance of coral reefs within the Gulf of Carpentaria as they support aggregations of marine life, biodiversity and endemism (DSEWPaC 2012b).

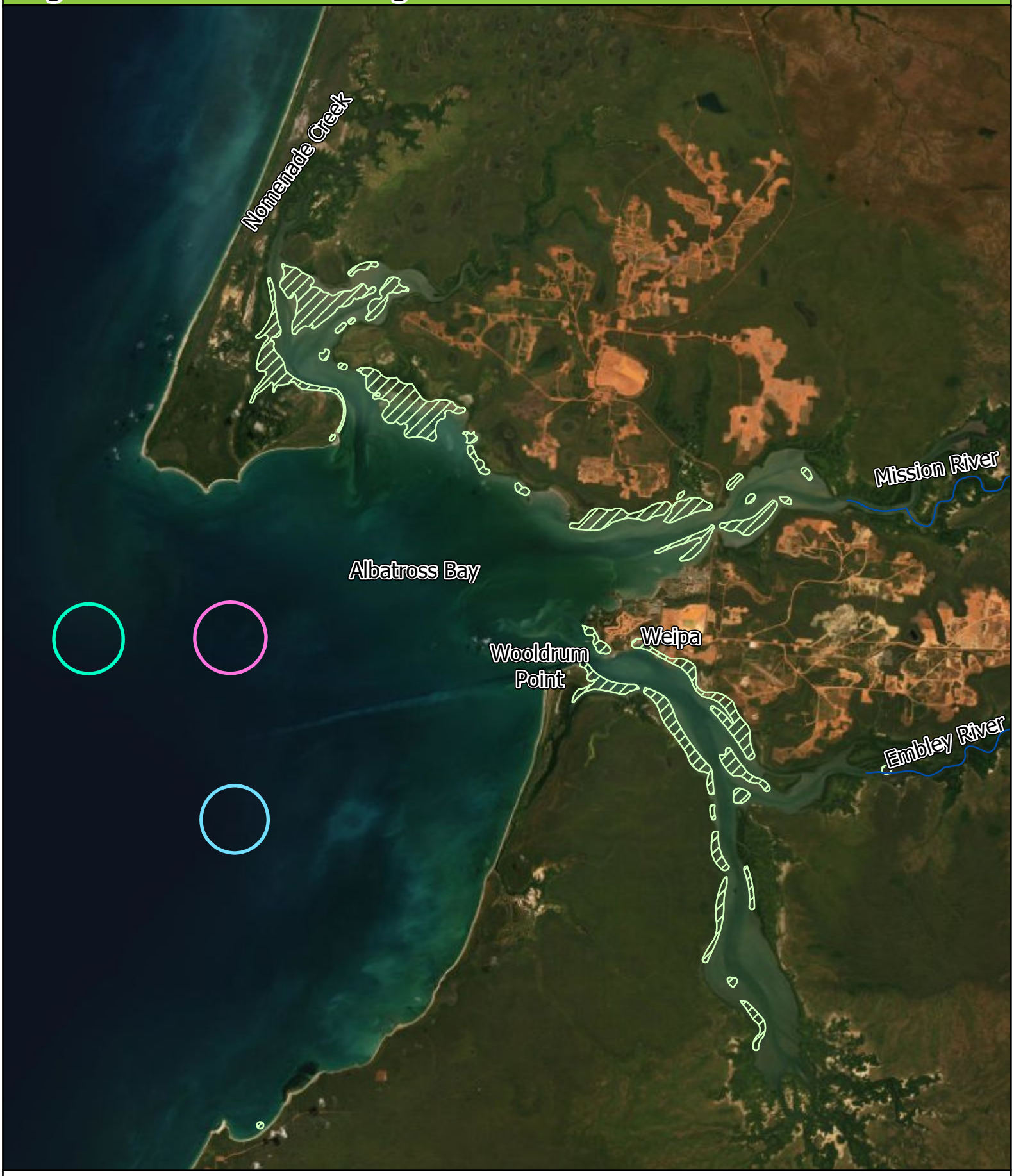
4.6 Seagrass

Seagrass has been extensively surveyed in the Port of Weipa region, and since 2000 annual monitoring has been undertaken, focussing on areas around the port and shipping infrastructure (Chartand et al. 2009). A number of seagrass communities have been identified in the Port and nearby areas, typically in sheltered, shallow sand or mud banks within shallow intertidal flats, which occur throughout the Mission and Embley Rivers, as well as within Pine River Bay and Hey River Inner Harbour (RTA 2015). The locations of seagrass communities in the Port of Weipa region can be seen in Figure 4-5. The most common species of seagrass in these communities include:

- *Halodule uninervis*;
- *Syringodium isoetifolium*;
- *Enhalus acoroides*;
- *Halophila decipiens*;
- *Halophila ovalis*; and
- *Thalassia hemprichii*.

Seagrass provides habitat for many marine species and is also an important food source. Diets of both the Green Turtle (*Chelonia mydas*) and Dugong (*Dugong dugon*) consist mostly of seagrass. Fishery productivity also relies on seagrass and other inshore habitats such as mangroves as they provide important habitat for juvenile crustacean and other fishery species in the region. This allows fish to shelter from predators and mature in a protected marine environment (National Oceans Office 2004).

Figure 4-5: Location of Seagrass



Legend

- Albatross DMPA Moved Region
- Albatross DMPA North (New)
- Albatross DMPA South (New)
- Major Watercourses
- Seagrass Meadows

N

0 2.25 4.5 9

Kilometers

Datum/Projection:
GDA 1994 MGA Zone 54

eco logical AUSTRALIA

Prepared by: SP Date: 17/01/2020

The long-term monitoring of seagrass in the area has identified periods of significant seagrass loss, the most significant of which occurred between 2001 to 2002 when coverage fell from approximately 5000 ha to 3800 ha. This was most likely a result of La Niña events that increased rainfall across the region; resulting in a decline in seagrass (Sozou & Rasheed 2018 and BOM 2014). Regional climate conditions have been identified as a key driver of annual fluctuations in seagrass coverage and monitoring since the La Niña events of 2002 and 2008 has revealed improved health and coverage of seagrass in the area (Sozou & Rasheed, 2018). This recovery highlights the resilient nature of seagrass which is able to recover from periods of significant disturbance.

During the 2018/19 wet season, three TCs (Owen, Penny and Trevor) and one monsoonal system impacted the Weipa region. This resulted in the highest annual sedimentation in the Port, but it also caused a longer than normal period of low light conditions and SSC. To determine the impacts of these weather events, an additional monitoring of seagrass habitat was undertaken in 2019. The results of the survey indicated that the 2018/19 wet season had no major impact to seagrass within the Port of Weipa. The seagrass meadows were in good condition, had maintained coverage and had a similar species composition to previous years (McKenna & Rasheed 2019). These results and the persistence of seagrass in the region further highlights the resilient nature of these seagrass communities and suggests that they are well-adapted to periodic low light and increased sedimentation (Sozou & Rasheed 2018; McKenna & Rasheed 2019).

4.7 Benthic infauna

A number of benthic fauna surveys have been undertaken within Albatross Bay since 1996, with the most recent survey being completed in 2019 (Advisian 2019). Benthic communities within the area are low in abundance and diversity, with high numbers of opportunistic species that can adapt to highly variable benthic conditions (Ports and Coastal Environmental 2013). The 2014 and 2019 surveys assessed community composition pre and post dredging at the DMPA, within a 1 km and 2 km radius of the DMPA and at control sites within Albatross Bay.

The results of the 2014 survey are shown in Table 4-3, and show a decrease in the prevalence of polychaetes and an increase in bivalves in comparison to pre and post dredging. The families with largest variations pre and post dredging were *Ampharetidae* (polychaetes), *Mactridae* (bivalves) and *Tellinidae* (bivalves). This is unsurprising as both mactrid and tellinid bivalve families facilitate recruitment of other taxa, while *Ampharetidae* polychaetes are second stage colonists that can rapidly colonise new areas (GHD 2015a).

Table 4-3: Community composition of benthic fauna pre and post dredging in 2014

Benthic fauna type	Percentage composition	
	Pre dredging	Post dredging (6 weeks after)
Polychaetes	57	29
Bivalves	18	60
Crustaceans	8	5
Other: asascidians, anemones, echinoderms, gastropods, nemerteans, oligochaetes, fish, sipunculids and a small octopus	17	6

Data from GHD, 2015a

The 2019 survey identified 36 taxonomic morphological-species pre dredging and 69 post dredging. The number of individuals was significantly higher post dredging with 2,929 individuals recorded compared to 85 pre dredging; the same trend was observed during the 2014 surveys. The abundance, diversity and species richness of the benthic community were low across all sites in the pre dredging survey compared to post dredging. It is likely that the results of the 2019 survey were heavily influenced by two cyclones that occurred in the region prior to the pre dredging surveys. Cyclone Penny (January 2019) and Cyclone Trevor (March 2019) resulted in heavy rain and winds in excess of 200 km/h during the months of January – March, with the pre-dredging surveys taking place in April. These events transported large quantities of sediment and it is suggested that extreme weather events such as these can interrupt successional processes within benthic communities, impacting abundance and diversity. However, the results do indicate positive benthic infauna community recovery following the cyclonic events, and the results of historical benthic fauna surveys indicate that the benthic fauna is resilient to disturbance from dredging activities (Advisian 2019; GHD 2019).

4.8 Mangroves

The mangrove system in the Weipa region is the most extensive on the eastern Gulf of Carpentaria, with over thirty different species being recorded (RTA 2013). Most of the mangrove communities occur throughout the sheltered areas tidal areas of the Embley River, Hey River and Mission River, yet also occur in Norman Creek, Winda Creek and Crawford Creek (RTA 2011). The most prevalent mangrove community is comprised of closed *Rhizophora, Avicennia* and *Ceriops* forests (RTA 2011).

Mangroves provide benefits to both ecological communities and human populations as they protect the shoreline, acting as a buffer to waves and currents, especially during extreme weather events. The key benefits of mangroves include:

- Providing important habitat (shelter and food) for many species including prawns, fish, birds and estuarine crocodiles;
- Providing nursery habitat for significant fishery species including barramundi, banana prawns and mud crabs (they are the only nursery habitat for banana prawns); and
- Assisting with nutrient cycling, sediment stabilisation and coastal protection (GHD 2019).

Mangroves also have a significant cultural value to indigenous people, providing a food source (fauna habitat), medicine, tools, dyes, fibres and acting as seasonal indicators (National Oceans Office 2004).

