Port of **Mackay**

Marine Environmental Monitoring Plan

August 2022

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1.0 Introduction

1.1 Background

North Queensland Bulk Ports Corporation (NQBP) manages the Port of Mackay, located on the central Queensland coast approximately 6km to the North-East of Mackay.

The Port is located at the Mackay Harbour, North of the mouth of the Pioneer River. The Port is situated within the Great Barrier Reef World Heritage Area but is outside of the Great Barrier Reef Marine Park.

The Port comprises four wharves located inside the Mackay Harbour and NQBP owns or manages around 800 hectares of land extending from the high-water mark westward for approximately 3km.

The Port of Mackay is a multi-commodity port with the facilities to handle petroleum, bulk molasses and sugar cane, bulk raw and refined sugar, tallow, ethanol, liquid chemicals, bulk fertilisers, iron concentrates, bulk grain, and general cargo.

Port infrastructure includes an artificial harbour enclosed by northern and southern breakwaters, and facilities for the handling of ships and cargo (Figure 1). The onshore port area contains major bulk storage. The port also provides access to the Mackay Marina.

FIGURE 1. PORT OF MACKAY

NQBP undertakes maintenance dredging and offshore placement activities within the Port of Mackay to maintain design depths within navigational areas.

The environmental values surrounding the Port of Mackay have been extensively studied (Jacobs 2016, 2Rog 2021). Aside from specific monitoring around maintenance dredging programs, NQBP also undertakes ongoing marine monitoring that provides an understanding of the long-term ambient environmental conditions around the Port of Mackay. This monitoring currently focuses on marine water quality, coral, seagrass and invasive marine species.

1.2 Purpose

This document provides details on the marine monitoring commitments relating to maintenance dredging activities at the Port of Mackay.

The marine monitoring outlined in this document is aimed at ensuring that best practice environmental management is applied to the design and execution of maintenance dredging at the Port of Mackay.

The specific aims of the Marine Environmental Monitoring Plan (MEMP) are to:

- Assess the long-term ambient health of the Port and nearby sensitive receptors and allow for the effective management of maintenance dredging activities.
- Detect any impacts from maintenance dredging, both immediately after dredging campaigns as well as over time.
- Respond to real time environmental conditions during maintenance dredging to prevent unpredicted environmental impacts from maintenance dredging, and dredging.
- Collect data that will be used to drive continual improvement.

1.3 Relationship to other documents

This monitoring plan supports the Port of Mackay Long term Maintenance Dredging Management Plan 2018-2043 (LMDMP) and provides details on the marine monitoring commitments established under that Plan. The LMDMP sets out the overall dredge management framework and process by which the results of the monitoring will be reviewed, analysed and reported.

This monitoring plan has been developed in line with the findings of the Port of Mackay Maintenance Dredging Environmental Risk Assessment (2Rog, 2021) to ensure monitoring is focused on key environmental values.

The current approved versions of these plans are maintained on NQBP's website www.nqbp.com.au.

1.4 Continuous improvement

This monitoring plan provides the mechanism for driving continuous improvement using the data gained from each of the discrete monitoring programs for each parameter. As such, the plan will be periodically reviewed to update (maintain, increase or decrease) monitoring efforts and focus, based on the new and historical findings from the monitoring data.

1.5 Plan review

This monitoring plan will be reviewed prior to and after each maintenance dredging program and updated, if required.

2.0 Environmental setting

The Port of Mackay is situated in an area that is largely surrounded by industrial and agricultural land use. The majority of land has either been cleared for existing port related infrastructure or disturbed from historical land uses (e.g. cattle grazing). Habitats of value occur in small pockets within and adjacent to the Port of Mackay (western land parcel) site including wetlands, waterways and mangroves.

The Port of Mackay is located on land that is predominately flat and low-lying. Historical development within the area for urban and agricultural use has substantially changed the natural conditions of the landscape, specifically the natural drainage patterns and tidal flows.

Port lands contain intact coastal dunes, freshwater wetlands and estuarine wetlands.

A constraints study undertaken in 2011 (GHD 2011) identifies the following topographic features within the area surrounding the Port of Mackay:

- Outcrops of Mt Bassett dolerite and Whitsunday volcanics at Mt Bassett and Radar Hill.
- Foredunes and parabolic dune systems to the north of the harbour.
- Levelled dunes that underlie the existing area of port development.
- Low-lying freshwater wetlands that are seasonally inundated and support melaleuca forests and woodlands.
- Remnants of older beach ridges west of Slade Point Road.
- Low-lying grasslands west of Slade Point Road that are seasonally inundated by brackish water.
- Low-lying estuarine areas that form the upper reaches of Bassett and Vines Creek.

