Port of **Mackay**

Long-term Maintenance Dredging Management Plan 2018 - 2043

Amended April 2022

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1.0 Introduction

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.

The Port is Queensland's fourth busiest multi-commodity port in terms of cargo throughput and is one of the major servicing centres for the central Queensland mining sector. The major functions of the Port are to facilitate the import of raw materials, fuel and general cargo, and the export of raw resources and finished products from the region. The region in which the Port is situated is one of the largest sugar producing areas in Australia and the Port hosts one of the world's largest bulk sugar terminals.

Development of the Port, together with surrounding urban development, has modified natural drainage patterns in the area. The extent of tidal inundation has been reduced in some areas, along with changes to freshwater inflow due to stormwater drainage systems. Although several habitat linkages between freshwater wetlands and adjacent estuarine areas have been altered, port lands still retain areas of relatively intact coastal dunes, freshwater wetlands and estuarine wetlands.

Left unmanaged, natural sediment fills up navigational infrastructure, impacting the depth necessary for safe loading, manoeuvring and transit of ships. A reduced ability to effectively load ships can have a substantial economic impact on the region that the Port supports.

1.1 Purpose and objectives

The purpose of this Long-term Maintenance Dredging Management Plan (LMDMP) is to document the strategy for managing natural sediment accumulation at the Port of Mackay, in a way that ensures the safe and efficient operation of the Port and the ongoing protection of local environmental values and the Outstanding Universal Value (OUV) of the Great Barrier Reef Word Heritage Area (GBRWHA).

The objectives of the LMDMP are to:

1. Provide a framework for maintenance dredging of the Port over the next 25 years.
2. Establish a robust, transparent long-term planning approach to managing port sediment.
3. Outline operational, planning, consultation and monitoring arrangements.
4. Maintain local environmental values, including the Outstanding Universal Value of the GBRWHA.
5. Apply continual improvement practices in the management of sediment and dredging actions.

1.2 Changes to the LMDMP

This plan is intended to demonstrate commitment to the long-term management of maintenance dredging and placement activities for the Port of Mackay from 2018 to 2043.

This LMDMP will be reviewed and updated every five (5) years or when one of the following occurs:

A. When permit conditions have been changed or amended or new permits issued, or

B. When monitoring results report substantially different environmental conditions or impacts than were expected.

This LMDMP will be maintained on the North Queensland Bulk Ports (NQBP) website – www.nqbp.com.au.

FIGURE 1: PORT OF MACKAY

1.3 Policy content

The plan will also ensure that dredging activities align with the principles, elements and objectives described in:

- Reef 2050 Long-term Sustainability Plan (CoA 2015)
- Environmental Code of Practice for Dredging and Dredged Material Management (Ports Australia 2016)
- GBRWHA Maintenance Dredging Strategy (SOQ 2016)
- National Assessment Guidelines for Dredging (NAGD) (CoA 2009).

Reef 2050 long term sustainability plan

The Reef 2050 Plan was first released by the Australian and Queensland Governments in March 2015 and is the overarching framework for protecting and managing the Reef until 2050. The Plan is a world-first document that outlines concrete management measures to ensure the Outstanding Universal Value of the Reef is preserved now and for generations to come.

The Plan sets clear actions, targets, objectives and outcomes to drive and guide the short, medium and long-term management of the Reef. The Plan firmly responds to the pressures facing the Reef and will address cumulative impacts and increase the Reef's resilience to longer term threats such as climate change.

In relation to ports, the Reef 2050 Plan noted that:

"As an island nation, Australia relies heavily on its maritime links. In 2012-13, ports in and adjacent to the World Heritage Area accounted for 20% of the total throughput of all Australian ports combined, with a value of $40 billion.

Ports have been operated along the Great Barrier Reef coast since well before its world heritage listing and are included within its boundaries. The footprint of port areas is small, covering less than 0.1% of the World Heritage Area. The importance of ensuring port activities are ecologically sustainable, particularly dredge projects and the placement of dredge material, is recognised by all levels of government and by the ports industry.

Ports on the Great Barrier Reef coast are major hubs for the export of Australian products including coal, minerals, sugar and other agricultural products, and liquefied natural gas. The ports of Gladstone (18 berths), Townsville (9 berths), Hay Point (7 berths) and Abbot Point (2 berths) are tiny compared to the megaports of China, Singapore, Europe and the United States which each have 75 to 250 shipping berths and will remain tiny by comparison after current expansion plans are completed.

In 2014 the Great Barrier Reef Outlook Report (GBRMPA 2014) found the direct and flow-on effects of port activities, including dredging and the placement of dredge material, generally occur in areas that are already under pressure from an accumulation of impacts. By 2019 the Outlook Report (GBRMPA 2019) had recognised that “Port management is already achieving positive outcomes following improvements in planning. While port activities have a significant localised effect, these activities pose a relatively lower threat to the health of the broader World Heritage Area compared to, for example, the broadscale impacts from land-based run-off.”

The Reef 2050 Plan included a number of port related actions that make clear the need for port authorities to understand the sedimentation characteristics of their ports, avoid and reduce impacts where possible, and establish sustainable long-term management arrangements.

A revised Reef 2050 Plan (2021-2025) (CoA 2021) was recently released as a result of the first five yearly review and notes that “planning systems for ports had been subject to major reforms that shipping was one of the strongest areas of management effectiveness.”

Ports Australia dredging code of practice

The Ports Australia *Dredging Code of Practice for Dredging and Dredged Material Management* sets out a number of environmental principles that Australian ports meet when undertaking dredging and placement of dredged material. The principles have been defined on the basis of ecologically sustainable development principles.

Queensland maintenance dredging strategy

Queensland’s *Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports* (SOQ 2016) provides a framework for sustainable, leading practice management of maintenance dredging at ports in the Great Barrier Reef World Heritage (GBRWHA). The framework builds on the current regulatory requirements to ensure the ongoing protection of the Reef’s values and the continued operating efficiency of ports within the GBRWHA.

The Strategy sets up a framework for maintenance dredging management and requires ports within the GBRWHA to develop and implement long-term maintenance dredging management plans (Figure 2).

FIGURE 2: FRAMEWORK FOR LONG-TERM MAINTENANCE DREDGING MANAGEMENT (SOQ 2016)

The development and implementation of this Plan is in line with applicable principles contained in the Maintenance Dredging Strategy, specifically:

- Developing the knowledge base, using the best science available.
- Avoiding or minimising the need for maintenance dredging.
- Application of the principles of ecologically sustainable development.
- Maintaining and enhancing environmental values, including the OUV of the Great Barrier Reef World Heritage Area.
- Going further than avoiding and mitigating impacts, to look for opportunities to deliver environmental protection, restoration or enhancement outcomes (working with nature principles).
- Application of comparative analysis to determine the most suitable solutions.
- Application of adaptive management and continuous improvement processes.
- Reporting evaluated performance and providing access to data and information from monitoring.
- Favouring transparency, consultation with key stakeholders and values-based assessment.

This LMDMP fulfils the expectations of the Queensland's *Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports*, as outlined in Figure 3. The LMDMP comprises the main planning and management tool for maintenance dredging at the Port. Supporting this Plan will be the Maintenance Dredging Environmental Management Plan (EMP) and a Monitoring Program.

The Maintenance Dredging EMP is developed in conjunction with the dredge operator; it is specific to an individual dredging program and contains the operational controls for the dredge.

The Monitoring Program is developed by NQBP and outlines the ambient, impact and adaptive monitoring overseen by the Port Authority.

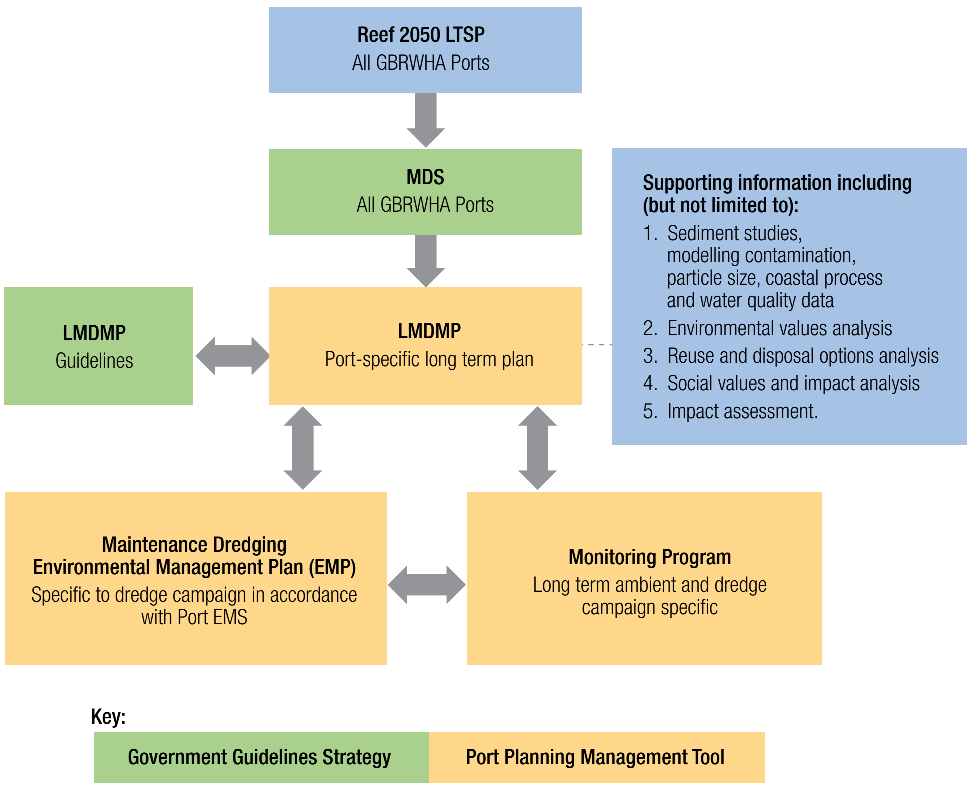

FIGURE 3: PLANNING AND IMPLEMENTATION MECHANISMS FOR MAINTENANCE DREDGING OF PORTS QUEENSLAND WIDE (SOQ 2016)

National assessment guidelines for dredging (NAGD)

The NAGD established a scientific assessment framework to determine if dredge material is suitable for ocean placement 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 (Figure 4) that is applied to ensure the impacts of dredged material loading and placement are adequately assessed.