Regional threats to the mangrove communities are limited and clearance has been minimal. Future clearance for development poses the greatest threat to mangroves and the species that rely on them.

4.8.1 Terrestrial fauna

Terrestrial fauna within the port of Weipa is limited to those species which utilise coastal and lower estuary habitats such as sandflats, banks, mudflats, seagrass beds, intertidal reefs and mangroves. Terrestrial species considered in relation to the Port are therefore restricted to migratory shorebirds.

The Weipa region is also an important roosting and feeding habitat for migratory shorebirds. Sixteen species of the East Asian – Australasian flyway population use areas within the Gulf of Carpentaria during

their annual migration. Migratory shorebirds use sheltered coasts with large intertidal mudflats or sandflats, often with seagrass beds and are also recorded in saltmarsh, mudflats and mangroves.

The following shorebird species listed under the EPBC Act have been recorded in the Port of Weipa region:

- Red Knot (*Calidris canutus*) – Endangered
- Curlew Sandpiper (*Calidris ferruginea*) – Critically endangered
- Bar-tailed Godwit (*Limosa lapponica*) - Vulnerable
- Northern Siberian Bar-tailed Godwit (*Limosa lapponica menzbieri*) – Critically Endangered
- Eastern Curlew (*Numenius madagascari-ensis*) – Critically endangered
- Common Sandpiper (*Actitis hypoleucos*)
- Sharp-tailed Sandpiper (*Calidris acuminate*)
- Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)
- Little Curlew, Little Whim-brel (*Numenius minutus*)
- Whimbrel (*Numenius phaeopus*)
- Osprey (*Pandion haliaetus*)
- Common Greenshank (*Tringa nebularia*)
- Marsh Sandpiper, Little Greenshank (*Tringa stagnatilis*)

4.9 Marine fauna

4.9.1 Marine reptiles

4.9.1.1 Turtles

Turtle populations in the region have been extensively studied under Rio Tinto Alcan Weipa (RTA)'s Marine Turtle Offset Plan and Feral Pig Management Offset Strategy, as part of their commitments for the Amrun bauxite mine (Amrun Project). Four of the six species of turtle occurring in Queensland waters were found to nest on beaches in the Amrun region; the Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricate*), Olive Ridley Turtle (*Lepidochelys olivacea*) and Flatback Turtle (*Natator depressus*; PE 2019). Although this survey focusses on the Amrun Project, the turtle species observed are also known to occur in Weipa (<50 km North) and individuals may travel between both regions, therefore, potentially being impacted by maintenance dredging activities.

A targeted dolphin survey was also conducted in 2018 as part of RTA's Inshore Dolphin Offset Strategy and recorded the same four turtle species, as well as The Loggerhead Turtle (*Caretta caretta*), foraging within the coastal habitats of Albatross Bay, including the seagrass beds and reef systems (BPM 2019). The Leatherback Turtle (*Dermochelys coriacea*) has not been observed in the Weipa region but suitable habitat is present and likely occurs as a transient species, foraging in the coastal habitats (BPM 2019).

The coastal habitats within Albatross Bay, particularly the seagrass beds and patchy reef systems, are important foraging areas for marine turtles. Seagrass is a key food source for the Green Turtle and acts as a nursery ground for fish and crustaceans, which are a food source for marine turtles. The significance of the coastal and habitats is highlighted by the high number of turtle observations within the region. The 2018 dolphin survey recorded 147 individuals in the Weipa region in 2018 and accounted for 44% of non-dolphin sightings recorded across the 2018 survey.

4.9.1.2 Sea snakes

Although no species of sea snake are listed as threatened under the EPBC Act, they are listed as marine species and are a priority of *The Marine Bioregional Plan for the North Marine Region* which helps guide the conservation and management of biodiversity in the North Marine Region, including the Gulf of Carpentaria (see **Section 4.13.1.1**). There are 35 species of sea snake listed under the EPBC Act, nine of which have been observed during surveys in the Weipa region (GHD 2019). These species include:

- Spine-bellied sea snake (*Lapemis hardwickii*);
- Horned sea snake (*Acalyptophis peronii*);
- Dubois' sea snake (*Aipysurus duboisii*);
- Olive sea snake (*Aipysurus laevis*);
- Stoke's sea snake (*Astrotia stokesii*);
- Beaked sea snake (*Enhydrina schistose*);
- Elegant sea snake (*Hydrophis elegans*); and
- Ornate reef sea snake (*Hydrophis ornatus*).

The most significant threat to sea snakes within the region is bycatch in commercial fishing gear. Habitat modification is considered a potential concern for sea snakes in the region, most commonly through dredging activities (DSEWPaC 2012a).

4.9.1.3 Salt-water crocodile

The salt-water crocodile (*Crocodylus porosus*) is listed as migratory and marine under the EPBC Act and is known to inhabit the creeks and estuaries of the Weipa region as well as transverse coastal waters. Salt-water crocodiles are also known to nest in the creeks and rivers of the Weipa region, primarily in the freshwater swamps further upstream. Threats to salt-water crocodiles in the region include entanglement or consumption of fishing nets and habitat destruction (GHD 2019).

4.9.2 Mammals

4.9.2.1 Dugong

The Dugong is listed as migratory and marine under the EPBC Act and is known to occur in the waters of the Weipa region. The seagrass habitats are a key food source for the Dugong and the shallow waters provide breeding habitat for the species (GHD 2019). The Dugong population in the Gulf of Carpentaria is considered to be one of the most important in Australia and the world and they are considered a priority for conservation effort under *The Marine Bioregional Plan for the North Marine Region*. The most significant threats to dugongs are those which impact seagrass habitats including coastal development, dredging and pollution (DSEWPaC 2012a).

4.9.2.2 Cetaceans

Targeted dolphin surveys have been undertaken in the Weipa region since 2014 as part of RTA's Inshore Dolphin Offset Strategy, with the most recent survey being conducted in 2018. A number of dolphin species have been recorded in the Weipa region during these surveys including:

- Australian snubfin dolphin (*Orcaella heinsohni*) – Migratory;
- Indo-Pacific humpback dolphin (*Sousa chinensis*) - Migratory, marine;
- Australian humpback dolphin (*Sousa sahulensis*) – Migratory;
- Indo-Pacific bottlenose dolphin (*Tursiops aduncus*);
- Orca (*Orcinus orca*) – Migratory, marine;
- Indo-Pacific (inshore) bottlenose dolphin (*Tursiops aduncus*);

- Offshore bottlenose dolphin (*Tursiops truncates*); and
- Spinner dolphin (*Stenella longirostris*).

Although a variety of dolphin species have been recorded, the most common species are the Australian snubfin dolphin, Indo-Pacific humpback dolphin and the Indo-Pacific bottlenose dolphin which are also of conservation value under *The Marine Bioregional Plan for the North Marine Region*. Other dolphin species occur less frequently and only one Orca has been recorded in the greater region; south of Amrun Port (BPM 2019).

Dolphins forage in the shallow coastal and estuary habitats of Weipa including mangroves, reef systems and seagrass beds. Theses habitats also provide important breeding grounds for the three common dolphin species and calves are regularly observed during the surveys (BPM 2019). Dolphins have a relatively low rate of reproduction and are long-lived, making them more susceptible to human induced threats. The most significant threat to dolphins in the North Marine Region is habitat modification through coastal development and dredging (DSEWPaC 2012a).

There are no species of whale known to regularly occur in the waters of the Weipa region. Bryde's Whale (*Balaenoptera edeni*) was recorded on one occasion and is therefore considered to be a species that may sporadically inhabit the area (GHD 2019).

4.9.3 Fish

4.9.3.1 Sawfish

The Gulf of Carpentaria is regarded as a stronghold for a number of sawfish species and contains populations of both national and global significance. Sawfish are a key conservation value of *The Marine Bioregional Plan for the North Marine Region* (DSEWPaC 2012a) and are particularly susceptible to human induced pressures due to their low rates of reproduction, late maturity and low rate of natural mortality. The main sources of pressure to the species are bycatch in commercial fishing, illegal fishing and changes in hydrological regimes (DSEWPaC 2012a). Four sawfish species listed as threatened and/or migratory under the EPBC Act are known or likely to occur in the Weipa region, including:

- Dwarf sawfish (*Pristis clavate*) – Vulnerable and migratory
- Freshwater sawfish (*Pristis pristis*) – Vulnerable and migratory
- Green sawfish (*Pristis zijsron*) – Vulnerable and migratory
- Narrow sawfish (*Anoxypristis cuspidate*) – Migratory

Sawfish inhabit rivers, estuaries, coastal and shallow offshore waters of the Weipa region and the protected coastal and estuary systems are likely to provide nursery habitats for many of the species. There are still significant gaps in the knowledge of sawfish and their populations on the region. Hence, one main strategy of *The Marine Bioregional Plan for the North Marine Region* is to support research into the species to allow for more informed conservation and management (DSEWPaC 2012a).

4.9.3.2 Other fish

A variety of fish species occur in the Weipa region including both demersal and pelagic fish. The seagrass beds and mangroves also provide nursey habitats for many species of fish, providing shelter from harsh marine conditions and predators. Common species within the reef habitats include snapper, emperor and grouper while pelagic fish include planktivorous species, schooling species, snapper, mackerel and shark (DSEWPaC 2012a). The Speartooth shark (*Glyphis glyphis*) has been recorded in the region, usually

occurring in upper freshwater and brackish waters of the Hay and Embley Rivers, but sometimes travelling further downstream into waters of higher salinity. Thirty species of seahorses and pipefishes are also known to occur within the North Marine Region, many of which are likely to occur within the coastal habitats of Weipa (DSEWPaC 2012a). Fish species targeted for both commercial and recreational fishing are also abundant within the region. This is discussed further in **Section 4.11**.

4.10 Heritage

4.10.1 A brief history of Weipa

Weipa was first populated in 1882 when a cattle station was established (GHD 2019). Following the discovery of bauxite deposits in 1955, a camp was established in 1956. As the mining industry expanded, so did the region with the Weipa township being established in 1663. The growth of Weipa resulted in the establishment of key developments including a major hospital, schooling, an RAAF Army Base and many industrial businesses. Aside from bauxite, tourism, cattle grazing, and fisheries provide significant economic input for the region (WTA 2019).

The region also has a rich indigenous history with evidence of Indigenous occupation for over 35,000 years. The Weipa Aboriginal Reserve was established in 1896 before being moved to Napranum in 1933 which is located on the traditional lands of the Alngith people. Other Traditional Owner groups located in the Weipa region include:

- Thaynakwith people;
- Peppan people;
- Wathayn people;
- Anhathangayth people; and
- Wik-Waya people.