These natural features provide important habitat corridors for a variety of native flora and fauna.

The marine environment adjacent to the Port and coastline also contributes to the diversity of values in the region and forms part of the much larger Great Barrier Reef World Heritage Area.

The environmental values of the Port and surrounds are summarised in the Port of Mackay LMDMP and are further described in detail in Jacobs (2016). Figure 2 provides a snap-shot overview of key environmental values of the marine environment, these include:

- Great Barrier Reef World Heritage Area and Great Barrier Reef Marine Park.
- Deepwater and coastal seagrass meadows, which are seasonally variable.
- Fringing rocky reefs dominated by sediment-tolerant hard coral species fringing Victor Island, Round Top Island, Flat Top Island, Taroba Rocks, Dudgeon Point, Keswick Island and St Bees Island.
- Intertidal mangrove and saltmarsh areas that are important as feeding habitats and fish nursery areas.
- Locally important populations of a number of threatened and migratory marine species, including marine turtles (green, flatback, leatherback and hawksbill), dugong, whales and dolphins.
- Internationally important migratory shorebird roosting sites.

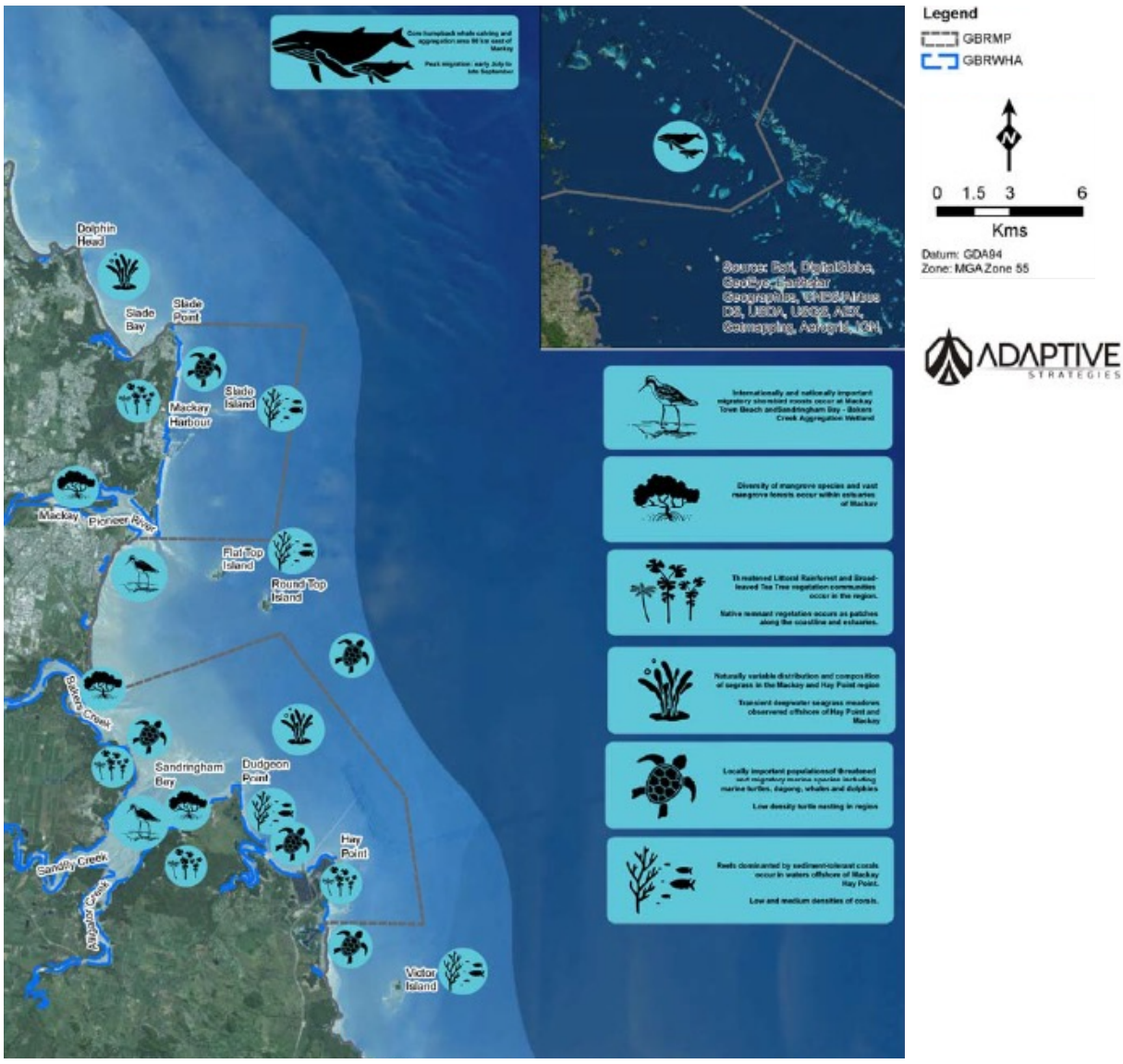

FIGURE 2: SUMMARY OF ENVIRONMENTAL VALUES AT THE PORT OF MACKAY AND SURROUNDS (SOURCE: PORT OF HAY POINT MEMP 2018, ADAPTIVE STRATEGIES)

3.0 Maintenance dredging

3.1 Sedimentation and volume

Dredging activities have occurred at the Port of Mackay since its construction in the late 1930's.

Analysis of historic bathymetric surveys and sediment transport modelling have been undertaken as part of a Sustainable Sediment Management (SSM) assessment for the Port of Mackay. These analyses have included the Port's navigational areas such as the swing basin, berth pockets, tug mooring areas and existing sedimentation trench.