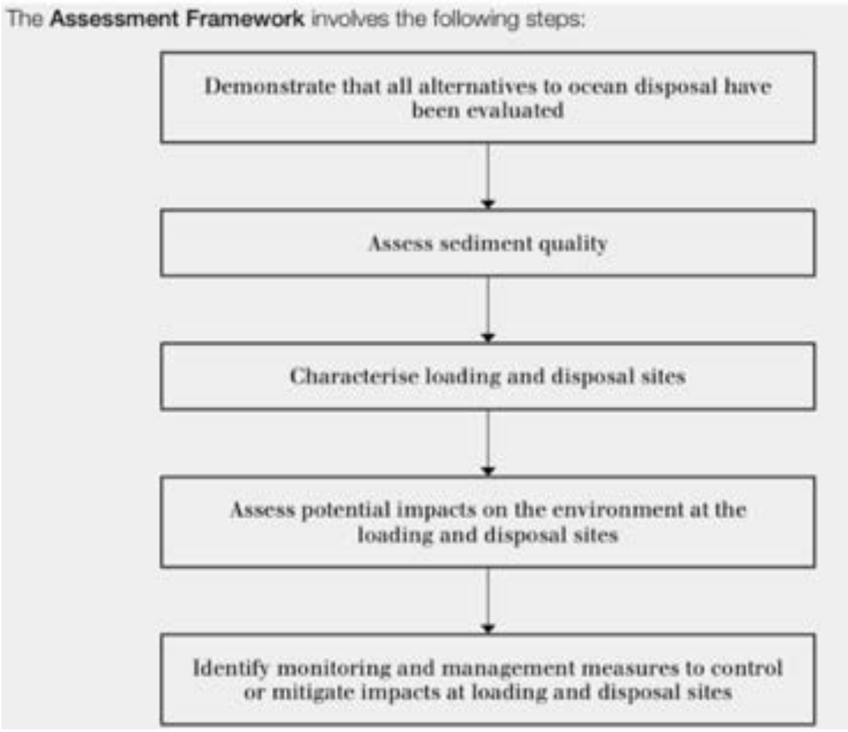

FIGURE 4: NATIONAL ASSESSMENT FRAMEWORK FOR DREDGE MATERIAL DISPOSAL (COA 2009)

1.4 Governance

Legislation and approvals

Maintenance and capital dredging programs are subject to a number of Commonwealth and Queensland Government laws and policies. This section describes the key environmental, cultural and planning legislation and policies that apply to dredging and dredge material placement projects undertaken at the Port of Mackay. Specifics on which of these particular legislation and approvals processes apply to a proposed dredging project will need to be undertaken in the initial planning stage of any proposed dredging program, taking into account the specifics of each proposed dredging program.

Commonwealth legislation and policy

A number of key pieces of Commonwealth environmental and cultural protection legislation may apply to dredging projects undertaken within Australia:

- Environment Protection (Sea Dumping) Act 1981
- Environment Protection and Biodiversity Conservation Act 1999
- Great Barrier Reef Marine Park Act 1975.

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 (DAWE), or by the Great Barrier Reef Marine Park Authority (GBRMPA) for activities inside the Great Barrier Reef Marine Park.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (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 as significant impact to MNES will not result.

Great Barrier Reef Marine Park Act 1975

The *Great Barrier Reef Marine Park Act 1975* is the primary Act relating to the Great Barrier Reef Marine Park. It establishes the Great Barrier Reef Marine Park and the Great Barrier Reef Marine Park Authority (GBRMPA), a Commonwealth authority responsible for the management of the Marine Park. The Act provides a framework for planning and management of the Marine Park, including through zoning plans, plans of management and a system of permissions.

Dredging or placement of material inside the Marine Park requires a permit issued by GBRMPA. Approval under this Act is not required as dredging and placement activities are not located within the Great Barrier Reef Marine Park.

State legislation and policy

The Queensland Government also regulates maintenance dredging under a series of State laws. The legislation that applies is determined by the location of the dredging activity and the type and scale of dredging being undertaken.

The primary legislation that may apply includes:

- Sustainable Ports Development Act 2015
- Queensland Marine Parks Act 2004
- Fisheries Act 1994
- Planning Act 2016.

Queensland Marine Parks Act 2004

The Great Barrier Reef Coast Marine Park (GBR Coast MP) is a state marine park that runs the full length of the GBR from just north of Baffle Creek (north of Bundaberg) to Cape York. It provides protection for Queensland tidal lands and tidal waters.

The *Marine Parks Act 2004* supports the creation of a comprehensive and balanced zoning system within the GBR Coast MP, providing protection of the Great Barrier Reef's unique biodiversity, while continuing to provide opportunities for the use of and access to the marine park.

Sustainable Ports Development Act 2015

The *Sustainable Ports Development Act 2015* (Qld) (SPD Act) restricts new port development in and adjoining the GBRWHA to within current port limits and outside Commonwealth and state marine parks. It also prohibits major capital dredging for the development of new or expansion of existing port facilities in the GBRWHA outside the priority ports of Gladstone, Abbot Point, Townsville and Hay Point/Mackay, and prohibits the sea-based placement of port-related capital dredge material within the GBRWHA.

Under the *Sustainable Ports Development Act 2015* a master plan for the Priority Port of Mackay/Hay Point is due for development. Such a plan will identify likely and possible growth opportunities for the Port, both in terms of trade and infrastructure. Port growth over time may alter the navigational infrastructure needs of the Port and the requirements for maintenance dredging. Any substantial alterations may require aspects of this plan to be reviewed and revised.

Fisheries Act 1994

The main purpose of the *Fisheries Act 1994* (Qld) is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats. This is undertaken in a manner that seeks to apply and balance the principles of ecological sustainable development.

Marine plants are a key component of fish habitat. Dredging activity impacts marine plants through a range of actions including the direct physical impact of the process, through the mobilisation of sediments and through smothering at dredged material placement sites. Approval is often required to ensure the goals of ecologically sustainable development are met.

Planning Act 2016

The *Planning Act 2016* (Qld) aims to establish an efficient, effective, transparent, integrated, coordinated, and accountable system of land use planning, development assessment and related matters that facilitates the achievement of ecological sustainability. Includes regulation of activities in tidal areas.

Approvals

There are a number of State and Commonwealth approvals necessary for ongoing maintenance dredging and placement at the Port of Mackay (Table 1).

Permit	Activity
Sea Dumping Permit	Maintenance dredging and placement at sea.
Environmental Authority (EA)	Undertake maintenance dredging of navigational infrastructure
Operational Works (Tidal Works)	Placement of dredged material below high-water mark

TABLE 1: DREDGING RELATED PERMITS

Notification and obligations schedule

Prior to maintenance dredging commencing NQBP will develop a 'notifications and obligations schedule' that clearly outlines relevant reporting requirements and obligations arising from all current permits.

The schedule will separately show notification requirements and condition obligations for the periods:

1. Pre-maintenance dredging commencing.
2. During active maintenance dredging and placement.
3. Post-maintenance dredging reporting and closeout.

The most current notifications and obligations schedule will be provided to the Technical Advisory Consultative Committee (TACC).

1.5 Responsibilities

NQBP is a government owned corporation that reports to two Government Shareholding Minsters (Minister for Transport and Main Roads, and the Treasurer). The Shareholding Ministers are represented by a Board of Directors who oversee the governance and direction of the organisation.

NQBP as the Port Authority for the Port of Mackay are responsible for the maintenance of all navigational areas within the Port. As such, NQBP are the holder of all permits related to maintenance dredging at the Port of Mackay.

A *Maintenance Dredging Steering Committee* oversees the day to day planning and operations of maintenance dredging at the Port of Mackay.

The committee is responsible for:

- Financial review and approval.
- Dredging contract review and approval.
- Approval of the LMDMP, monitoring program and environmental management plans.
- Review and approval of external affairs and media correspondence.

The committee is chaired and attended by key senior managers and executives of NQBP.

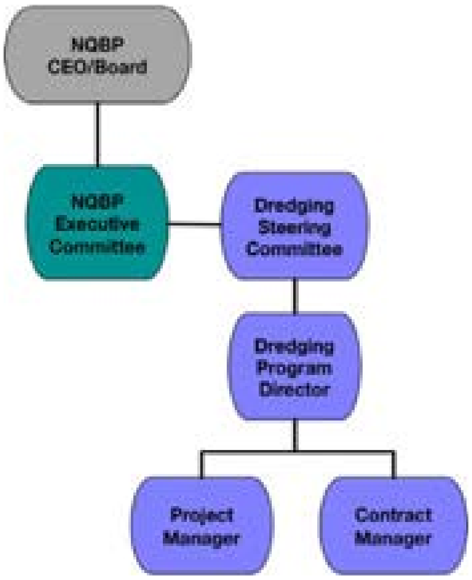

FIGURE 5: STRUCTURE OF MAINTENANCE DREDGING STEERING COMMITTEE

2.0 Port locality, setting and shipping

The Port of Mackay is located approximately 6km to the North-East of Mackay on Australia's east coast. The Port is located at the Mackay Harbour, North of the mouth of the Pioneer River. It is situated close to the neighbouring residential communities of North Mackay to the South-West, Andergrove-Beaconsfield to the North-West, and Slade Point to the North.