4.10.2 Non-indigenous cultural heritage

The National Heritage List, the Commonwealth Heritage List, the Queensland Heritage Register and the Register of National Estate do not include listings for any non-Indigenous cultural heritage sites within the Weipa area. The Weipa Town Authority does not have a local heritage register. However, areas of local heritage and historical interest are still recognised. Only one area of local heritage interest, remnants of house stumps near Hey Point, Weipa is present within the Port Project Area. However, due to extensive environmental impacts, such as flooding and bushfires, the site can no longer be identified and is not considered significant.

4.10.3 Indigenous cultural heritage

Indigenous cultural heritage in Australia can be understood as cultural heritage relating to Aboriginal and Torres Strait Islander communities and may include traditional stories, knowledge and practices, and places with traditional stories and knowledge attached to them. An extensive legislative framework protects Indigenous cultural heritage.

It is also important to note that Indigenous people see the natural environment and the cultural landscape as integral parts of the Aboriginal heritage concept. Indigenous cultural values are viewed as being inextricably linked to the natural attributes of the landscape. The cultural significance of an area is not just due to the presence of tangible sites or objects; it is rooted in the ‘connection to country’ of its people.

Although there is no native title covering the Weipa Project area, native title is recognized in the nearby Amrun area by the Wik and Wik Way People. The Weipa region has also been subject to extensive archeological surveys, largely by Rio Tinto for the Alcan bauxite mine. . The following indigenous cultural heritage sites occur within the region and their locations are shown in Figure 4-6:

- 15 places of cultural significance to Traditional owners;
- 525 scarred trees;
- 43 artefacts including 23 surface stone artefacts;
- 111 shell middens; and
- ethnographic sites.

The marine environmental values in the Weipa region are of significant cultural importance to the Indigenous people. Recreational fishing is common amongst the Traditional Owners in Weipa with the mangrove systems being utilised during fishing practices. The importance of mangroves to Indigenous people is discussed further in **Section 4.8**.

4.11 Fisheries

4.11.1 Commercial fisheries

Commercial fishing provides significant economic input to the Weipa region with a variety of species being targeted including:

- Tiger and banana prawns in shallow coastal areas;
- Barramundi and threadfins in inshore areas; and
- Spanish mackerel, grey mackerel, and shark species further offshore (RTA 2011).

Northern Prawn Fishery and Gulf of Carpentaria Commercial Fisheries are the main fisheries operating in Weipa, predominantly targeting prawns and Spanish mackerel respectively (RTA 2011). Fisheries are also important for the tourism industry in Weipa with several fishing charters also operating in the region (further discussed in **Section 4.12**).

The Northern Prawn Fishery's average annual production value was $95 million (1999 -2007) with the Weipa region providing the third largest catch of tiger and banana prawns in 2007. The Weipa region provides 12% of the Gulf of Carpentaria Commercial Fisheries annual catch; a value of approximately $150,000. The combined income of the eight fishing charter businesses operating in Weipa was $396,000 in 2001 and since then, this has likely increased (RTA 2011). Maintaining healthy fisheries is therefore important for Weipa, particularly the inshore mangrove and seagrass habitats that provide key spawning and nursery areas for prawns and many target species of fish.

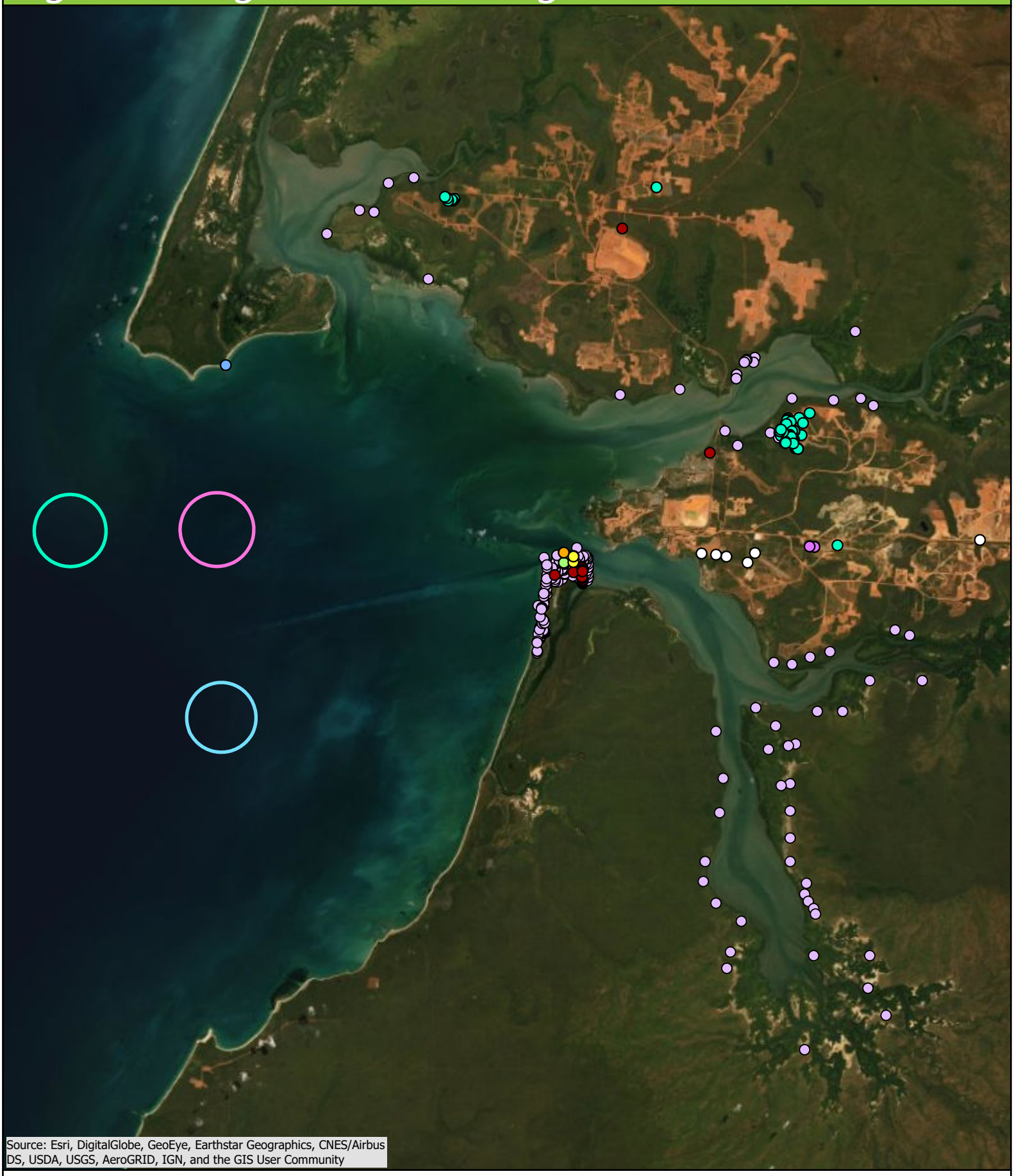
4.11.2 Recreational fisheries

Recreational fishing is practiced by Traditional Owners in Weipa and is also very popular for both tourists and local residents. Commonly targeted species include:

- Barramundi;
- Fingermark mackerel;
- Mangrove jack; and
- Threadfins (RTA, 2011).

Recreational fishing is further discussed in **Section 4.12**.

Figure 4-6: Indigenous Cultural Heritage Sites



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

Legend

- Albatross DMPA Moved Region
- Albatross DMPA North (New)
- Albatross DMPA South (New)

Cultural Heritage (GHD 2018)

- Artefact Scatter
- Burial(s)
- Cultural Site
- Dwelling(s)
- Historical Place
- Isolated Find
- Resource Area
- Scarred/Carved Tree
- Shell Middens

N

0 2.25 4.5 9

Kilometers

Datum/Projection:
GDA 1994 MGA Zone 54

eco logical AUSTRALIA

Prepared by: SP Date: 17/01/2020

4.12 Tourism and recreation

Fisheries are central to the tourism and recreation industry in Weipa, with 71% of visitors travelling to the area to fish and a number of fishing charters operate in the area. There are opportunities for beach, deep-water and estuary fishing, as well as camping and bird watching (RTA 2011). A community centre and the primary public boat ramp are located at Evans Landing in the Port. This boat ramp is owned by Department of Transport and Main Roads and maintained by the Weipa Town Authority and is used for both recreational and commercial activities. A range of community and tourist events occur at the community centre and surrounding area, including the Fishing Classic, which in 2017, attracted over 2,200 participants and provided an estimated $1 million in increased business opportunities for Weipa (DSDMIP 2018).

The natural environment, particularly marine areas, is central to the lifestyle and societal values of the region. The isolated location provides a number of pristine camping and fishing locations, utilised by both the general public and tourists.

4.13 Matters of National Environmental Significance (MNES)

A list of MNES with the potential to occur within the project region was generated through a search of protected matters using DoEE's online Protected Matters Search Tool (PMST) on the 25 November 2019. A summary of this assessment is provided in Table 4-4. The MNES included in this list were then assessed to determine their likelihood of occurrence within the project area. This assessment took into account:

- Results of studies undertaken within the vicinity of the Port Weipa (as summarised in GHD 2019) and any existing data for the region more broadly;
- The habitat requirements and known distribution of the species;
- Professional judgement from this assessment's authors.

The likelihood of occurrence assessment categorised MNES into five categories as follows:

- Known: the species or ecological community was or has been observed on the site.
- Likely: a medium to high probability that a species or ecological community occurs on the site.
- Potential: suitable habitat for a species or ecological community occurs on the site, but there is insufficient information to categorise the species or ecological community as likely to occur, or unlikely to occur.
- Unlikely to occur: a very low to low probability that a species or ecological community occurs on the site.
- Not occurring: habitat on the site and in the vicinity is unsuitable for the species or ecological community.

The results of this assessment are provided in **Appendix B**.