The bathymetric analysis and modelling has determined that over a 10-year period the anticipated volume of sediment required to be managed is in the order of 500,000m^3 (575,000m^3 including 15% contingency). Maintenance dredging will likely be required once every three to five years with volumes in order of 120,000m^3 to 150,000m^3 per campaign.

The approach to monitoring has also been developed in consideration of the anticipated sediment volume and likely frequency of maintenance dredging required.

4.0 Monitoring framework

4.1 Framework

The monitoring detailed in this plan is an important component of the overarching Dredge Management Framework as described in the LMDMP. NQBP will oversee the implementation of the monitoring plan, with each component being undertaken by appropriately qualified marine scientists contracted for their support.

Overall, the monitoring plan is made up of a combination of regular ambient monitoring (long-term monitoring) and individual dredging event related monitoring (short-term impact and adaptive). The three-tiered approach to monitoring is outlined in Figure 3. A summary of the key monitoring parameters for each tier is provided in Table 1.

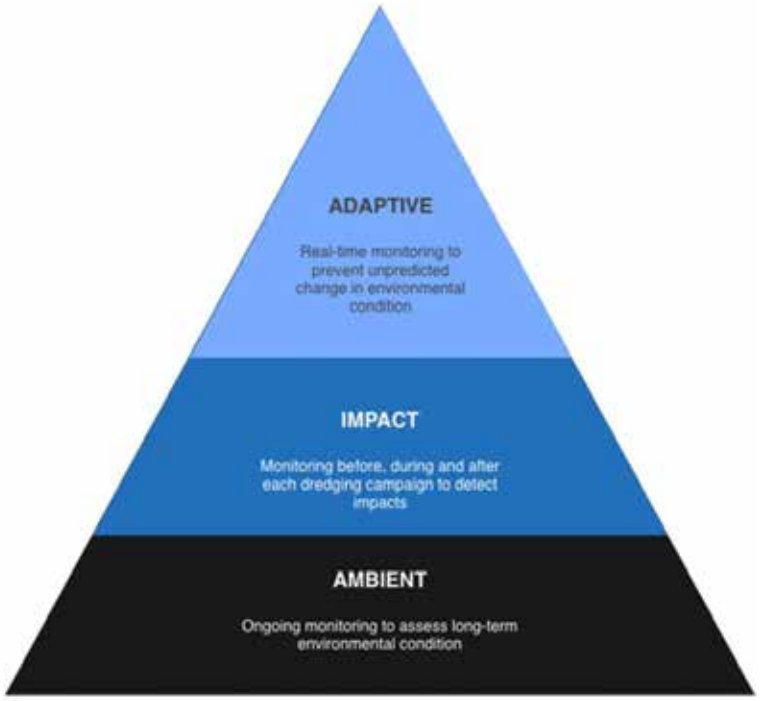

FIGURE 3. THREE-TIERED APPROACH TO MARINE ENVIRONMENTAL MONITORING

Parameter	Ambient	Impact	Adaptive
Marine water quality – data loggers	✓	✓	
Marine water quality – satellite imagery			✓
Island fringing corals	✓		
Seagrass	✓		
Sediment quality	✓		
Invasive marine pests	✓		
Marine megafauna			✓

TABLE 1. THREE-TIERED MONITORING REGIME

5.0 Ambient monitoring program

The following section describes the ambient monitoring programs that will continue to be undertaken at the Port of Mackay. The aim of this monitoring is to provide a long-term baseline environmental condition assessment of the Port and nearby sensitive receptors.