Infrastructure and facilities are being upgraded at the Port to support growth opportunities, in particular in the areas of break bulk trade associated with the mining and agriculture industries and Over-Size, Over-Mass (OSOM) cargoes.

To accommodate bulk carriers and large cargo vessels the navigational areas within the Port have historically been deepened to enable the safe arrival and departure of loaded vessels.

Figure 6 provides a cross-sectional representation of the various depths related to dredging and safe vessel movements.

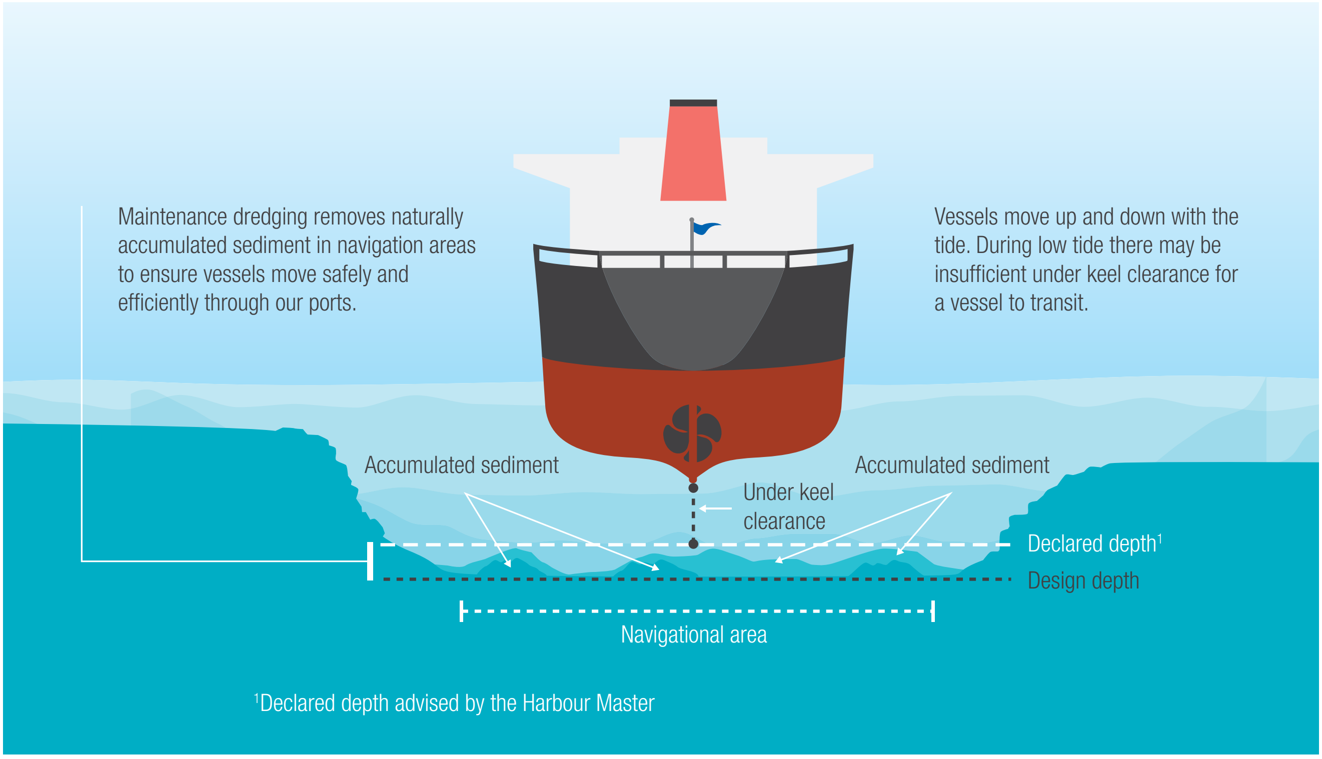

FIGURE 6: SHIPPING CHANNEL TERMS AND DEPTHS

2.1. Port navigational infrastructure

The Port of Mackay consists of four multi-user wharves available for break bulk cargo within a harbour sheltered by breakwaters (Figure 7).

There is a central swing basin and four berths with varying design depths:

- Swing Basin: area = 352,500 m^2, design depth = -8.6 m LAT
- Berth 1: area = 7,560 m^2, design depth = -10.6 m LAT
- Berth 3: area = 9,720 m^2, design depth = -13.5 m LAT
- Berth 4: area = 5,400 m^2, design depth = -10.6 m LAT
- Berth 5: area = 10,800 m^2, design depth = -12.5 m LAT.

A new permanent tug berth facility was constructed in 2021 in the northern area of the Harbour to the east of Berth 5 (referred to as Operational Area 2 or New Tug Area). Operational Area 2 has a total area of 36,800m^2 and has a design depth of – 7.0m LAT. These new tug berths may require maintenance dredging periodically to ensure a safe working depth and to reduce unnecessary propeller wash generated turbidity in the Harbour.

A siltation trench is also located adjacent to Berth 1 and Berth 3 and extends along the southern breakwater to the Harbour entrance. The siltation trench covers 29,700m^2 and has a design depth of -10.0 m LAT.

There is also a slipway within the Harbour adjacent to Wharf 3 and old Tug Berth area.

FIGURE 7: NAVIGATIONAL INFRASTRUCTURE AND DESIGN DEPTHS IN THE PORT OF MACKAY

3.0 Port environmental values

In managing sediment and dredging activities at the Port of Mackay it is essential to understand the environmental, social and cultural values of the Port and the surrounding area. The commercial activities were discussed previously in Section 3.

The focus is on values that are considered important or notable at a national, regional or local level. The aim is to provide a useful level of detail and relevance to management planning. Values are described for the broader area incorporating the port limits and adjacent environs. More detailed information regarding these values can be found in the *Port of Hay Point Environmental Values Report* (Jacobs 2016) and *Addendum Report* prepared by 2rog (2021). These reports cover the area including the Port of Mackay from Slade Point south to Victor Island.

The area from the north of the Port of Mackay to the south of the Port of Hay Point has been highly modified. The area supports agricultural, urban, industrial, port and shipping, and commercial and recreational uses. The sub-catchments in this region are some of the most modified catchments along the Queensland coast, with over 50% of catchment areas used for intensive agriculture such as sugar cane (Reef Catchments 2014).

The region also continues to support areas of international, national and state environmental significance. Historic land use practices have resulted in fragmented remnants of native vegetation throughout the landscape and along riparian corridors. 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 importantly the Outstanding Universal Value (OUV) of the GBRWHA.

What is an 'important value'?

For the purposes of this review, important environmental values are those that are:

- Matters of national environmental significance protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Matters of state environmental significance protected under Queensland environmental protection and management laws.
- Habitats or ecosystems that are considered 'important' or 'critical to the survival' of listed species or communities.
- Values that contribute significantly to the Outstanding Universal Value of the GBRWHA.

Important *social* and *cultural* values are those that are:

- Included in national or state registers.
- Identified by traditional owners or community members.
- Values that contribute to the appreciation culture and heritage in the region.
- Features that provide a connection to the landscape, history or previous or current use of the area.

3.1. OUV of the GBR World Heritage Area

The Port of Mackay is within the GBRWHA (listed as a World Heritage Area in 1981). **The GBRWHA is listed based on it meeting four World Heritage criteria for OUV:**

- Natural beauty and natural phenomena (Criterion (vii)).
- Major stages of the Earth's evolutionary history (Criterion (viii)).
- Ecological and biological processes (Criterion (ix)).
- Habitats for conservation of biodiversity (Criterion (x)).

Of the important environmental values present in the region, three are considered to contribute significantly to the OUV of the GBRWHA (Jacobs 2016, 2Rog 2021). **These are:**

1. Internationally recognised **migratory shorebird roosting sites** at Sandringham Bay and Mackay Town Beach that support 23,000 shorebirds each year during their annual migration.
2. A core **aggregation/calving area** for the east-coast population of humpback whales approximately 80 km east of Mackay.
3. A high diversity of **mangrove species** within estuarine areas.

3.2. Regional environmental features

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.

There is no good quality agricultural land (GQAL) identified within the area. The nearest GQAL lies north west of the Port (Jacobs 2016).

The key environmental values present within the region are summarised in Table 2.

Feature	Description
World Heritage	The area lies adjacent to, and within the Great Barrier Reef World Heritage Area. Of the important key environmental features present within the region, three are considered to contribute significantly to the OUV of the GBRWHA. These include internationally recognised migratory shorebird roosting sites at Sandringham Bay and Mackay Town Beach, a core aggregation/calving area for humpback whales 80 km offshore of Mackay, and a high diversity of mangrove species.
Remnant Vegetation	The Mackay region supports a wide range of remnant vegetation types in varying condition and patch size. Vegetation types mapped within the area include mangroves, dunal vegetation, vine forest, swamps and wetlands, open eucalypt forest and tussock grassland (Jacobs 2016). Of these vegetation types (or Regional Ecosystems) a number are listed as ‘endangered’ or ‘of concern’ under the Queensland *Vegetation Management Act 1999* (Jacobs 2016, 2Rog 2021). Approximately 2,547 ha of ‘endangered’ REs are present and 5,571 ha of ‘of concern’ REs are present (2Rog, 2021). These vegetation types occur as scattered patches along the coastline and estuaries.