Table 4-4: Summary of MNES identified through the PMST

MNES	Comment
World Heritage Places	None
National Heritage Places	None
Wetland of International Importance	None
Great Barrier Reef Marine Park	N/A
Commonwealth Marine Area	1 – Exclusive Economic Zone and Territorial Sea (see Section 4.13.1)
Listed Threatened Ecological Communities	None
Listed Threatened Species	42 – see Section 4.13.2. See Appendix B for full list of threatened species
Listed Migratory Species	53 – see Section 4.13.2. See Appendix B for full list of migratory species

4.13.1 Commonwealth marine areas

The Commonwealth Marine Area (CMA) is defined under Section 24 of the EBPC Act as any waters of the sea inside the seaward boundary of the exclusive economic zone (200 nautical miles offshore), except those waters vested in the state (coastal waters). Coastal waters are defined in the *Coastal Waters (State Powers) Act 1980*, but generally comprise of waters within three nautical miles of the Territorial Sea Baseline (usually the low water line along the coat). In Bays such as Albatross Bay, the Territorial Sea Baseline occurs as a straight line between low waters lines of the entrance points to the bay. For Albatross Bay this from the low water line of Jantz Point to Pera Head. As a result, all areas of the Port of Weipa within the scope of this project are within coastal waters. The PMST result identified the area as occurring in the CMA due to the 50 km buffer used in the assessment.

Although areas of the Port related to maintenance dredging will occur within coastal waters, it is still important to consider any dredging activities that may have indirect impacts to environmental values within the CMA. A number of listed threatened species and listed migratory species (discussed in **Section 4.13.2** below) occurring in the CMA will also occur within the Port and will therefore be directly assessed under this ERA.

4.13.1.1 North Marine Region

Marine bioregional plans have been developed for areas of the CMA to assist in the decision-making process under the EPBC Act. The North Marine Region covers the CMA within the Gulf of Carpentaria as well as the Arafura Sea and the Timor Sea and is covered by *The Marine Bioregional Plan for the North Marine Region* (the plan). The plan aims to ensure that the marine environment remains healthy and resilient and improve management and protection of the marine environment. The Gulf of Carpentaria Coastal Zone is identified by the plan as a key ecological feature with high levels of productivity and biodiversity. The plan also identifies MNES within the region and describes priorities, strategies and actions for the region. Although the Port and maintenance dredging activities are within state coastal waters, *The Marine Bioregional Plan for the North Marine Region* will assist in the development of this ERA, particularly when assessing any MNES that occur within the Port of Weipa.

4.13.2 Listed species

The likelihood assessment indicated a number of threatened species and migratory species that are either known or considered likely to occur. These are listed in Table 4-5. The results of the full likelihood of occurrence assessment is provided in **Appendix B**.

Table 4-5: Threatened species and migratory species known, likely or with the potential to occur at the Port Weipa

Scientific Name	Common name	EPBC Act listing status	Likelihood of occurrence	Comment / justification
BIRDS				
Calidris canutus	Red Knot	Endangered, Migratory	Known	Species has been recorded in the region and inhabits mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours
Calidris ferruginea	Curlew Sandpiper	Critically endangered, Migratory	Known	Species has been recorded in the Gulf of Carpentaria and inhabits mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours
Limosa lapponica	Bar-tailed Godwit	Vulnerable, Migratory	Potential	There are limited records of this species in the project area, however the habitat is highly suitable with the species mainly occurring in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is also often found around beds of seagrass.
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Critically endangered, Migratory	Potential	This is a sub-species of the Bar-tailed Godwit and is known to occur in northern Australia. There are no current records of its occurrence in the project area or region, however, there are many records of the Bar-tailed Godwit and therefore there is also the potential for the northern Siberian sub-species to occur.
Numenius madagascariensis	Eastern Curlew	Critically endangered, Migratory	Known	This species has been recorded in the Weipa region. Known to forage in inertial mudflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons.
REPTILES				
Caretta caretta	Loggerhead Turtle	Endangered Migratory	Likely	This species has been recorded in the Weipa region. Is likely a transient species in the area, foraging on the surrounding reef systems or seagrass beds. No nesting observed in the region.
Chelonia mydas	Green Turtle	Vulnerable Migratory	Known	This species has been recorded in the Weipa region. Known to forage on the surrounding reef systems or seagrass beds in shallow coastal waters. Small numbers of green turtle nests have also been observed.

Scientific Name	Common name	EPBC Act listing status	Likelihood of occurrence	Comment / justification
Dermochelys coriacea	Leatherback Turtle	Endangered Migratory	Likely	Transient species in the area. May forage on the surrounding reef systems or seagrass beds.
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable Migratory	Known	This species has been recorded in the Weipa region. Known to forage in surrounding reef system and nest on beaches in the region.
Lepidochelys olivacea	Olive Ridley Turtle	Endangered Migratory	Known	This species has been recorded in the Weipa region. Known to forage in surrounding reef system and nest on beaches in the region.
Natator depressus	Flatback Turtle	Vulnerable Migratory	Known	This species has been recorded in the Weipa region. Known to forage in surrounding reef system and nest on beaches in the region.
SHARKS				
Glyphis glyphis	Speartooth Shark	Critically endangered	Potential	Preferred habitat is upper freshwater and brackish waters within tropical river systems but can tolerate higher salinity. Species has been observed in the Hay and Embley Rivers (last seen in 1986).
Pristis clavata	Dwarf Sawfish	Vulnerable	Known	This species has been recorded in shallow waters of Albatross Bay. Estuarine habitats in the region potentially provided nursery habitat.
Pristis pristis	Freshwater Sawfish	Vulnerable	Known	This species has been recorded in the Weipa region and inhabits rivers, estuaries, coastal and offshore waters up to 25 m depth.
Pristis zijsron	Green Sawfish	Vulnerable	Known	This species has been recorded in Albatross Bay. Estuarine waters potentially provide breeding habitat and shallow coastal habitats potentially provide nursery habitat.
MIGRATORY MARINE BIRDS				
Anous stolidus	Common Noddy	Migratory, Marine	Potential	This species has been recorded in the Weipa region but is an offshore or pelagic species only in Queensland
Fregata ariel	Lesser Frigatebird	Migratory, Marine	Potential	This species has been recorded in the Weipa region but is an offshore or pelagic species only.
Fregata minor	Greater Frigatebird	Migratory, Marine	Potential	This species has been recorded in the Weipa region but is an offshore or pelagic species only.

Scientific Name	Common name	EPBC Act listing status	Likelihood of occurrence	Comment / justification
Sternula albifrons	Little Tern	Migratory, Marine	Known	This species inhabits sheltered coastal environments and the northern subpopulation is known to breed in areas of the Gulf of Carpentaria, including Weipa.
MIGRATORY MARINE SPECIES				
Anoxypristis cuspidata	Narrow Sawfish	Migratory	Potential	There are no recent recordings of this species in the Weipa region. This species' Australian distribution is unclear though it is most common in the Gulf of Carpentaria.
Crocodylus porosus	Salt-water Crocodile	Migratory, Marine	Known	This species is known to inhabit the creeks and estuaries of the Weipa region and transverse coastal waters.
Dugong dugon	Dugong	Migratory, Marine	Known	Dugongs are known to occur in the waters off Weipa. They are known to forage on seagrass beds and breed in shallow waters of the Weipa region. The Dugong population in the Gulf of Carpentaria is considered to be one of the most important in Australia and the world.
Orcaella heinsohni	Australian Snubfin Dolphin	Migratory	Known	This species has been recorded in the Weipa region. Typically forages in shallow coastal waters (<20 m) and estuarine systems.
Sousa chinensis	Indo-Pacific Humpback Dolphin	Migratory, Marine	Known	This species has been recorded in the Weipa region. Typically forages in mangrove and estuary habitats or shallow reef systems.
Sousa sahulensis	Australian Humpback Dolphin	Migratory	Known	This species has been recorded in the Weipa region. Typically occurs in coastal waters.
MIGRATORY WETLAND BIRDS				
Actitis hypoleucos	Common Sandpiper	Migratory, Marine	Known	This species has been recorded in coastal habitats of the Weipa region and areas of national importance occur in the South-eastern Gulf of Carpentaria.
Calidris acuminata	Sharp-tailed Sandpiper	Migratory, Marine	Known	This species has been recorded in coastal habitats of the Weipa region and is widespread along the Queensland coast.
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	Migratory, Marine	Potential	This species has been recorded in the Weipa region, but prefers wetlands and other freshwater habitats.

Scientific Name	Common name	EPBC Act listing status	Likelihood of occurrence	Comment / justification
Numenius minutus	Little Curlew, Little Whimbrel	Migratory, Marine	Potential	This species has been recorded in the Weipa region, but prefers terrestrial habitats near floodplains and occasionally coastal habitats including estuaries, mudflats and beaches.
Numenius phaeopus	Whimbrel	Migratory, Marine	Known	This species has been recorded in the Weipa region and occurs in a variety of coastal habitats including beaches, mangroves and intertidal reefs.
Pandion haliaetus	Osprey	Migratory, Marine	Known	This species has been recorded in the Weipa region and often forages in inshore waters, reefs, bays, coastal cliffs, beaches, estuaries and mangrove swamps.
Tringa nebularia	Common Greenshank	Migratory, Marine	Known	This species is widespread in the Gulf of Carpentaria, including Weipa and occurs in a variety of coastal habitats including seagrass, mangroves, saltmarsh and harbours.
Tringa stagnatilis	Marsh Sandpiper, Little Greenshank	Migratory, Marine	Potential	This species has been rarely recorded in the Weipa region compared to a stronghold population in the south-eastern Gulf of Carpentaria. This species can occur in saline coastal habitats but prefers wetland habitats.

5. Potential impacts

The potential impacts of dredging have been well documented in Ports Australia (2014) and McCook *et al.* (2015). These impacts are discussed below, with particular focus on those relevant to maintenance dredging at the Port of Weipa. Detailed impact analysis and risk assessment of how these potential impacts may affect environmental values at the Port are provided in **Sections 7** and **8** below.

5.1 Seabed disturbance

5.1.1 Within the dredging footprint

Maintenance dredging involves the removal of sediments that have accumulated in artificially deepened channels and berths between maintenance dredging periods (generally annually in the channel and once every few years in other areas). Each maintenance dredging campaign generally involves disturbance of the same area or dredge footprint.

Sediments at the Port of Weipa are predominately comprised of sand and silt, with lower levels of clay and gravel. These sediments are transported by tidal currents into the South Channel within Albatross Bay and sheltered sections of channels and berths within the Inner Harbour. Most of the fauna and flora that colonise the accumulating sediments between dredging episodes are species that are adapted to exploiting disturbed habitats and typically involve common and widespread species such as shellfish, crabs, worms and algae. Material to be dredged is almost always unvegetated (other than microalgae).

Unless environmental conditions change markedly, direct impacts associated with maintenance dredging (removing the seabed) are generally localised and short term.

5.1.2 Within the dredged material placement area

Placement of dredged material at the DMPA results in burial and smothering of resident benthic communities. Similar to dredging footprints, impacts to a DMPA are an unavoidable consequence of placing material at-sea. DMPAs are designated for this impact process and are specifically located in recognition of the inevitability of such impacts and the need to minimise adverse effects to adjacent areas.