The ambient monitoring focuses on sediment quality, water quality, seagrass, coral and invasive marine pests.

5.1 Sediment characteristics and quality

Sediments within the Port of Mackay are comprised of predominantly fine grained silt and clay (Advisian, 2018). Sediment quality has been regularly assessed at the Port of Mackay to ensure suitability for at sea placement under the approach outlined in the *National Assessment Guidelines for Dredging* (NAGD, DEWHA 2009). Assessments undertaken in accordance with the NAGD 2009 generally have a currency of five (5) years.

Maintenance dredging and offshore placement has occurred at the Port of Mackay since its construction in the late 1930's with regular placement at the current offshore dredge material placement area since the 1960's. NQBP has previously commissioned testing of sediments for maintenance dredging in 2007, 2010, 2013 and 2018.

These previous assessments have shown that the sediment in the Port has been suitable for at sea placement.

The most recent 2018 survey found no concentrations of contaminants to be above screening levels and therefore the sediment has been deemed to be currently suitable for at sea placement (Advisian, 2018).

Sediment characterisation and quality assessments will continue to be undertaken in accordance with the NAGD 2009.

5.2 Marine water quality - data loggers

Extensive water quality monitoring has previously been undertaken at the Port and surrounds. In 2014, NQBP established an ambient marine water quality monitoring program in the coastal zone around the Ports of Mackay and Hay Point (located 30km south) with the aim of developing a longer-term water quality dataset to characterise marine water quality conditions within the Mackay region that will support future planned port activities (Waltham et al, 2020).

The program commenced with twelve (12) monitoring sites covering a 60km stretch of coastline from Slade Point to Freshwater Point and offshore to Keswick Island. The number of monitoring sites was reduced to seven (7) and these have been monitored since 2015. Sites in the monitoring network have been chosen to spatially align with the location of key sensitive receptor habitats (e.g. corals and seagrass), along with key features in the study region (e.g. river flow points). Today these monitoring sites remain in place and form the current ambient marine monitoring program (Figure 4 and Table 2).

Annual reports and outcomes of the program can be viewed on NQBP's website at https://nqbp.com.au/sustainability/research-and-reports.

The ambient marine water quality program consists of*:

- Benthic data loggers – situated on the seafloor at each monitoring site, data being downloaded approximately every six (6) weeks.
- In situ physiochemical analysis – hand held water quality instrument gathering instantaneous measurements at each monitoring site, approximately every six (6) weeks.
- Water samples laboratory analysis – seawater samples collected at each monitoring site, laboratory analysis for metals, nutrients, chlorophyll a, pesticides and herbicides. Undertaken twice yearly in wet and dry seasons.
- Planktonic community analysis – plankton tows undertaken at each monitoring site twice yearly in wet and dry seasons.

*See the latest annual report for detailed program design and methodology https://nqbp.com.au/sustainability/research-and-reports

FIGURE 4. AMBIENT MARINE WATER QUALITY MONITORING SITES – LOGGERS (GREEN), WITHOUT LOGGERS (BLUE), SITES DECOMMISSIONED (YELLOW)

Site name	Site code	Latitude	Longitude	Water quality	Logger
Freshwater Point	MKY_AMB1	-21.42	149.34	Yes	Yes
Hay Reef	MKY_AMB2	-21.26	149.30	Yes	Yes
Round Top Island	MKY_AMB3B	-21.17	149.26	Yes	Yes
Slade Island	MKY_AMB5	-21.09	149.24	Yes	Yes
Dudgeon Point	MKY_AMB6B	-21.24	149.25	Yes	No
Spoil Grounds	MKY_AMB8	-21.18	149.30	Yes	Yes
Victor Island	MKY_AMB10	-21.32	149.32	Yes	Yes
Mackay Harbour	MKY_AMB11	-21.11	149.22	Yes	No
Keswick Island	MKY_AMB12	-20.93	149.42	Yes	Yes

TABLE 2: AMBIENT MARINE WATER QUALITY MONITORING SITES (MACKAY – HAY POINT)

5.3 Seagrass and benthic habitat

Seagrass communities are considered sensitive receptors in the marine environment around the Port of Mackay. The communities have been historically highly ephemeral when compared year-on-year (McKenna et al. 2016). Seagrasses are also highly seasonal, with peak abundance and distribution in winter through spring. Many seagrasses in the region are only present between July and December annually.