Feature	Description
Threatened Ecosystems	Two threatened ecological communities occur within the area of influence, the critically endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia and Broad Leaf Tea-tree Woodlands in High Rainfall Coastal North Queensland occurs adjacent to the Port of Mackay coastline. This area of rainforest vegetation forms a larger patch of the RE 8.2.2 that is listed as Of Concern (VM Act).
Threatened Terrestrial Fauna and Flora	The Mackay area is a known stronghold for the vulnerable water mouse. Potentially suitable habitat for the species has been observed within the wetland areas within the Port. A number of migratory terrestrial, marine and wetland birds are known to occur, or have the potential to occur within the Port of Mackay. Significant impacts from the proposed onshore placement of dredged material to populations of terrestrial birds common in the region or migratory birds known or with the potential to occur in the area are unlikely to occur as the site is not known to support an important habitat or an ecologically significant proportion of any of the migratory species identified. For the same reasons, significant impact on the only other migratory fauna species known to occur within the area, the saltwater crocodile (*Crocodylus porosus*) is also unlikely.
Shorebirds	Internationally recognised migratory shorebird roosting sites occur at Sandringham Bay and Mackay Town Beach, supporting approx. 23,000 shorebirds each year during their annual migration.
Mangroves	The Pioneer River and Sandringham Bay – Bakers Creek Aggregation support extensive mangrove communities. These areas contain a diversity of mangrove species that is found throughout the Mackay region. The area suffered significant mangrove dieback in 2002, particularly of the Grey Mangrove due to pesticide use on cane farms within catchment areas.
Rivers	The Pioneer River, which runs through the city of Mackay, and Bassett Basin lie south of the Port of Mackay. Basset Basin is an estuary of the Pioneer River and provides important fish nurseries. It was declared a Fish Habitat Area in 1993 and is assigned management category B (i.e. where existing or planned use requires a more flexible management approach). Prior to this it was a wetland reserve and managed to enhance existing and future fishing activities. Mangroves and related tree communities make up 4.2 km^2 of the 6.6 km^2 Fish Habitat Area. The Pioneer River catchment is one of the most modified catchments of the Great Barrier Reef coast, with over 50% of the catchment used for intensive agriculture production (Reef Catchments 2013). Water quality in the area is frequently identified as poor due to the high levels of nutrients and pesticides resulting from the surrounding land uses.
Soils	Soils within port lands are comprised of Quaternary alluvium, lacustrine deposits (sand, silt, mud and gravel) and Cretaceous deposits (GHD 2011; Jacobs 2016). The Quaternary deposits are found within low-lying areas. These areas, at or below 5m AHD (where the natural ground level is below 20 m AHD) may contain Acid Sulfate Soils (ASS). A detailed Acid Sulphate Soil Assessment would be required for the proposed placement site to confirm whether ASS is present.
Islands	A small number of islands lie offshore of the Mackay region. The nearest islands to the Port of Mackay include Slade Islet, Round Top Island and Flat Top Island. Keswick and St Bees Island occur further offshore to the North-East of the Port.
Seagrass	Seagrass in the region is naturally variable in distribution and species composition due to a number of seasonal factors. Deepwater seagrasses are particularly transient, and usually only occur between July and December. Two deepwater seagrass beds and one coastal seagrass bed (north-western shore of Round Top Island) have previously been observed in the waters offshore of the Port of Mackay. Deepwater seagrass meadows have also been recorded offshore of Hay Point. These meadows are particularly variable, and often occur as small patches during December and May. Surveys have also found three small patches of inshore seagrass adjacent to Dudgeon Point.
Coral	There are a number of reefs dominated by sediment-tolerant hard coral species within the waters offshore of Mackay. Victor Islet, Round Top Island, Flat Top Island, Taroba Rocks, Dudgeon Point, Keswick Island and St Bees Island all support areas of coral. These areas have been shown to support low to medium densities of corals.
Benthic Habitats	The region supports macroalgae and benthic invertebrate communities of varying densities which also vary over time. Macroalgae species observed within the area include *Sargassum* sp., *Udotea* sp. and *Caulerpa* sp. (Rasheed et al 2004; Thomas et al 2010). Low density (<1 – 5%) macroalgae communities are present surrounding both the Port of Mackay and the Port of Hay Point. High macroalgae cover (>20%) occurs on the rocky reef areas surrounding islands within the area including Flat Top and Round Top islands, Slade Islet and Slade Point (Rasheed et. al. 2001). The seafloor offshore of the two ports supports large areas of medium density algae (5-20%), with patches of low and high density occurring in inshore and offshore areas. Most of the seafloor in the area is comprised of open sandy areas with sparse cover of invertebrates such as bivalves, ascidians, bryozoans, echinoids and corals.

Feature	Description
Sediments	Marine sediments along the coastal strip of the area can be described as silts and silty sands. Further offshore sediments have been found to be dominated by medium and coarse sand, with small amounts of gravel and finer fractions of silts and clays. Analysis of sediment from the Port of Mackay have found that contaminant substances have regularly tested below the thresholds listed in the National Assessment Guidelines for Dredging (NAGD, DEWHA 2009).
Threatened Marine Fauna	The area supports locally important populations of a number of threatened and migratory marine species. Marine species known to occur in the area include: marine turtles (green, flatback, leatherback and hawksbill), dugongs, whales and dolphins. Low-density marine turtle nesting has been identified on beaches in the region. There is also an important aggregation area for humpback whales 80 km off the coast of the Port of Mackay. It is thought that whales aggregate for calving and resting in these waters.

TABLE 2: REGIONAL ENVIRONMENTAL FEATURES

3.3. Marine values

The key marine values present in the vicinity of the Port of Mackay are summarised in Table 3 and shown in Figure 8.

Marine	
Rocky and coral reefs	• Round Top Island, Flat Top Island, Slade Islet, Victor Islet, Dudgeon and Hay Reefs are known to support small rocky fringing reefs. Reefs in these areas are comprised of hard coral species common to turbid marine environments in the Great Barrier Reef (genera Montipora, Acropora, Pocillopora and Turbinaria) and a diverse range of soft corals, sponges, sea fans, ascidians and hydroids similar to fringing reefs in areas experiencing large tidal variations (Ayling et al 1998). • These rocky and coral reef habitat areas are locally important to fish and other marine species. They are not considered to be regionally significant areas of coral or rocky reef habitat.
Seagrass	• Seagrass beds within the assessment area are likely to be ephemeral (Rasheed et al 2001; Rasheed et al 2004). Historically, seagrass has been found within survey areas in low and medium densities. The most recent seagrass surveys located offshore *Halophila decipiens* beds within and adjacent to the existing dredge material placement area (McKenna et al 2016). • Seagrass beds have also historically occurred in inshore areas at Dudgeon Point, Flat Top and Round Top islands.
Macroalgae	• Cumulative algae cover in areas within and surrounding the existing dredge material placement area indicate the region supports large areas of medium density algae (5-20%), with patches of low (<1-5%) and high density (>20%) occurring in inshore and offshore waters. Algae species observed in the area have been found to generally include *Sargassum*, *Udotea* and *Caulerpa* (Rasheed et al 2004; Thomas et al 2010).
Benthic invertebrate communities	• Surveys of benthic invertebrate communities within the existing spoil ground indicated the area was predominately comprised of low density communities (1-10%) with a small patch of moderate density (>10%) communities (Thomas & Rasheed 2001). These regions had a mostly open seafloor (with small areas of rubble patches) with a moderate density of encrusting bryozoans and polychaete worms (Thomas & Rasheed 2001).
Threatened and migratory marine fauna	• There are no known important populations of threatened or migratory marine animals within the offshore assessment area. The assessment area does however support marine species foraging or resting in the area these include: - flatback, green, loggerhead, leatherback, olive ridley and hawksbill turtles forage in the algal, seagrass and rocky reef areas - dugong forage in the inshore and offshore seagrass areas - humpback whales use the nearby offshore waters for resting during their migration along the east coast - saltwater crocodile transit through the area (NQBP 2010; 2011, 2018). • There is also potential for the scalloped hammerhead shark, indo-pacific humpback dolphin, the Australian snubfin dolphin, and inshore and offshore forms of the bottlenose dolphin to occur within the offshore areas (NQBP 2011). • The intertidal wetlands of Sandringham Bay- Bakers Creek Aggregation provide seasonally important feeding habitats for waders and other migratory shorebirds, particularly between August and April (Harding & Milton 2003).

Marine	
Marine water and sediment quality	• Water quality in the offshore waters of the Port of Mackay is influenced by wind driven currents and large ranging tidal currents, causing naturally turbid waters as a result of constantly resuspended sediments. Water quality analysis in areas surrounding the existing port infrastructure indicate that offshore areas have a lower percentage of total nitrogen than inshore sites. The offshore areas also have higher salinities, DO (% saturation) and pH than inshore sites (Worley Parsons MDMP 2013). • Sediments within the existing dredge material placement area are dominated by medium and coarse sand (>85.5%) and gravel (6.4%), the finer fractions <63 µm (silt and clay) represent <4% of the sediments (Worley Parsons – Marine 2012). Sediments within the potential outer placement area are comprised of mostly sand (80.6%) with small fractions of silts (10.5%) and clays (8.6%) (Worley Parsons 2013).