Recovery within DMPAs generally follows consistent patterns at Queensland Ports, including the Port of Weipa. Studies of the impacts of dredged material disposal have shown that (Ports Australia 2014):

- Seabed fauna (e.g. polychaetes, bivalves, and anemones) in the DMPA were initially adversely impacted due to burial and smothering (reduced abundance and diversity)
- Community recovery (increased biomass and diversity) began within a short time (<2 months) after the completion of placement activities
- Placement of dredged material may have provided an abundance of nutrients for organisms at the site with some species rapidly colonising the new material
- Surveys undertaken 3 – 11 months after placement activities (port and year dependent) indicated the benthic community of the DMPA had recovered and was not substantially different from adjacent or reference locations (some minor changes in community structure occurred but were restricted to close areas to the DMPA).

- There was some evidence of opportunistic rapid colonisers (mainly polychaetes) being more common at the DMPA than at reference sites.

Surveys conducted in 2019 at the Port of Weipa DMPA assessed the benthic community pre and post dredging (3 months later) and found that the abundance, diversity and species richness of the benthic community was higher post dredging. This was likely due to the detrimental impacts of two significant TCs in January and March of 2019. The results indicate that the benthic fauna in Albatross Bay is resilient to both dredging activities and cyclonic events (Advisian 2019).

5.2 Impacts to water quality

5.2.1 Turbidity and sedimentation

Dredging and dredged material placement may cause sediment to be introduced to the water column (turbidity) and result in impacts as these sediments settle (sedimentation).

Turbidity and sedimentation effects can result from the dredging operation (e.g. through hopper overflow waters, disturbance to the seabed by the dredge draghead or propeller wash), the placement of material at the DMPA (e.g. through Trailing Suction Hopper Dredge discharges or barge releases) and through dispersion of placed material from the dredged material placement area.

The level of impacts and rates of recovery from turbidity and sedimentation effects depend on several factors such as the timing, duration, intensity, and scale of the dredging and dredged material placement works as well as the type of species affected.

Suspended materials may either settle at the dredge and/or DMPA, contributing to direct effects or cause indirect effects as they are transported by currents to adjacent areas (depending upon the sediment particle sizes involved and the hydrodynamic regime of the dredge area). Settled suspended sediments may smother benthic communities, such as corals and seagrass, impacting growth rates and in extreme cases, result in mortality. Sedimentation on intertidal shores also has the potential to impact mangrove communities.

5.2.2 Release of contaminants and/or nutrients

All material proposed for at-sea placement is tested according to the NAGD and subject to strict testing and approval protocols to ensure potential impacts relating to the resuspension or placement of contaminated material are assessed. All dredged material at the Port of Weipa has undergone testing in accordance with the NAGD. Contaminant levels are all below screening criteria and are considered suitable for ocean disposal (Advisian 2018a).

Dredging and dredged material placement may release nutrients held within the seabed sediments. The ecological impact of additional nutrients depends on a broad range of factors including the background concentrations in the water column, nutrient release rates and dredging techniques, and needs to be considered on a site-specific basis. The NAGD does not provide guidance in relation to nutrient levels in marine sediments.

Elevated nutrient levels in the water column are of interest as there may be a potential to stimulate algae growth with both positive and negative effects. Whilst increases in nutrient levels may increase

the risk of algal blooms, the turbidity created by dredging reduces light and hence may reduce the risk of blooms.

Most assessments of nutrient-related impacts have indicated any increase in nutrient concentrations is likely to be localised and short-lived and comparable to the effects of storms which impact much more extensive areas. Adverse effects of eutrophication related (algal bloom) water quality issues are rare because the events are short lived, there is typically a fairly rapid dilution and relative to the dilution, nutrient release is small.

5.2.3 Spills and leaks from dredge vessel

Ship-sourced oily wastes are those produced during the normal operation of ships and include lubricating oil and hydraulic oil, fuel residues, oily sludges, oily bilge water, oily tank washings, oily cargo losses, and used oil filters and oily rags. Most oily wastes are liquids, albeit with suspended solids, except for oil filters and oily rags which are solid wastes.

Ship sewage is typically considered to be human waste (from urinals and toilets) but is defined by the IMO as also including drainage from onboard medical areas. Any material that is mixed with sewage is to be treated as sewage and in some ships, this may include greywater (i.e. drainage water from dishwashers, sinks, showers, laundries, baths and washbasins) that is drained into common holding systems.

Garbage is generated in ships as an inevitable consequence of the operation and routine maintenance of the ship and the sustenance of those onboard (i.e. crew and passengers if carried). Much of the garbage generated in ships is analogous to that generated in residential premises, offices and light industrial workshops.

Under IMO regulations, ships are not permitted to discharge treated sewage (from an approved sewage treatment plant) within three nautical miles of the nearest land or twelve nautical miles for untreated sewage; only when the ship is travelling at no less than 4 knots and discharge is at an approved rate. Discharge of garbage and waste material is prohibited except for food waste, cargo residues, cleaning agents and additives and animal carcasses which are subject to specified discharge provisions under MARPOL Annex V.

5.3 Underwater noise

Large ships generate broadband noise which can radiate throughout the underwater marine environment. This originates from their propellers, engines, auxiliary machinery, gear boxes and shafts, plus hull wake and turbulence and can be substantial in an aggregated sense.

The radiated noise spectrum from TSHD vessels is typically in the range of 30 Hz to 500 Hz (WODA 2013). Low frequency acoustic energy propagates well in marine waters, particularly the deep oceans, and ships' low frequency noise components contribute significantly to the amount of low frequency ambient oceanic noise, particularly in regions with heavy ship traffic.

Low frequency broadband noise from shipping is of potential concern as it may impede use of the acoustic spectrum by marine fauna, particularly cetaceans. This concern centres upon the possibility that such noise may:

- Mask echolocation vocalisations or communications
- Acoustically mask predators or prey
- Lead to separation of calves from mothers
- Alienate the animals from preferred aggregation areas or migration pathways, if intense and localised.

5.4 Ship lighting

Ships emit light from a variety of sources at night. These include compulsory navigation lighting as required by the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs), with the actual configuration dependent upon ship size and type and activity engaged upon, particularly whether underway or at anchor. In addition to mandatory lighting, COLREGs also encourage ships to maximise upper deck illumination as a means of enhancing a ship's visual presence, intended to reduce collision risks.

During dredging, the dredge vessel will be operating 24 hours a day and therefore operational lighting will be required at night.

Artificial lighting has the potential to impact marine fauna through a range of processes including:

- Dis- or mis-orientation
- Attraction/repulsion
- Decrease in habitat suitability
- Alteration in foraging and breeding behaviours
- Change in fauna community interactions (competition and predation).

5.5 Interactions between the dredge and marine fauna

Ship strike can be defined as a collision between a vessel and a marine species causing either injuries or death to the marine animal and/or damage to the vessel and sometimes to its passengers. Ships strikes occur anywhere that vessels and marine fauna distributions' overlap, mostly within coastal zones, however, there have been reports of high seas collisions. Vessel speed is a significant factor in the likelihood of collisions occurring. Marine fauna may be slow to react and avoid fast, highly mobile craft (such as speed boats and jet skis) and these pose a particularly significant risk to smaller fauna such as turtles and dugongs.

Ship strike injuries to marine animals tend to fall into two categories – lacerations from sharp objects, most commonly propellers and/or injuries from impact with the hull resulting in fractures and/or bruising. Both these risks are considered low during dredging operations due to the slow speeds at which dredge vessels operate. Specific risks are also associated with dredging, whereby marine fauna (particularly turtles) may collide with or become entrained with the drag head. Resultant injuries can result in fauna mortality.

5.6 Introduction of marine pests

Introduced marine pests are marine plants or animals that are not native to Australia that have been introduced by human activities such as shipping. They have the potential to significantly impact marine

industries and the environment. Introduced marine pests are known to be introduced or translocated by a variety of vectors, including ballast water, biofouling, aquaculture operations, aquarium imports, marine debris and ocean current movements.

Ballast water is able to act as a vector for marine organisms when species are entrained in the ballast, able to survive the intervening voyage, and then successfully establish in the new environment after discharge from the conveying vessel. Dependent upon where and how the vessel loads ballast, the ballast water may also include sediments and sludges, which can also act as a vehicle for the transfer of exotic species.

Any dredge vessel contracted to undertake dredging works at the Port of Weipa will be required to comply with best hygiene practices, including Australian Quarantine and Inspection Service and Bio-Security Queensland requirements in relation to ballast water and marine pest management, this includes the National System for the Prevention and Management of Marine Pest Incursions, in particular the National Biofouling Management Guidance for Non-Trading Vessels.

5.7 Impacts to other users

Impacts from dredging to other users of the region will be limited both due to the short duration of maintenance dredging and restrictions on usage of Port areas. Fisheries are likely to have the greatest potential for impacts, both direct and indirect.

Direct impacts include loss or modification of access. Indirect impacts can be through changes to productivity principally through modification or loss of habitat. Indirect impacts can also arise on fishing activities that may be impacted by the displacement of fishing effort when access arrangements change. Changes to the economic structure of a region may also have impacts on the availability of business services that support commercial fishing and the cost of accessing such services.

Impacts to fisheries and marine environmental values could also result in impacts to Indigenous culture. The marine environment is of high significance to Traditional Owners of the area, with fishing being a common activity in the Weipa region. Marine environments such as mangroves also hold other value to Indigenous people and are utilised in a variety of ways, including production of traditional tools and medicines. Impacts include changes in access to the marine environment, modification/loss of habitat or displacement of fishing effort.

6. Measure to avoid and reduce impacts

Significant work has been undertaken to analyse the optimal options for managing sediments at the Port of Weipa. The SSM project did the following:

- Assessed the feasibility of avoiding or reducing the need for maintenance dredging at the Port of Weipa
- Comprehensively investigated opportunities to beneficially reuse accumulated material that must be dredged
- Considered alternatives to at-sea disposal, based on environmental values and constraints in the region
- Compared the range of alternatives in a way that considers (at a minimum) risks to the environment, health and safety, social and economic values and the exclusion of future uses

The overarching outcome of the project was that maintenance dredging will be required annually at the Port of Weipa in order to maintain the operational efficiency and safety of the Port. The outcomes of the SSM project provide a range of measures that will be implemented to avoid and reduce impacts of sediment management at the Port of Weipa. These are discussed below.