Seagrass monitoring has occurred around the Ports of Mackay and Hay Point since 2001. The current Hay Point - Mackay Long Term Seagrass Monitoring Program was established in 2014. The annual monitoring program assesses condition of representative seagrass meadows around Hay Point, Mackay, Dudgeon Point, St Bees Island and Keswick Island (Figure 5). Seagrass meadows in these areas represent the range of different seagrass community types found in the Mackay-Hay Point region (York and Rasheed 2021). Variations in biomass, area and species composition are assessed and use to determine a seagrass condition index for each site and overall*.

Surveys are conducted annually between September and December. This is when seagrasses are at the seasonal peak in distribution and abundance and provides an understanding of the condition of seagrass communities and how this varies in the long term. This information is vital to ensure effective management of seagrass habitat and ecosystem function.

Seagrasses within the broader region are also conducted every three (3) years (Figure 5).

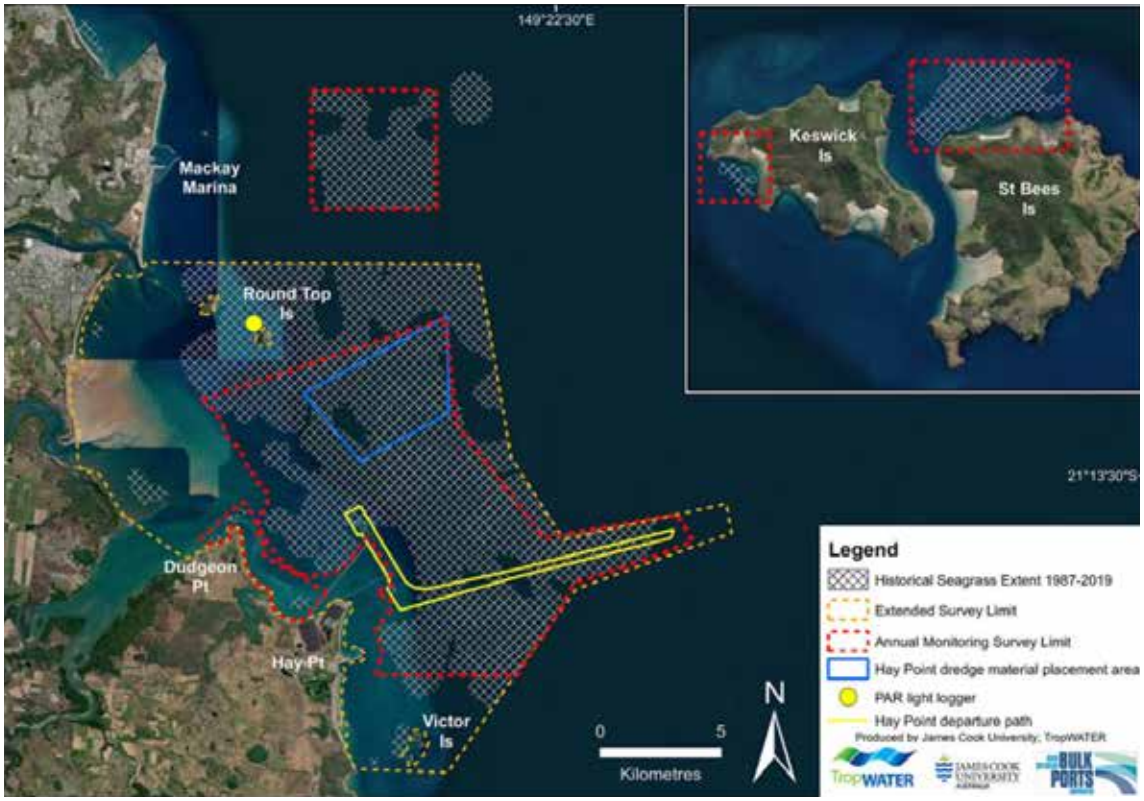

FIGURE 5. AMBIENT SEAGRASS MONITORING LOCATIONS (MACKAY – HAY POINT)

Annual reports and outcomes of the program can be viewed on NQBP's website at https://nqbp.com.au/sustainability/research-and-reports.