TABLE 3: MARINE VALUES

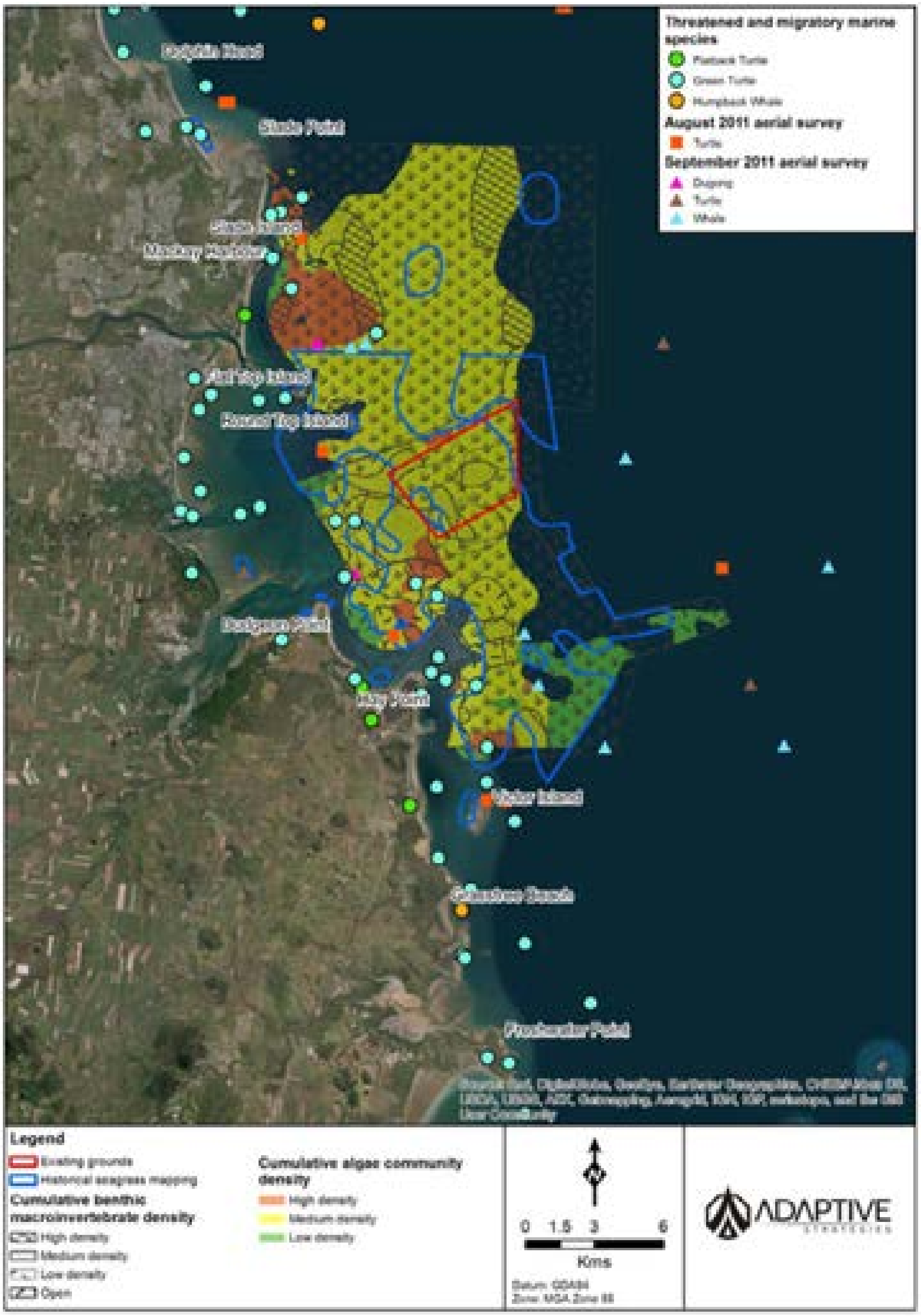

FIGURE 8: MARINE VALUES IN VICINITY OF PORT OF MACKAY

3.4. Social values

As well as facilities for port and shipping activities within the Port of Mackay area, there are also several recreational areas including a kiosk, park facilities and memorials, a small boat harbour facility, bathing reserve, tourist jetties and a boat ramp. Multi-storey residential apartment complexes have been constructed adjacent to the boat harbour.

Strategic Port Land (SPL) at the Port of Mackay falls within the Mackay Regional Council Local Government area, however it is outside its jurisdiction in terms of planning and development and general management control.

Development adjoining SPL at the Port of Mackay is a mix of residential, commercial and industrial uses, together with areas of vacant Crown land, and land used for community purposes. Where possible, NQBP has sought to designate lower impact land uses at the interface with areas outside of the port area (NQBP 2009).

Areas of high environmental value are located in close proximity to the Port of Mackay (NQBP 2009):

- The Great Barrier Reef World Heritage Property located seaward of low water mark.
- The Slade Point Reserve for natural resource management that adjoins the northern boundary of the Port.
- The Bassett Basin Fish Habitat Area located south of the Port.

There are several conservation areas including portions of the Melaleuca wetland areas in the northern and western port lands with walking tracks and camping; fires and vehicles are not permitted. The northern area of the Port is little used, but local joggers regularly run along the dune tracks in the northern area, commencing at the harbour end of Harbour Beach.

The southern area includes a number of general industrial leasehold areas (e.g. marine engineering and construction services) and a 'tank farm' for the storage of bulk liquid fuel. Several roads and railroads dissect this area. Mt Bassett is located in the western corner of the southern area and has a small conservation area located at the base of its western slope. The Mackay Surf Life Saving Club (MSLSC) is located at Harbour Beach parallel to the boundary of the southern area. The mangrove community located behind the MSLSC is a regular fishing spot and is easily accessed by walking and vehicle tracks along the sand dunes.

Near the Port of Mackay are the residential areas of Slade Point, Andergrove and North Mackay. There are businesses located on Harbour Road and Slade Point Road, which provide access to the Port of Mackay.

Wetland Protection Areas (wetlands of high ecological significance, MSES) and Wetland Management Areas (wetlands of general ecological significance, MLES) are mapped as occurring within the area.

The inshore areas and sandy coastal beaches adjacent to the Port of Mackay provide habitat for locally important populations of threatened marine and migratory bird species and recreational and leisure opportunities for local residents.

Community needs and interests

The Mackay region experienced significant growth in population during the mining boom, and the region experienced pressures in relation to the provision of affordable housing and other infrastructure and service provision. The Mackay Regional Council notes that the region's population is estimated to grow to 180,000 by 2036 from the current 120,000. Plans are that 'the focus of that population will be in urban areas, particularly in Mackay, and also Sarina, Marian, Mirani and Walkerston'.

The region's urban growth has been fragmented, making infrastructure more expensive to deliver and requiring high levels of community subsidy. The development of this situation was due to the pressures of an unprecedented boom in mining and mining services. As well as noting the importance of minimising rate rises and containing the cost of funding new infrastructure, the Council notes that a much greater choice of housing needs are required, as well as residential development that is well linked to and serviced by infrastructure and community facilities.

Employment and industry

Mining and tourism continue to be of key economic benefit to the Mackay region. **Data from the 2016 Census (ABS, 2016) indicate that:**

- Tourism supports an estimated 2,960 jobs, which is 6.2% of total employment.
- 10.6% of Mackay Local Government Area (LGA) population are employed in the coal mining industry.

Unemployment in the Mackay region is at 8.6% which is higher than the State average of 7.6%, while the median household income is below that of the State average at $1232 compared to $1402 (ABS 2016).

Population characteristics

The Port of Mackay is within the LGA of Mackay. Table 4 shows key population characteristics for the Mackay Harbour area in comparison to local and state data.

Indicator	Mackay Harbour (gazetted locality)	Mackay Regional Council LGA	Queensland
Total area (km^2)	16.5	7,601.2	1,729,958.1
Population	555	114,969	4,703,193
Population density (person/km^2)	33.6	15.1	2.7
Indigenous population (% of population)	1.6	5.1	4
Predominant country of birth (Top 3)	Aust (64%) England (4.3%) NZ (3.7%)	Aust (79.7%) NZ (2.5%) England (1.9%)	Aust (71.1%) NZ (4.3%) England (3.8%)
Gender ratio (female:male)	0.9:1	1:1	1:1
Median age	49	37	37
Predominant age group	50-54 years	45-49 years 50-54 years	30-34 years 40-44 years 45-49 years
Unemployment (%)	8.4	8.6	7.6

TABLE 4: POPULATION PROFILE (2ROG 2021)

Indicator	Mackay Harbour (gazetted locality)	Mackay Regional Council LGA	Queensland
Industries of employment (Top 3)	Coal mining (14%) Hospitals (except psychiatric hospitals) (6.8%) Real estate services (5.5%)	Coal mining (10.6%) Hospitals (except psychiatric hospitals) (3.7%) Primary education (3%)	Hospitals (except psychiatric hospitals) (4.3%) Primary education (2.5%) Supermarket and grocery stores (2.4%)
Median household income ($/weekly)	2098	1232	1402
Average household size (people)	2	2.5	2.6
Family characteristics			
Total families	137	30,330	1,221,148
Couples without children	95	12,200	481,451
Couples with children	29	13,150	518,494
One parent families	18	4,573	201,308
Other families	0	388	19,838

Prior to European settlement, the general area of the Port consisted of a complex mosaic of coastal dune vegetation, freshwater wetlands, estuarine plant communities with patches of rainforest and woodland around rocky outcrops. Port development to date has mainly occurred on areas of coastal dunes. Hard rock resources have been extracted from a quarry at Mt Bassett and used mainly for the construction of breakwaters at the Harbour.