In addition to the SSM, a framework has been developed to reduce frequency, extent and severity of unavoidable impacts from maintenance dredging at the Port. The framework is based on three key documents:

- Port of Weipa Long-term Maintenance Dredging Management Plan
- Port of Weipa Marine Environment Monitoring Program
- A works species Environmental Management Plan
    - This will be developed or revised prior to the commencement of annual dredging activities and will be developed in partnership with the relevant dredging vessel operator

Together, these documents will provide a series of measures to reduce and manage impacts from maintenance dredging based on the findings of this impact assessment.

In undertaking this risk assessment, it has been assumed that standard best practice mitigation measures will be applied. In addition, a number of specific measures and adaptive management approaches are noted and recommended throughout the text.

7. Impact analysis

7.1 Impacts to water quality

7.1.1.1 Resuspension of sediments

Resuspension of sediments in the Port of Weipa can be from both natural and man-made causes. Wave action resuspends the natural fine-grained sediment from the seabed in Albatross Bay. Resuspension of sediments was analysed as part of the development of environmental thresholds for the Sustainable Sediment Management Assessment (PSC 2019a). The analysis found that the relationship between turbidity (NTU) and SSC can vary and change throughout dredging operations based on the properties of the sediment being dredged.

In regard to maintenance dredging, the properties of the sediment suspended due to dredging compared with naturally suspended sediment are not expected to significantly differ (PSC 2019a). This is due to the fact that the sediment to be removed is natural sediment which has been recently deposited in the dredged areas as a result of sediment transport (refer **Section 4.2.2**). Consequently, the NTU to SSC relationship is not expected to change significantly during periods of maintenance dredging.

The natural environment around the Port of Weipa is inherently turbid and any increase in SSC due to dredging activities is likely to be less than the natural variability (PSC 2019b). Consequently, the resuspension of sediments during dredging is not anticipated to have a significant detrimental effect on sensitive habitat or marine fauna.

Long-term resuspension modelling was undertaken as part of the dredge plume modelling and predicts that sediments placed in the DMPA will only be resuspended as a result of extreme meteorological conditions during the wet season (e.g. tropical cyclones; PSC 2019a). Any sediments resuspended in the DMPA will be focused in the areas directly adjacent to the sites and will not result in a noticeable increase in deposition in the dredged areas (McKenna & Rasheed 2019).

7.1.2 Sediment transport

PSC (2018) undertook conceptual sediment transport modelling to understand the erosion and accretion processes in the Port of Weipa. The conceptual model identified that natural sedimentation and transportation in the South Channel of the Port is a result of a combination of wave and tidal current processes. Wave action resuspends natural fine-grained sediment from the seabed and then the spatial distribution of tidal currents control where the fine-grained sediment is deposited (PSC 2018). In the Inner Harbour the modelling identified that there have only been localised areas of sedimentation, as the relatively high tidal current speeds limit deposition of fine-grained sediment in most areas (PSC 2018). The sedimentation has typically been due to the existing shallow sand banks encroaching on the channel due to bedload transport driven by the tidal currents.

Sedimentation rates and transportation of sediment can be significantly altered during extreme weather events including tropical cyclones. Very high rates of sedimentation occurred at the Port of Weipa over the 2018/19 wet season, with more than two million cubic metres of sediment deposited in the South Channel, which is approximately three times higher than the previous highest annual sedimentation volume (PSC 2019a). The very high sedimentation was found to be a result of multiple large wave events

occurring during two tropical cyclones and a prolonged tropical low, resulting in widespread resuspension of bed sediment (PSC 2019a).

Dredge plume modelling indicated that the deposition of sediment resulting from maintenance dredging campaigns is small in spatial extent and low in intensity in comparison with the natural deposition rates within the port (PSC 2019a). Generally it is only possible to distinguish between natural deposition and natural plus dredging deposition at either the dredging and/or placement locations (PSC 2019a).

Dredged sediment will be placed in unconfined ocean disposal away from dredge areas. The sediment will remain in the system and over time the natural process that drive sedimentation and transport will inevitably result in the sediment making its way back to the dredge areas. Importantly, maintenance dredging campaigns have historically been conducted within the Port of Weipa with no alteration to the natural sediment transport regime. The upcoming maintenance dredging works are also not expected to significantly alter the natural sediment transport regime of the Port of Weipa.

7.1.3 Release of contaminants and nutrients

As discussed in **Section 4.2.1**, the sediments from the Port of Weipa have previously been sampled and deemed appropriate for unconfined ocean disposal. The most recent sampling (2018) confirmed that no concentrations of contaminants (including TBT, metals, hydrocarbons, BTEXN and PAHs) were above the NAGD screening levels (Advisian 2018a). Consequently, impacts from the release of contaminants are not likely to occur at either the dredge areas or DMPA.

7.1.4 Water quality impact thresholds

7.1.4.1 Developing impact thresholds

Water quality impact thresholds have been developed in order to avoid and manage potential impacts to water quality and sensitive receptors. The thresholds have been developed by PSC (2019a and 2019b) based on a statistical analysis of site-specific measure water quality and deposition data using an intensity, duration and frequency (IDF) approach. This approach has been used to understand the natural variability in the environment in terms of turbidity, benthic light availability (benthic PAR) and sediment deposition. The analysis undertaken was based on approximately nineteen months of water quality monitoring data collected at three sites in the Port of Weipa area.

The most sensitive environmental receptor that may be impacted by changes in water quality within the Port of Weipa is seagrass. Environmental thresholds for seagrass are generally defined in term of benthic PAR rather than turbidity. The IDF results indicated that turbidity data is the most appropriate parameter for monitoring during dredging operations, and as such data was used to determine relationships between benthic PAR and turbidity (PSC 2019b). The relevant literature for the seagrass species present in the project area indicates that a turbidity threshold in the order of 15-20 NTUe (equivalent to approximately SSC of 30 mg/l) is representative of the lower threshold for light availability at the monitoring sites during the dry season (PSC 2019b).

IDF percentiles were calculated for a 20 day and 40 day dredging campaign to capture a range of dredging scenarios (e.g. typical, cyclonic and worst case), with the 90th percentile adopted as a suitable turbidity intensity threshold (PSC 2019a and 2019b). The proposed threshold was analysed against water quality data collected during the 2019 maintenance dredging program (a worst-case sedimentation year). The results from the analysis (presented in Table 7-1) define the natural conditions in terms of

both the intensity and duration, providing a basis for trigger limits if adaptive monitoring is required during future maintenance dredging programs (PSC 2019a and 2019b).

Table 7-1: Threshold values and cumulative durations above thresholds (40-day period)

Site	Intensity (mg/l)	Intensity (NTU)	Average duration (hours)	90th percentile duration (hours)	Maximum duration (hours)
Wet season					
WQ1	43	33	96	271	324
WQ2	273	204	96	366	396
WQ4	168	95	96	237	252
Dry season					
WQ1	22	17	96	142	155
WQ2	20	15	96	239	273
WQ4	31	18	96	194	248

7.1.4.2 Plume modelling and assessment against thresholds

Changes in water quality and associated impacts to sensitive environmental values have been assessed as part of dredge plume modelling. An example map plot comparing the modelled natural SSC and natural plus dredging SSC is shown in Figure 7-1. Four sensitive receptors were identified and adopted for the assessment (PSC 2019a and Figure 7-2):

- AB1: closest area of extensive seagrass meadows to the South Channel in Albatross Bay
- AB2: closest rocky reef to the South Channel in Albatross Bay
- IH1: nearest area of seagrass to the location of the tailwater discharge/reclamation failure and close to the Evans Landing and Humbug wharves and the Departure
- IH2: area of widespread seagrass on the southern bank of the Embley River located to the south-east of the Approach Channel

Since no data were collected at the exact locations of the sensitive receptors, for the assessment the thresholds defined (refer **Section 7.1.4.1**) at WQ1 are considered applicable to IH1, the thresholds defined at WQ2 are considered applicable to AB1 and AB2 and the thresholds defined at WQ4 are considered applicable to IH2 (PSC 2019a). The natural and natural plus dredging exceedance of intensity thresholds have been calculated for each of the four sensitive receptors for three dredge volume scenarios:

- Typical –400,000 m^3 taking 24 days to complete with one dredger
- Cyclonic –800,000 m^3 taking 48 days to completely with one dredger
- Worst-case – 2,500,000 m^3 taking 33 days to complete with two dredgers

For each scenario the disposal method is unconfined ocean disposal at the Albatross Bay DMPA. The modelling and analysis demonstrated that the natural turbidity is generally much higher than the SSC predicted to result from maintenance dredging and turbidity was predicted to remain within natural conditions for the sensitive receptors for all dredge scenarios considered (refer Table 7-2 and Table 7-3).