*See the latest annual report for detailed program design and methodology https://nqbp.com.au/sustainability/research-and-reports

5.4 Island fringing corals

Inshore island fringing coral communities are sensitive receptors in the regional marine environment around the Port of Mackay.

Coral monitoring at four offshore islands to the Port of Mackay and Hay Point was established in 2006 with surveys undertaken up until 2013. In 2015, the ambient coral monitoring program was established at all four locations being Round Top Island, Victor Islet, Slade Islet and Keswick Island (Figure 6). The purpose of the program is to gain a greater understanding of background coral conditions and the main drivers of change in these communities. This program enables greater management and mitigation capacity during periods of port related activities.

Coral monitoring occurs twice yearly around March – April (post wet season) and November (pre-wet season). Monitoring includes assessing benthic cover, coral health, sedimentation and coral recruitment*.

In the years that maintenance dredging occurs at the Port of Mackay, the outcomes of the ambient coral monitoring program will be reviewed to determine if any potential impacts (e.g. increased sedimentation, coral disease or loss) are likely to be attributed to maintenance dredging activities.

*See the latest annual report for detailed program design and methodology https://nqbp.com.au/sustainability/research-and-reports

FIGURE 6. AMBIENT CORAL MONITORING LOCATIONS (MACKAY – HAY POINT)

Annual reports and outcomes of the program can be viewed on NQBP's website at https://nqbp.com.au/sustainability/research-and-reports.

5.5 Invasive marine pests

Invasive marine pests (IMP) have the capacity to enter into ports in ballast water, internal seawater systems and on the hulls of vessels (ships and yachts). NQBP established an Invasive Marine Pest Plate Monitoring Program within the Port of Mackay in 2010 with the objective of early detection to assist in preventing establishment of any IMP's.

NQBP have deployed settlement plates at two (2) locations in the Port of Mackay (Wharf 1 and Wharf 5). Monitoring sites are shown in Figure 7. Settlement plate locations are selected on a risk-based approach, with deployment at sites of the highest risk (e.g. locations likely to experience primary infestation). Plates are retrieved and checked quarterly by Port staff. Monitoring is conducted in accordance with NQBP's Environmental Control Procedure ECP-120p: IMP Monitoring.

FIGURE 7. PORT OF MACKAY IMP PLATE MONITORING LOCATIONS

In 2019, NQBP partnered with Biosecurity Queensland (BSQ) as part of the Queensland Seaports eDNA Surveillance Program (Q-SEAS). This program involves deployment of two additional arrays at Wharf 1 and 5 twice yearly (winter/spring and summer) with arrays analysed using metabarcoding (eDNA analysis). The program also includes plankton sampling (via plankton tows) twice yearly (winter/spring and summer) and shoreline surveys.

6.0 Impact monitoring

Impact monitoring occurs in addition to the ongoing ambient marine monitoring program, and typically occurs both prior to and following maintenance dredging activities.

Impact monitoring occurs in the form of:

- marine water quality – review of logger data.

6.1 Marine water quality – data logger

Turbidity data from the ambient water quality program (loggers) will be collected and analysed post maintenance dredging. The review will include logger data collected pre, during and post maintenance dredging and analysed in comparison to daily satellite derived data, metocean and meteorological conditions and dredge vessel logs. The purpose of this analysis is to determine the level of impact, if any, from dredging and placement activities.

7.0 Adaptive monitoring

Adaptive monitoring occurs in addition to the ongoing ambient marine monitoring program.

Adaptive monitoring involves:

- marine water quality – satellite imagery, and
- marine megafauna monitoring.

7.1 Marine water quality – satellite imagery

For each maintenance dredging program, satellite derived Total Suspended Material (TSM) concentration will be used to monitor daily sea surface turbidity at the Port of Mackay and greater region (Figure 8).