The dune, wetland and emergent bedrock system on the coastal plain between Slade Point and the Pioneer River is not repeated anywhere else in the Proserpine-Sarina Lowlands sub-region. Collectively, this section of coastal plain is an area of high biodiversity, possessing a package of ecological values associated with vegetation communities, wildlife habitat, biodiversity and landforms. (NQBP Land Use Plan 2009, p. 11)

As early as 1884 the European settlers assessed the existing Pioneer River port as inefficient, because it had problems coping with large ships. The growth of the town of Mackay and its surrounding areas also required the development of a new and improved port. Initial work on ideas for a new port for Mackay was underway 1887, but the building of the Port took decades. The Australian Government issued Mackay with a loan for a million pounds, including a grant for a quarter of a million pounds in 1933 once a site had been proposed. Work began in 1935 and took just under four years to complete. The Mackay Port was opened on 26 August 1939.

In 1952 the construction of a major new terminal was approved in order to capitalise on the region's sugar industry. The terminal was designed to handle bulk sugar, and, when it opened in 1957, it became the largest shed for storing sugar anywhere in the world (https://nqbp.com.au/our-ports/mackay)

Traditional owners

The Yuwibara People are the traditional owners and native title holders of the land and sea country of an area that includes the Port of Mackay. They must be consulted with regard to the Indigenous cultural heritage of the area and any assessment of its significance.

Native Title has been extinguished over freehold land within the Port. However, areas of reserve tenure are also held by NQBP and Native Title may exist over these areas.

Cultural heritage at the Port of Mackay

The Port of Mackay's Land Use Plan notes that cultural heritage surveys have been undertaken at the Port. As part of the land use planning process, the Port was in contact with various Traditional Owner groups, Native Title claimants and the Central Queensland Land Council. Fieldwork was undertaken in association with representatives from each of the various Native Title claimant groups. **The assessment of cultural heritage values found that:**

- Lands at the Port of Mackay have a range of traditional resources present (e.g. bush medicines). Port lands were used by Traditional Owners (including some who participated in the study) for the purposes of hunting and collecting to procure such resources. The area is therefore of cultural significance to the Traditional Owners.
- No Aboriginal cultural heritage material, that would be considered to be 'items of the Queensland Estate' under the *Cultural Record Act 1987*, was positively identified during the course of the field surveys.
- The site of a homestead, reported to be Slade Point Station homestead, was identified in the northern part of the study area during the field surveys. No substantial remains of the homestead or associated structures were identified. The homestead site does not currently meet any of the criteria for entry onto the Queensland Heritage Register.

Earlier cultural heritage studies of the port area have concluded that, considering the level of industrial disturbance and development in the study areas, there is a higher possibility of locating cultural heritage resources in the northern area and a lower possibility in the southern area. There is a high likelihood that archaeological remains located in the study area would be disturbed, damaged or degraded given human and animal impacts, industrial development, tidal and/or episodic flooding and the eroding effects of coastal weather conditions.

Shell middens are likely to be the dominant archaeological site located in the study area. These are most likely to be located in the dunal zone in the northern area, and possibly in dunal and mangrove areas in the southern area. Shell middens located in the dunal zones, particularly the exposed foredune areas, may be highly degraded and eroded.

Stone artefact scatters are likely to be the second most common archaeological site located, and are most likely to comprise of single isolated artefacts or low multiples of artefacts.

There is an ongoing cultural significance of the area to the contemporary local Aboriginal community. Despite lack of physical evidence, an area can remain and continue to be of cultural and economic significance to the local Aboriginal community (Bird 1996). The local Aboriginal community has made it clear that the Port of Mackay area is an important cultural landscape regardless of the presence or absence of physical archaeological remains.

NQBP has a Cultural Heritage Management Plan in place with the Yuwibara people and any future activities would need to be undertaken in accordance with this plan. Further surveys are planned.

Other cultural heritage

The Great Barrier Reef World and National Heritage Property is located seaward of low water mark.

The National Heritage List, the Commonwealth Heritage List, the Queensland Heritage Register and the Mackay Regional Council Local Heritage Register do not include any other listings for any non-Indigenous cultural heritage sites within the Port of Mackay area.

4.0 Consultation

4.1. Technical advisory and consultative committee

A Technical Advisory and Consultative Committee (TACC) is necessary to assist in the consultation process required for a Sea Dumping Permit application. The NAGD (CoA 2009) states that "the TACC is intended to assist ports and other proponents and Determining Authority to access local knowledge and reconcile various stakeholder interests".

The TACC is intended to:

- Provide continuity of direction and effort in protecting the local environment.
- Support communication between stakeholders.
- Assist in the establishment of longer term management arrangements, including reviewing the development and implementation of management plans and monitoring programs.
- Review dredging and dumping activities in accordance with forecast plans and programs.

NQBP has an established TACC for the Port of Mackay which includes representatives from Commonwealth, Queensland and local governments, port users and community interest groups as detailed in Table 5.

Organisation	Member category
North Queensland Bulk Ports	Port Authority
Department of Agriculture, Water and the Environment	Commonwealth Government
Department of Environment and Science	Queensland Government
Department of Agriculture and Fisheries (including Biosecurity Queensland)	Queensland Government
Department of Transport and Main Roads	Queensland Government
Maritime Safety Queensland	Queensland Government
Mackay Regional Council	Local Government
Yuwi Aboriginal Corporation	Traditional Owners
Reef Catchments Limited	Natural Resource Management Group
James Cook University	Technical
Queensland Seafood Industry Association	Industry
Tug Services Provider	Industry
Whitsunday Charter Boat Industry Association	Industry
Mackay Tourism Limited	Industry
Conservation Volunteers Australia	Environment / conservation
Australian Marine Conservation Society	Environment / conservation
Mackay Conservation Group	Environment / conservation
Mackay Recreational Fishers Alliance Inc.	Community
Port of Mackay Community Reference Group	Community

TABLE 5: TACC MEMBERSHIP

5.0 Sediment assessment

5.1. Port sediment characteristics

Port navigational areas, including shipping channels, aprons, swing basin and berth pockets, are areas that have been deepened to allow the safe navigation, movement, loading and transit of ships trading at the Port. In these deeper areas of the Port, currents, wave energy and tidal regimes are responsible for mobilising and transporting sediments. This can be different to what is occurring in the adjacent natural seabed areas. The different depths and water movement can cause significant changes in the patterns of sediment scouring and accumulation.

There are four operational berths and associated loading/unloading facilities, ranging between -10.6 and -13.5m lowest astronomical tide (LAT). Some shipping movements entering the Harbour are tidally dependant. The Harbour has an interior turning basin of 500m in diameter with a bed level of -8.6m LAT. The entrance width through the breakwaters is 183m.

Accretion of seabed sediments results in 'high spots' or 'high areas' within the navigational areas, above which safe navigational depths are enforced by the Regional Harbour Master. The result is often reduced 'declared' depths, the effects of which may significantly alter the efficiency of the Port.

Nature of the sediment

Based on laboratory analysis the nature of the sediment accumulating in the navigational infrastructure at the Port of Mackay was found to be fine clay/silt material (Advisian, 2018a). Figure 9 shows the particle size distribution for sediment tested in late 2018.

It was noted that the operational area two and parts of swing basin and channel that are closer to the entrance of the Harbour have a slightly higher sand content, most likely a result of sand settling out of the incoming tidal current upon reaching the calmer waters of the H arbour. Finer silts remaining suspended longer and deposit throughout the harbour, particularly in the deep berth areas where they are less affected by tidal currents and wave action.

Given the mixed nature of the sediment and dominance by fine material, it is considered that it would be unrealistic to separate sediment types during maintenance dredging. The type and mixture of the sediments is an important consideration when examining the ability to avoid, reduce, reuse or dispose of sediment.

Laboratory testing has consistently shown that the sediment is suitable for ocean placement with very low levels of contamination and bioavailability as per the NAGD (CoA 2009).

Laboratory analysis in late 2018 (Advisian 2018b) confirmed these previous findings with:

- Concentrations and/or 95% UCL of the mean of all chemical contaminants are below the respective NAGD screening criteria.
- The sediments in the DMPA are physically and chemically similar to the sediments in the reference area therefore support the continued placement of material at the DMPA.

LABORATORY TESTING OF SEDIMENT

As per the NAGD assessment framework, it is considered that the sediments in the Port of Mackay harbour entrance, swing basin, berth pockets and tug berths are suitable for unconfined ocean placement in the DMPA. In accordance with Section 4.2.1 of the NAGD, the typical validity period for Phase II and Phase III results is five (5) years. This means that, depending on other activities at the Port, the results from this assessment may be valid until 24 September 2023. Post this date new testing will be required.