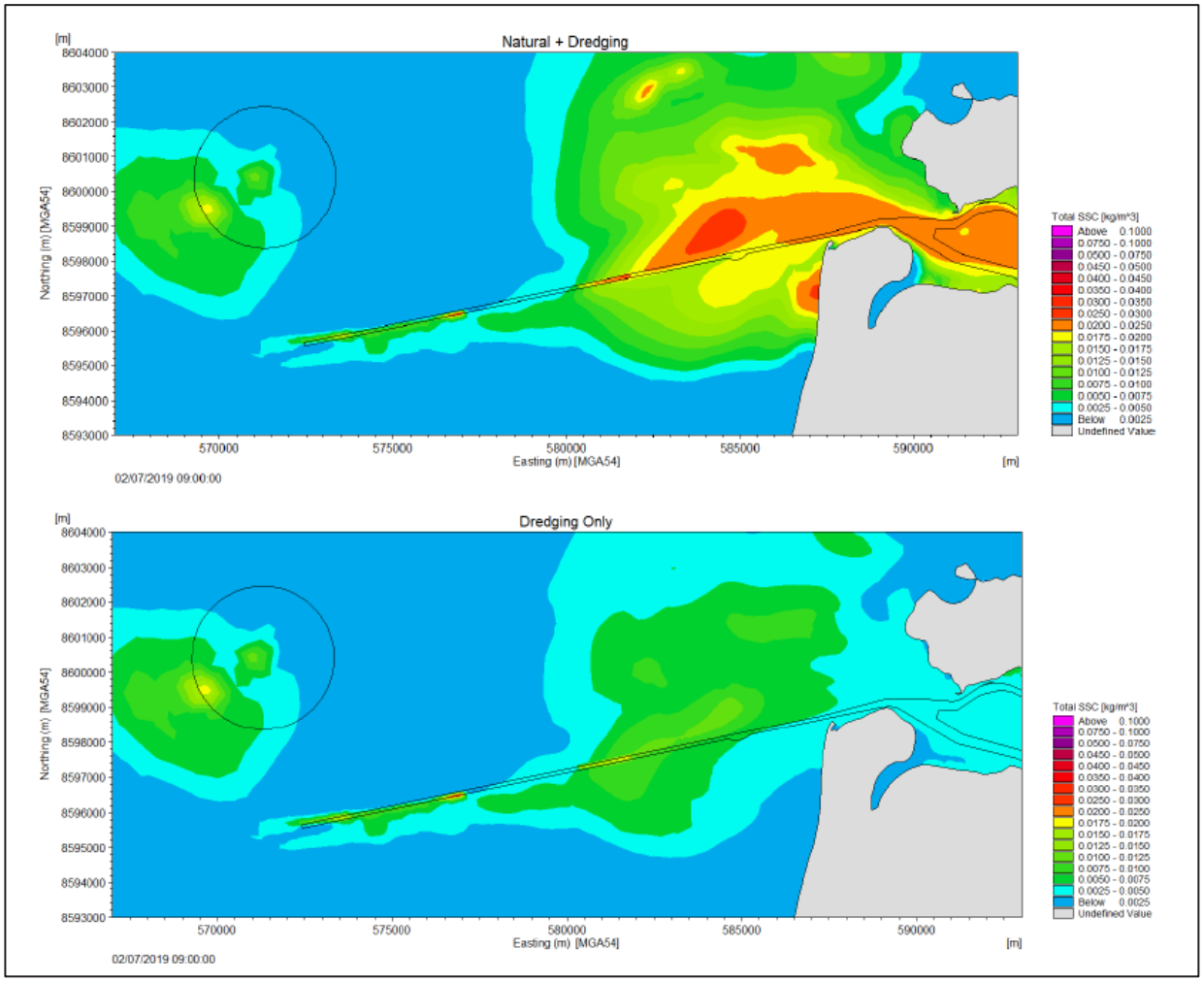


Figure 7-1: Comparison of turbidity from satellite imagery and modelled SCC for natural and dredging and dredging only scenarios

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Figure 7-2: Sensitive receptor assessment locations

Only for the worst-case dredge volume was the duration above the threshold value for longer than the 90th percentile natural duration (PSC 2019a).

Overall, the results show that for the typical and cyclonic dredge volumes the unconfined ocean disposal result in small increases in turbidity and deposition and the increases are negligible in relation to the natural conditions at the sensitive receptors. Historical maintenance dredging campaigns have also routinely been conducted without any significant impacts to water quality. Consequently, the upcoming dredging program is not anticipated to have any significant impact on water quality within the Port of Weipa.

Table 7-2: Comparison of modelled SSC conditions across typical maintenance dredging volumes against intensity and duration threshold (for ambient dry season)

Dredge volume scenario	Dredge duration (days)	Duration over threshold[1] (hours)								Max duration threshold (hours)				Threshold exceedance?			
		Natural				Natural + dredging											
		AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2
Typical	24	57	57	57	57	57	57	61	58	247	247	142	179	No	No	No	No
Cyclonic	48	115	115	115	115	115	115	124	124	240	240	147	210	No	No	No	No
Worst Case[2]	33	79	79	79	79	80	79	122	99	267	267	144	196	No	No	No	No

1 Threshold is 20 mg/l

2 The worst-case scenario assumes both the small and large TSHD working concurrently making the duration significantly shorter than the cyclonic year which only assumes the small TSHD

Table 7-3: Comparison of modelled SSC conditions across typical maintenance dredging volumes against intensity and duration threshold (for energetic dry season)

Dredge volume scenario	Dredge duration (days)	Duration over threshold[1]								Max duration threshold				Threshold exceedance?			
		Natural				Natural + dredging											
		AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2	AB1	AB2	IH1	IH2
Typical	24	57	57	57	57	57	57	60	58	247	247	142	179	No	No	No	No
Cyclonic	48	115	115	115	115	115	115	120	122	240	240	147	210	No	No	No	No
Worst Case[2]	33	79	79	79	79	86	79	135	84	267	267	144	196	No	No	No	No

1 Threshold is 20 mg/l

2 The worst-case scenario assumes both the small and large TSHD working concurrently making the duration significantly shorter than the cyclonic year which only assumes the small TSHD

7.2 Impacts to sensitive habitats

7.2.1 Seagrass

Seagrass beds are the primary sensitive receptor in and around the Port of Weipa, in areas where maintenance dredging could potentially result in changes to water quality (PSC 2019a). Seagrass communities have multiple environmental values as they provide foraging habitat and nursey habitat for marine species.

Seagrass communities and their inherent values have the potential to be impacted as a result of sediment deposition and/or decreased light levels resulting from maintenance dredging. The impacts are anticipated to be largely avoided due to the likely timing of maintenance dredging campaigns. Historically, the dredging campaigns in the Port have been undertaken throughout the winter months. The seagrass species present throughout the Gulf of Carpentaria generally have the greatest above ground biomass immediately following the summer months between March and June before dying back in winter.

As discussed in **Section 7.1**, impacts to water quality are a result in resuspension of sediment and increases in turbidity are expected to negligible, with turbidity not expected to exceed the natural variation present within the project area. Previous monitoring of seagrass communities has identified no negative impact on seagrass communities during times of inclement water quality as a result of multiple cyclones and tropical lows (McKenna & Rasheed 2019).

Changes in water quality as a result of maintenance dredging will be negligible and consequently, significant impacts to seagrass patches are not anticipated.

7.2.2 Benthic infauna

Benthic infauna has the potential to be directly impacted by disturbance within the dredge footprints and smothering at the dredged material placement site. Up to 2,500,000 m^3 of sediment will be removed under a worst-case, multiple tropical cyclones scenario, all of which is potential habitat for benthic infauna.

Smothering of benthic habitats will occur within the dredge footprint and at the Albatross Bay DMPA due to placement and deposition of sediments. Deposition analysis indicates it is only possible to distinguish between natural deposition and natural plus dredging deposition at either the dredging and/or placement locations (PSC 2019a).

Previous benthic infauna studies within the Port of Weipa have indicated that events resulting in extensive transportation of sediment (e.g. extreme weather events) can result in disruptions to abundance and diversity of benthic infauna communities (Advisian 2019; GHD 2019). The results of historical benthic fauna surveys indicate positive benthic infauna community recovery following the cyclonic events, and that the benthic fauna is resilient to dredging activities (Advisian 2019; GHD 2019). Consequently, any impacts to benthic infauna will be localised, temporary and unlikely to be significant.

7.2.3 Other sensitive environments

Coral communities known to occur within the Port area are limited to patchy areas of reef in Albatross Bay and the mouth of the Embley River. The species are predominantly hard coral that are typically found in environments of high turbidity and temperature.

Dredging activities have the potential to impact coral communities through the creation of turbidity plumes and subsequent resuspension and deposition of sediments. The dredge plume modelling undertaken as part of the SSM identified that the corals are located in areas expected to be beyond where the increased turbidity occurs as a result of maintenance dredging programs (PSC 2019a and 2019b). Impacts to coral communities are not anticipated for maintenance dredging campaigns.

Other coastal environments that have the potential to be impacted by dredging include the mangrove communities that occur throughout the sheltered areas tidal areas of the Embley River, Hey River and Mission River.

These communities are already subject to variation in sediment deposition due to the natural deposition rates throughout the Port of Weipa. Natural deposition is spatially variable, with discrete deposition occurring along the coastlines to the north and south of the Port, as well as within parts of the South Channel and the Embley River. Deposition as a result of maintenance dredging is comparison to natural deposition is comparably small, with only limited spatial extent and intensity (PSC 2019a).

Maintenance dredging of the volumes proposed in the current and future campaigns will not result in conditions that are outside of those that occur naturally in the region, limiting the potential for impacts on sensitive coastal environments, including mangroves. Sediments have been sampled and been deemed suitable for unconfined ocean disposal. Consequently, impacts from water sedimentation on mangroves and coastal environments are not expected.

7.3 Impacts to protected species

Section 5 described the potential impacts of dredging. Of these impacts, the following are considered to pose a direct or indirect impact to protected marine species:

- Interaction with the dredge
- Removal/degradation of habitat (seabed disturbance, impacts to water quality)
- Underwater noise
- Ship lighting

7.3.1 Turtles

Interactions with the dredge vessel and/or drag head are considered highly unlikely to occur. Smaller marine fauna including turtles are most at risk of vessel strike from small, fast watercraft (boats and jet skis) within shallow coastal waters, particularly in those areas that contain seagrass meadows (Commonwealth of Australia 2017). By comparison, the dredge vessel operates at very slow speeds. Standard mitigation procedures will be implemented, including turtle exclusion devices as these have proven successful in preventing turtle mortality at ports throughout Queensland. Also suction pressure will not occur unless the drag head is in contact with the seabed, further reducing risk.

Marine fauna monitoring should be implemented as part of the adaptive management strategy for the dredging works. Marine fauna monitoring requires dredging/placement to cease (or relocate) if marine

fauna are sighted within 150 m of the vessel and operations must not recommence until individuals have vacated the area or until 20 minutes after the last sighting. Marine fauna includes turtles, dugongs, whales and dolphins.

Marine turtles have the potential to be impacted by underwater noise. However, the noise generation from the dredging equipment is not likely to be at a level to that may cause injury or behavioural disturbance. The physiology of turtle hearing means that turtle species do not hear noise through air well and as such are unlikely to hear dredging activities when basking/nesting. The marine fauna monitoring described above will reduce the chance for turtles to be continuously exposed to underwater noise, as dredging will cease/relocate if fauna are sighted.

Turtles may be indirectly impacted via removal/degradation of habitat or from disturbance via artificial lighting. Direct impacts to seagrass habitat as a result of dredging will be minor, particularly as seagrass is not present in the dredge areas. Seagrass located throughout the rest of the port including adjacent to the DMPA is ephemeral and has been shown to recover after previous maintenance dredging campaigns and periods of inclement water quality. Limited and short term (up to one growing season) loss of seagrass is not likely to adversely affect turtle food availability in the region over small spatial scales relevant to maintenance dredging.

Artificial lighting can cause disorientation and disturbance to marine turtle species and interrupt breeding patterns by stopping species from coming to shore. Artificial lighting will be concentrated in the dredge areas and will come from at most two dredge vessels. Any increase in light will be negligible compared with that generated continually by the operating port.

As all six turtle species present in the region are listed as threatened and migratory under the EPBC Act, an assessment against significant impact criteria was undertaken (**Appendix C**). This concluded that impacts to marine turtles from maintenance dredging at the Port are not likely to be significant.