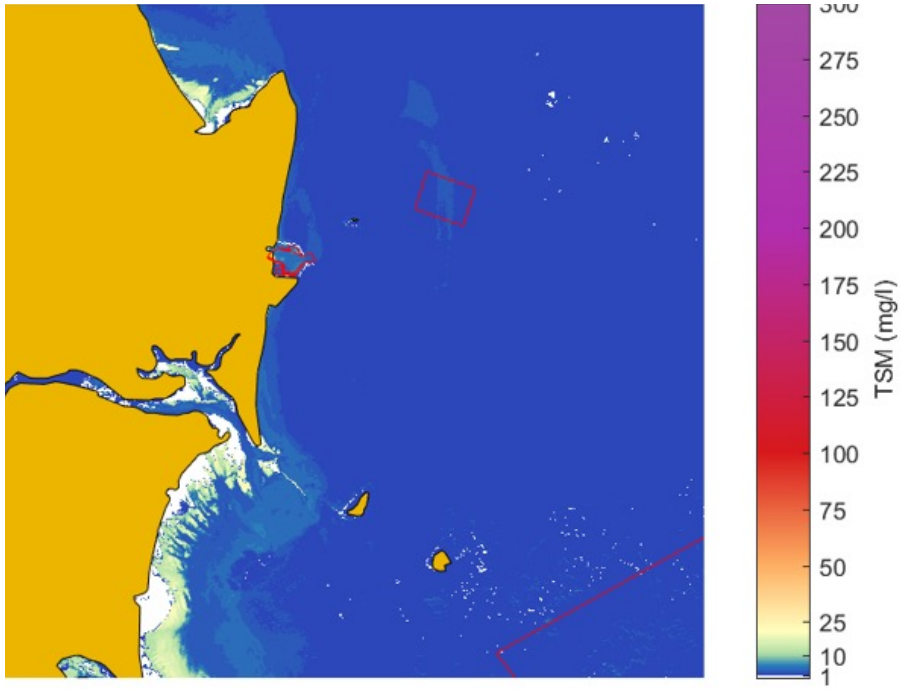

FIGURE 8. SATELLITE DERIVED TURBIDITY FROM LANDSAT-8 SENSOR
(EXAMPLE ON 23/12/2020 AT 10:05 AEST (DURING 2020 MAINTENANCE DREDGING PROGRAM)

Daily satellite image capture will commence seven (7) days prior to the planned maintenance dredging program and continue until seven (7) days following departure of the dredger.

7.1.1 Threshold concentration and management status

Island fringing corals are one of the key sensitive environmental receptors in the region. These communities can be at risk from poor water quality, both due to decreased light levels and physical smothering.

Published information on thresholds for corals are typically defined in terms of suspended solid concentrations.
The relevant published literature indicates that the types of coral which occur in the Mackay region are tolerant or partially tolerant to elevated suspended solid concentrations (SSC) (Erftemeijer et al, 2012).

The tolerances of these types of corals to continuous expose to SSC are understood to be:

- less than 20 mg/l - no impacts
- 20-40 mg/l - possible minor sublethal effects
- 40-100 mg/l - possible lethal and major /minor sublethal impacts
- more than 100 mg/l - lethal (partial mortality) and major lethal (mass mortality).

This aligns with the Great Barrier Reef Marine Park Authority water quality guidelines (2010), that propose an annual mean greater than 15 mg/l may cause stress for coral communities in the enclosed coastal areas of the Central Coast Region of the Great Barrier Reef Marine Park.

The sensitive receiving sites (trigger areas) around the Port of Mackay are shown in Figure 9.

FIGURE 9. IDENTIFIED SENSITIVE RECEPTORS (YELLOW TEXT)

A conservative threshold of 15mg/L sea surface TSM will be adopted for satellite derived adaptive water quality management at the Port of Mackay for sensitive receptors (Figure 9). This aligns with the environmental thresholds developed for a 12 day dredge program, which ranged between 15mg/L (Round Top) to 53mg/L (Slade Islet) during wet season and between 16mg/L (Round Top) and 41mg/L (Slade Islet) during dry season (Port and Coastal Solutions, 2021).

Satellite derived turbidity data is provided in mg/l sea surface TSM. Management status based on TSM concentrations are set out in Table 3 below.

Trigger area	TSM concentrations^ (mg/l)	Management status
Slade Islet	0-15	No Action
	15-20	Investigate
	20+	Respond
	25+ (3 days*)	Stop
Round Top Island	0-15	No Action
	15-20	Investigate
	20+	Respond
	25+ (3 days*)	Stop
Coastal Zone^	0-15	No Action
	15-20	Investigate
	20+	Respond
	25+ (3 days*)	Stop
Northern Extent (to Cape Hillsborough)	0-15	No Action
	15-20	Investigate
	15+ (2 days*)	Respond
	15+ (3 days*)	Stop

*Consecutive days ^ area around DMPA within 2 nautical miles from coastline

TABLE 3. TRIGGER CONCENTRATIONS FOR ADAPTIVE MANAGEMENT RESPONSE

7.1.2 Management actions

Based on the Management Status, the following response actions set out in Table 4 will apply.