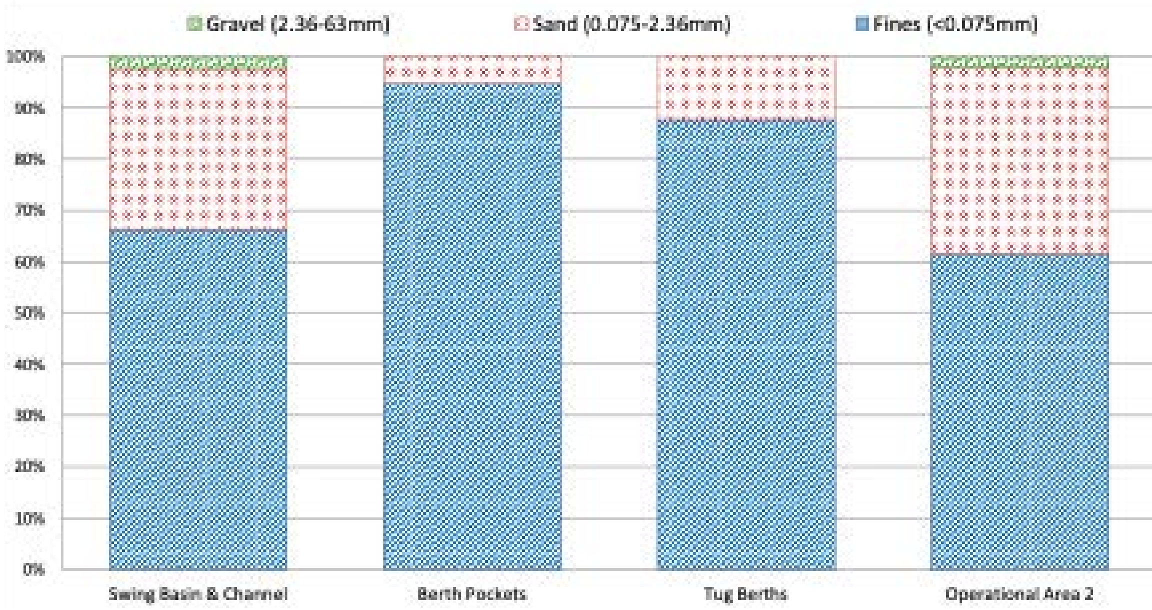

FIGURE 9: PARTICLE SIZE DISTRIBUTION BY AREA

Sediment budget

An in-depth examination of the sediment transport and dynamics in the central Great Barrier Reef (Gibbs *et al.*, 2016) identified and clarified the major sediment types and distributions in the region. This study has enabled the development of an integrated conceptual model of the sediment transport mechanisms and provides estimates of sediment transport rates and fluxes.

This work has shown that the dominant source of sediments accumulating in the navigational areas at the Port of Mackay are large stores of available sediments on the inner continental shelf which are transported through coastal processes. Cyclones are also known to be a contributing cause of sediment movement and accumulation within the navigational areas of the Port.

Tropical Cyclones have the potential to result in increased sedimentation in the Port of Mackay. The highest sedimentation occurred in 2017 following TC Debbie and in 2014 following three tropical cyclones over the 2013/14 wet season, with TC Dylan resulting in the largest waves. In the 2019 wet season two tropical cyclones passed within 200 km of Mackay, one in December 2018 (TC Owen) and one in January 2019 (TC Penny).

Year	Sedimentation (m^3)	Tropical cyclone
2010	39,011	Ului
2011	21,135	Anthony
2013	50,313	Oswald, Tim
2014	83,658	Dylan, Edna, Ita
2017	85,256	Debbie
2019	42,669	Owen, Penny

TABLE 6: SEDIMENTATION FROM CYCLONES AT THE PORT OF MACKAY

Annual sediment transport volumes were estimated using the Mackay wind and wave data, published tidal heights and rates, available grain size data and the 'Sedtran05 1-d model'. The conceptual sediment budget for the Mackay region was produced using 'ArcGIS' and the 'United States Army Corps of Engineers Coastal Inlets Research Program Sediment Budget Analysis System (SBAS)'. **The sediment budget calculations indicate that sediment is generally moving northwards within three defined sediment transportation processes:**

- *Littoral drift* - littoral transport along the surf zone is one of the major sediment transport pathways on exposed coastlines. The offshore reefs of the GBR act as efficient dissipaters of ocean swells and hence the energy contained in the wave environment by the time it reaches the coast is substantially reduced by comparison to coastal areas south of Fraser Island.
- *Fluvial* (river) or 'new' sources of fluvial sand inputs, while important, are of a tiny magnitude in comparison to the existing available seabed sources of coarse sediments available for littoral transport.
- *Nearshore turbidity pathway* - re-suspension which is not driven by breaking waves but rather the transient orbital flows beneath waves, along with tidal flows, act on the seafloor to create a bed shear stress large enough to mobilise fine sediments. Once mobilised, waves, wind and tidal movements transport the finer particles northwards along the coastline.
- *Inner-shelf bed load transport* - Larger waves (~ 1 m) and stronger tidal currents (> 0.25 m/s) are able to re-suspend larger sand particles. As in the turbidity pathway, once the bed shear stress is sufficient to mobilise sand particles, a near bottom current flow is required to generate the transport of material. The wind generated water movements established during prolonged wind events, the same winds that generated the waves, are able to mobilise the sands and transport these northwards.

Findings

The model indicates that the volume of sediment deposition (storage) is relatively small compared to the overall volume of sediment moving within the system. In areas where there is high tidal activity or where fluvial currents are strong and dynamic, much higher gravel content is found in the sediment than in other areas where sand, carbonates, or muds are more prevalent.

As a result, the system is considered balanced, meaning almost the same volumes of sediments that are entering a location are leaving, other than in an area of sand accumulation well to the north of Mackay.

When investigating the contribution of catchment derived sediments in consideration of reducing sedimentation in the port area, the model proposes that reducing fluvial sources of sediment through in-catchment sediment control measures will result in very little reduction in sediment accumulation.

5.2. Maintenance dredging and placement requirements

To better understand exactly where sediment accumulates and in what quantities within the Port's navigational areas, an examination was undertaken of the historic siltation in the channel, apron and berths at the Port of Mackay (Port and Coastal Solutions 2018). **The work was designed to:**

1. Provide quantitative changes in bathymetry overtime.
2. Analyse the cause and reasons behind any changes.
3. Develop a predictive tool for use in future sediment management decision making.

Coastal processes were defined using a wide range of hydrodynamic, meteorological and sedimentation data. Some of the key findings around coastal processes are shown in Table 7.

Process	Description
Tides	• The Port is located in an area of the Queensland coast that experiences very high tidal ranges, with semi-diurnal tides and a peak tidal range of 7.14 m (MSQ, 2015).
Wind Climate	• Local wind climate is governed by the east to south east trade winds, with lighter land breezes from the south-west sector during the winter months and lighter North-Easterly afternoon sea breezes common during summer afternoons.
Wave Climate	• The Port is largely protected from swell waves as a result of the GBR, islands and breakwalls. • Large open fetch to the south east and predominant south easterly trade winds dominate the local wave direction.
Current Regime	• Water currents at Mackay are predominantly driven by the large astronomical tides. • Predominant south easterly trade winds act to reinforce the net northerly tidal current.
Rainfall / Fluvial Flows	• The major catchment discharging nearby to the Port is the Pioneer River (approximately 4 km to the south) which does play a role in the delivery of sediments to the marine environment.
Cyclones	• Recent notable cyclones include TC Ului (March 2010), TC Dylan (January 2014) and TC Debbie (March 2017) had a notable effect on resuspension and sediment movements in the region.
Water Quality	• Concentrations of suspended sediment in waters adjacent to the Port are predominantly driven by bed sediments being suspended through current and wave action. • During the summer months higher suspended sediment concentrations occur compared to the winter months as a result of stronger winds and the increased occurrence of higher energy waves from cyclones and storm events.

TABLE 7: COASTAL PROCESSES AND SITE CONDITIONS AT THE PORT OF MACKAY

In summary, the dominant processes which result in the resuspension of sediment in the Mackay region are wave action (locally generated due to wind conditions) and tidal currents. The waves have the potential to result in much higher resuspension, while the tidal currents (and wind-generated currents) will transport the sediment when it is suspended. The currents at the entrance to Mackay Harbour are flood dominant, which indicates that the Harbour will act as a net importer of sediment and the low ebb current speed suggests that limited export of sediment from the harbour occurs. The tidal currents in the area directly offshore of Mackay Harbour are relatively high and as a result there is expected to be limited ongoing deposition in the area. In contrast, the tidal currents within Mackay Harbour are relatively low indicating that any fine-grained sediment which is transported into the Harbour in suspension is likely to be deposited within the Harbour (Port and Coastal Solutions 2018).

Port and Coastal Solutions (2018) has conducted an extensive bathymetric analysis of historical hydrographic survey data of the Port of Mackay and sediment movements to better understand sedimentation rates and bathymetric changes in the navigational areas of the Port. This analysis was updated in 2021 (Port and Coastal Solutions 2021). Figure 10 shows the cumulative change in bathymetry from 2009 to 2020 excluding the maintenance dredging activities undertaken in 2013 and 2020.