7.3.2 Dugongs

The Dugong is known to occur in the waters off Weipa and forage on seagrass beds in the shallow waters of the broader region. The species has historically been recorded in low numbers in the Port area, with larger populations (considered to be an important population) occurring throughout the Gulf of Carpentaria.

As with marine turtles, the risk of vessel strike is considered very low due to the slow speed of the dredge vessel. Marine fauna monitoring will include monitoring for dugongs, further reducing the risk of interaction with the dredge.

The most pertinent impact to dugongs is the potential for removal or degradation of key habitat resources including seagrass meadows. The Port area is known to support numerous areas of seagrass, typically located in sheltered, mud banks within shallow intertidal flats which occur throughout the Mission and Embley Rivers, as well as within Pine River Bay and Hey River Inner Harbour (Rio Tinto Alcan 2015).

Dugongs are known to preferentially feed on the seagrass genera *Halophila* and *Halodule* (DoEE 2019). The dominant species observed during 2019 monitoring of the Port area was *Enhalus acorooides* (McKenna and Rasheed 2019), which is not considered a preferred seagrass species in the Dugong diet.

This combined with the low numbers of dugongs observed in these areas suggests that the seagrass communities present in the Port are not important foraging resources for the species.

Direct impacts to seagrass habitat as a result of dredging will be minor, particularly as seagrass is not present in the dredge areas. Seagrass located throughout the rest of the port including adjacent to the DMPA is ephemeral and is not comprised of preferred foraging species for Dugong. The seagrass present in the Port of Weipa has been shown to recover after previous maintenance dredging campaigns and periods of inclement water quality. Limited and short term (up to one growing season) loss of seagrass is not likely to adversely affect Dugong food availability in the region over small spatial scales relevant to maintenance dredging.

Increased risk of auditory injury and/or behavioural disturbance associated with underwater noise to dugongs is considered to be low due to the limited number of species likely to utilise the Project area and the transient nature of their potential occurrences. Marine fauna monitoring will further reduce the risk for dugongs to be continuously exposed to high levels of noise.

As dugongs are listed as migratory under the EPBC Act, an assessment against significant impact criteria was undertaken (**Appendix C**). This concluded that impacts to Dugong from maintenance dredging at the Port are not likely to be significant.

7.3.3 Whale and dolphins

There are no species of whale known to regularly occur in the waters of the Weipa region and consequently, direct or indirect impacts to whales from dredging are highly unlikely. A number of dolphin species have been recorded in the Weipa region with the most commonly recorded species being the Australian snubfin dolphin, Indo-Pacific humpback dolphin and the Indo-Pacific bottlenose dolphin.

As with other marine fauna, the risk of vessel strike is considered very low due to the slow speed of the dredge vessel. Marine fauna monitoring will include monitoring for dolphins, further reducing the risk of interaction with the dredge.

Dolphins may also be indirectly impacted via habitat removal/disturbance and/or from underwater noise. Inshore dolphin species are known to utilise a variety of inshore coastal habitats for foraging including estuarine systems and shallow reefs. Dredging activities will not removal any inshore coastal habitats used by dolphin species. The Port of Weipa area does not contain any important feeding, aggregation or breeding areas for migratory dolphin species.

Increased risk of auditory injury and/or behavioural disturbance associated with underwater noise to migratory dolphins is considered to be low due to the limited number of species likely to utilise the Project area and the transient nature of their potential occurrences. Marine fauna monitoring will further reduce the risk for dolphins to be continuously exposed to high levels of noise.

As the three most common dolphin species are listed as migratory under the EPBC Act, an assessment against significant impact criteria was undertaken (**Appendix C**). This concluded that impacts to migratory dolphins from maintenance dredging at the Port are not likely to be significant.

7.3.4 Sawfish

Three species of sawfish are known to inhabit the Embley River, with the Green Sawfish and Dwarf Sawfish also known to occur in Albatross Bay. The migratory species, the Narrow Sawfish has not been recently recorded in the Weipa region, although it is thought to be most common in the Gulf of Carpentaria.

Little is known about the lifecycle of sawfish species. However, the Dwarf Sawfish is likely to breed in more sheltered estuarine areas, the freshwater species has been known to breed in freshwater habitats and the Green Sawfish returns seasonally to inshore coastal waters to breed (DoEE 2019).

As with other marine fauna, the risk of vessel strike is considered very low due to the slow speed of the dredge vessel. The use of turtle exclusion devices will also be suitable for minimising interactions between sawfish the dredge.

Increased risk of auditory injury and/or behavioural disturbance associated with underwater noise to sawfish is considered to be low due to the morphology of the species. Generally fish morphology links their hearing organs to their swim bladder, which makes them highly sensitive to underwater noise. Sawfish are not overly sensitive to noise as they have similar hearing to rays and sharks, in that they have a skeletal structure consisting of cartilage and do not have a swim bladder (McCauley & Salgado Kent, 2008).

Sawfish use a number of habitats throughout their lifecycles and have been recorded in both shallow turbid waters as well as open coastal waters. The Port of Weipa contains minimal habitat values for the species in the form of inshore waters, and does not contain any important feeding, aggregation or breeding areas. The maintenance dredging will not result in the removal of habitat used by sawfish and is unlikely to impact the species during any important part of their life cycle (e.g. breeding) as they move to other areas to breed.

Sawfish feed on both fish species and benthic invertebrates. The dredging will result in the removal of habitat for benthic infauna and may cause disruptions/avoidance to fish species that generally use the area. However, the placement of the dredged material at the DMPA will result in the creation of new benthic infauna habitat, which sawfish species are likely to utilise in their movements throughout the Weipa region.

As the sawfish are listed as vulnerable and migratory under the EPBC Act, an assessment against significant impact criteria was undertaken (**Appendix C**). This concluded that impacts to sawfish species from maintenance dredging at the Port are not likely to be significant.

7.3.5 Other protected species

A number of other protected species are known or likely to utilise the Project area including shorebirds, sea snakes and the salt-water crocodile. A number of the species are protected under the EPBC Act as either endangered, vulnerable or migratory. Impacts to these species from maintenance dredging are not anticipated for the following reasons:

- Migratory shorebird species are predominantly terrestrial and will not have any direct interactions with the dredge vessel.

- The greatest threat to sea snake species in the Weipa region is accidental bycatch during trawling. The use of turtle exclusion devices will limit the potential for sea snakes to interaction with the dredge vessel.
- The Salt-water Crocodile primarily inhabits tidal rivers, coastal floodplains and inland waterways, none of which will not be significantly impacted by the dredging activities.
- Deposition and resuspension of sediments from dredging is not predicted to alter water quality (i.e. increase turbidity) and will be within the range of naturally highly turbid conditions present at the Port.

Any impacts to these species from maintenance dredging at the Port are not likely to be significant.

7.4 Impacts to other users

7.4.1 Fisheries

Commercial fisheries utilise a range of areas including shallow coastal areas, inshore areas and deeper offshore areas for larger species. Maintaining healthy fisheries is of importance to the Weipa region due to the significant economic contribution they have.

Key areas for commercial fisheries include inshore mangrove and seagrass habitats that provide spawning and nursey areas for prawns and target fish species. As discussed in **Section 7.2.1** and **Section 7.2.3**, impacts to seagrass and mangrove communities are not considered likely. Importantly, routine maintenance dredging has regularly been undertaken at the Port without having any significant impact on sensitive environments important to commercial fisheries.

7.4.2 Cultural heritage

The dredging campaigns will be maintenance dredging as opposed to capital, which reduces the likelihood of uncovering items of cultural significance. Previous dredging campaigns have been successfully undertaken without impacts on any cultural values that the Port of Weipa contains. All future dredging campaigns will be undertaken in consultation with the Technical Advisory and Consultative Committee, which includes local traditional owners.

8. Risk assessment

A risk assessment has been completed based upon the result of the impact analysis undertaken in **Section 7**. The risk assessment will be used to inform risk treatment and management measures during dredging operations.

The results of the risk assessment are provided in Table 8-1. The risk assessment is based on the application of mitigation measures as outlined throughout this report (refer **Section 6**).

Overall, the risk assessment conclusions are that all potential risks are rated as low, with the exception of smothering of benthic communities at the expanded dredge material placement area (moderate). Maintenance dredging is short in duration and changes to water quality are within the range of natural variability of the region. This in turn limits the likelihood of flow on impacts to species and their habitats, as well as protected areas and other users. Direct impacts to benthic communities and seagrass at the DMPA will be temporary in nature and will not affect a unique environment.

Table 8-1: Risk assessment results

Risk activity (cause)	Potential environmental receptors	Potential impact	Consequence	Likelihood	Risk rating
Smothering from dredge material placement	Benthic macroinvertebrate communities	Temporary disturbance of benthic habitat and associated communities	Minor Temporary, short term negative impact	Likely	Medium
Dredging and placement generated sediment plume	Coral reef, seagrass and mangrove habitats	Changes to water quality leading to mortality or changes in the diversity or cover of coral, seagrass or mangroves	Negligible Impact is within the natural variation and tolerance of the system.	Rare	Low
Dredging and placement generated sediment plume	Coral reef, seagrass and mangrove habitats	Sediment deposition resulting in the loss of coral, seagrass or mangroves	Negligible Impact is within the natural variation and tolerance of the system.	Rare	Low
Movement of dredge vessel from the Port to the dredge material placement area	Transitory threatened and migratory marine animals	Potential for marine fauna vessel strike	Negligible No impact at the population or sub-population level	Unlikely	Low
Release of contaminants and nutrients	Marine biota	Potential for lethal and sub-lethal effects on biota	Negligible Material is suitable for disposal at sea	Rare	Low
Dredging suction	Foraging marine turtles	Potential for marine fauna to be caught	Negligible No impact at the population or sub-population level	Unlikely	Low
Noise	Inshore dolphins, dugong and marine turtles	Potential for alienation of habitat	Negligible No impact at the population or sub-population level	Rare	Low
Lighting	Foraging inshore dolphins, dugong and marine turtles	Alienation of habitat, animal mortality	Negligible No impact at the population or sub-population level	Rare	Low

Risk activity (cause)	Potential environmental receptors	Potential impact	Consequence	Likelihood	Risk rating
Introduction of marine pests	Marine biota	Potential competition with native species and changes to the ecosystem	High Significant impact on the environment in the Port and potentially in the greater region	Possible	High
Dredge program	Marine users	Disruption of activities	Negligible Impact is confined to a small area or interest group that is not vulnerable	Possible	Low

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