Status	Management action
No Action	No response action required. Apply standard measures to dredging program
Investigate	Investigate to determine whether TSM concentrations at trigger area/s is potentially dredging and/or placement related. Examine: • Dredging and placement activities of the dredger for the preceding 24-hour period • Meteorological (rainfall) and sea state conditions (wave, wind and tides) • Determine if flow from Pioneer River is contributing to turbidity levels. • Where possible examine trigger site to ensure no natural processes or human activity (e.g. fishing) are contributing to turbidity levels • Broader regional MODIS imagery If it is determined that dredging activities have contributed to the higher than background turbidity levels, the dredging operation should be placed in a warning status.
Respond	If it is determined that dredging activities have contributed to the higher than background turbidity levels, NQBP Project team to determine management actions and inform vessel master. Consider: • Slowing the vessel during placement • Focusing placement activities to the most western part of the DMPA • Alteration of overflow regimes (limit or no overflow dredging) • Modification of placement phase with respect to tide, wind direction and velocity • Reduction of dredger load Management actions should be considered in conjunction with prevailing weather / tidal predictions and plume behaviour. More than one action may need to be applied. If dredging activities are not causing high background turbidity, dredging activities continue.
Stop	If it is determined that dredging activities have contributed to the persistent higher than background turbidity levels, placement activities should cease until: • Turbidity falls below trigger levels • Weather or tidal predictions stabilise to a point where continued raised turbidity from a dredge related plume is unlikely If dredging activities are not causing high background turbidity, dredging activities continue.

TABLE 4. MANAGEMENT ACTION RESPONSE

An analysis of daily satellite derived data along with daily metocean and meteorological conditions and dredge vessel logs will be complied following the completion of each maintenance program, to determine the level of impact, if any, from dredging and placement activities. This information will also be compared against turbidity data from ambient water quality program (loggers) collected pre, during and post maintenance dredging.

This report will inform the Marine Environmental Monitoring Program and promote continuous improvement.

7.2 Adaptive marine megafauna monitoring

Adaptive monitoring of marine megafauna during dredging campaigns will be undertaken according to the protocol provided in Table 5.

Protocol	Details
Parameters	Presence of marine megafauna in monitoring zone: • Megafauna includes whales, dolphin, dugong, turtles • Monitoring zone is within 300 m of dredging activity
Method	Observations using binoculars from bridge of dredger by crew
Timing and frequency	Throughout dredging campaign Observations to commence prior to any activities commencing and will continue until all activities cease
Sites	Wherever dredge is operating
Data analysis	Record observations in Masters' log and reported daily to the environment manager

TABLE 5: ADAPTIVE MARINE MEGAFAUNA MONITORING PROTOCOL

8.0 Data analysis and reporting

8.1 Ambient monitoring

Data analysis and reporting will be undertaken annually for ambient water quality, coral and seagrass surveys.

Data analysis will focus on reporting on each parameter investigated and will include analysis of the most recent year's data (e.g. new data) and the long-term dataset (historical trends). Individual reports will be prepared for water quality, coral and seagrass results.

Summary reports of ambient monitoring will be placed on NQBPs website.

8.2 Impact monitoring

Data analysis and reporting will be completed within three (3) months of the completion of each dredge campaign.

Data analysis will focus on comparing the before, during and after results to determine any potential impacts, if any, from dredging. Data from ambient monitoring will be used to provide regional and long-term context. Individual reports will be prepared for water quality results.

8.3 Adaptive monitoring

Data analysis for the adaptive water quality monitoring will occur for the entirety of the dredge campaign. The NQBP project team will be provided daily updates and the Technical Advisory Consultative Committee (TACC) weekly updates on dredge progress, incidents and an overview of the adaptive monitoring from the previous week.

8.4 Summary report – environment and compliance

A summary report will be completed within six (6) months of the completion of each dredge program detailing all monitoring results, permit condition compliance and dredging execution parameters (in situ volume removed, post dredge bathymetry, operational timing and shutdowns). Outcomes of this report will be discussed with the TACC members.

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