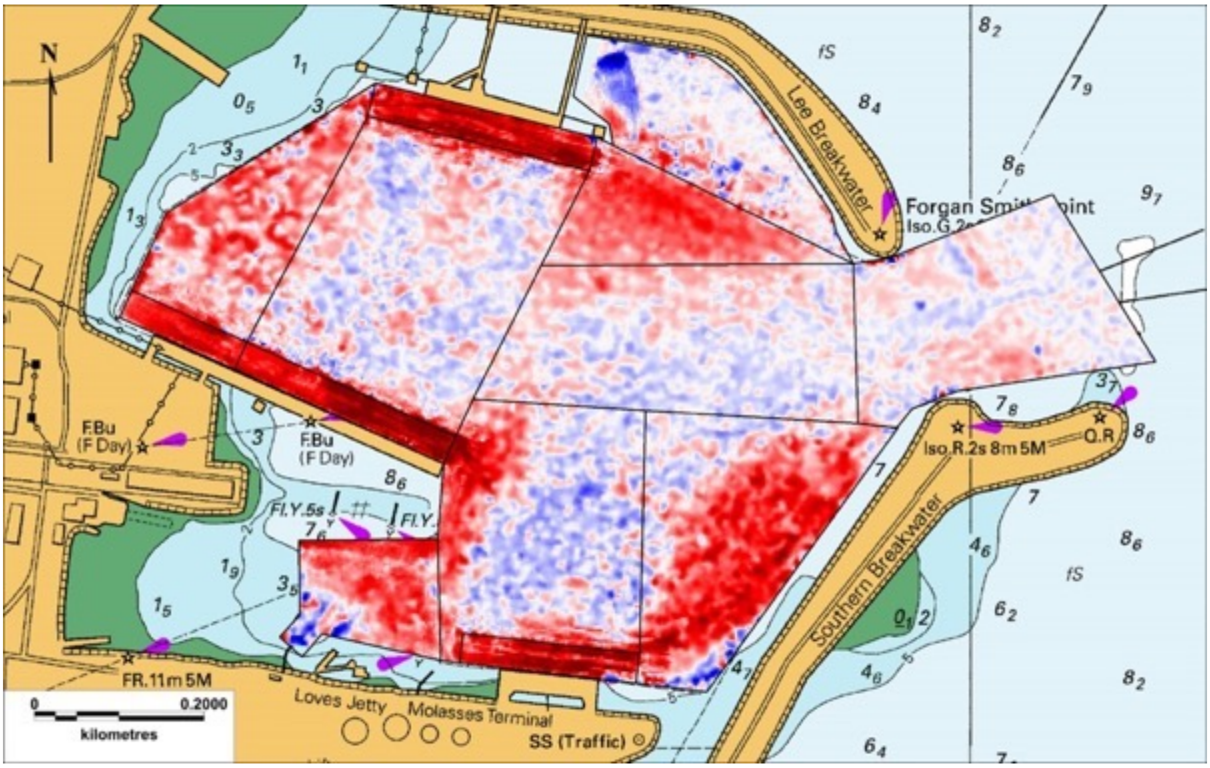

FIGURE 10: CUMULATIVE SEDIMENTATION/EROSION IN THE PORT OF MACKAY FROM 2009 TO 2020 (EXCLUDING THE CHANGES DUE TO THE 2013 AND 2020 MAINTENANCE DREDGING).

The bathymetric analysis has shown that the largest volume of historical sedimentation at the Port of Mackay occurred in the swing basin, but that the majority of the sedimentation above design depths accumulates in the berths, as the propeller wash from vessels limits longer term accumulation in the swing basin.

Sediment sampling has shown that the majority of the sediment within the Port of Mackay is silt and clay. Consequently, it is expected that, in most locations, the sedimentation will predominantly be fine-grained sediment. The only exception to this is the shoal at the entrance to the Harbour, where it is likely that sand sized sediment has historically accumulated in the form of an ebb bar.

The majority of the sedimentation which occurs within the Port of Mackay is due to fine-grained sediment being imported into the Harbour as suspended load during the flood tide. This is natural sediment which has been resuspended from the seabed within the adjacent nearshore coastal region around Mackay due to wave action and tidal currents (AECOM, 2016). The tidal currents in the area result in some of the suspended sediment from the adjacent coastal region being transported into the Harbour during the flood tide. Due to the relatively low ebb tidal currents in the Harbour and at the entrance to the Harbour, combined with the fact the Harbour is sheltered from wave action, it is expected that much of the suspended sediment transported into the Harbour will settle out and be deposited. Based on the findings from bathymetric analysis (Port and Coastal Solutions 2021), a conceptual sediment transport model for the Port of Mackay has been developed to schematically explain the key processes influencing sedimentation (Figure 11).

Sedimentation volumes

Based on the bathymetric analysis (Port and Coastal Solutions 2021) it is possible to estimate the future sedimentation within the Port of Mackay and therefore estimate the future sediment management requirements. As the volume specified will represent the maximum volume of sediment that can be removed it is important that it represents a realistic upper volume for future sedimentation requiring maintenance dredging for a 10 year period. Accordingly, it has been assumed that the volume represents eight years with typical wave activity and two years with high wave activity, accounting for the likelihood of two cyclonic events in the 10 year period.

The likely future sedimentation above design depths are therefore:

- Eight typical wave activity years: an annual maintenance dredging requirement of 40,000 m^3/yr; resulting in a total maintenance dredging volume over the eight years of 320,000 m^3.
- Two high wave activity years: an annual maintenance dredging requirement of 90,000 m^3/yr; resulting in a total maintenance dredging volume over the eight years of 180,000 m^3.

Providing a total of 500,000 m^3 of predicted maintenance dredging volume over a 10 year period. This amount does not include an allowance for over dredging which should also be included.

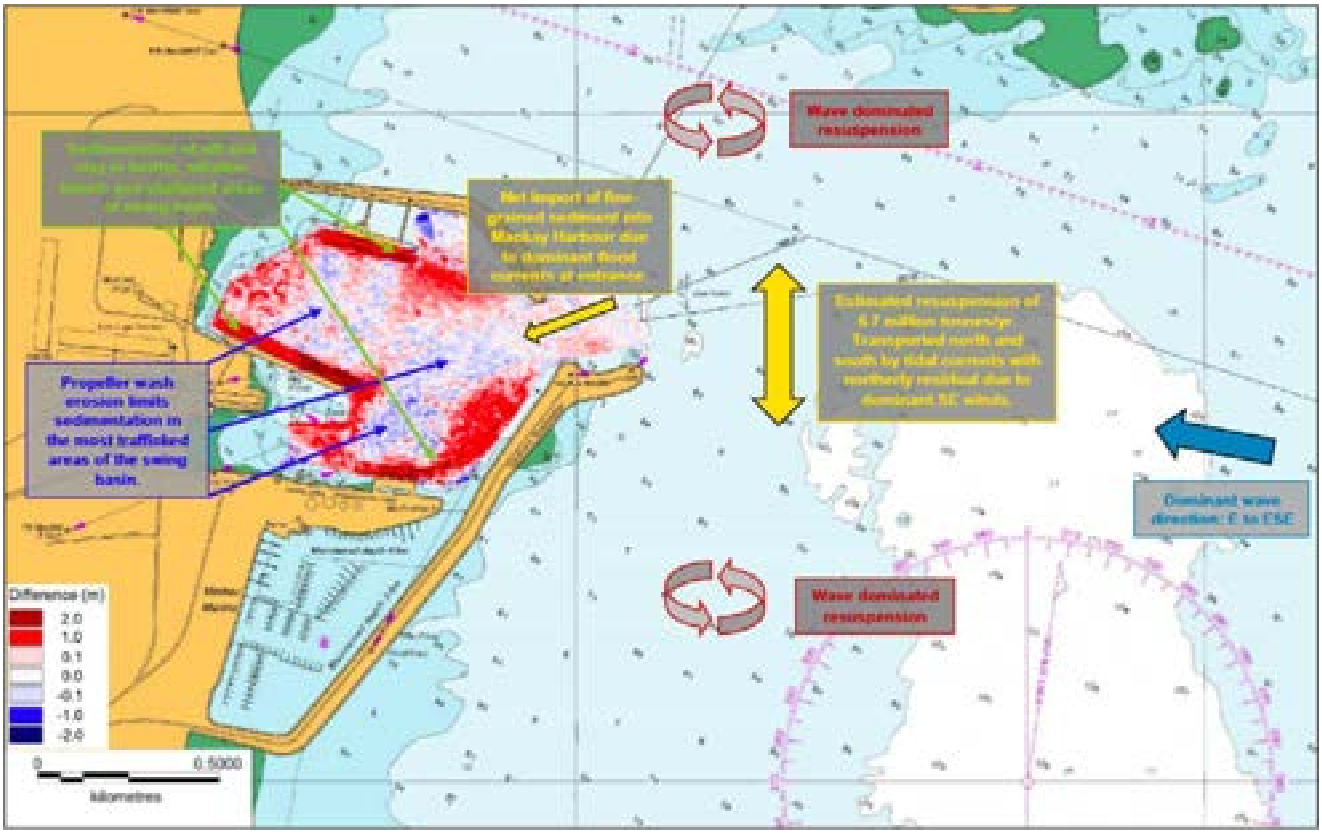

FIGURE 11: CONCEPTUAL MODEL OF SEDIMENT TRANSPORT AT THE PORT OF MACKAY (PORT AND COASTAL SOLUTION 2021)

5.3. Minimisation of sediment accumulation and dredging needs

Sustainable sediment management

From 2015 to 2018, NQBP undertook an extensive research project to investigate the most sustainable way to manage accumulated sediment in and around the Port of Hay Point.

The Port of Hay Point Sustainable Sediment Management (SSM) assessment was a comprehensive approach to examine all possible options and solutions to avoid, re-use, recycle and dispose of maintenance dredging material. Full details and data associated with the Port of Hay Point SSM Assessment and supporting technical reports are available at https://nqbp.com.au/sustainability/research-and-reports/sustainable-sediment-management-research.

In 2020, NQBP replicated its SSM research methodology at the Port of Weipa and subsequently a similar approach has been undertaken for the Port of Mackay.

NOTE: As the Port of Mackay is located in close proximity to the Port of Hay Point (approximately 20km apart) many of the detailed studies undertaken for the Port of Hay Point SSM are relevant and used for the Port of Mackay Assessment.

This section presents key findings from these reports.

SSM assessment at Port of Mackay

Given the geographical, social and environmental proximity of the Port of Hay Point to the Port of Mackay and the currency of the studies undertaken it has been possible to leverage the Port of Hay Point SSM assessment for the Mackay SSM assessment. **Additionally, a number of supporting studies have been undertaken specific to the Port of Mackay, these include:**

- Port of Mackay Avoid and Reduce Assessment including Bathymetric Analysis (Port and Coastal Solutions 2018, updated 2021)
- Sediment characterisation and contaminant testing (Advisian 2018)
- Marine sediment properties (Advisian 2018)
- Beneficial reuse assessment (Advisian 2019)
- Comparative analysis of sediment management options (Adaptive Strategies and Open Lines 2018 and updated in 2022 by NQBP).

The Mackay SSM assessment investigated where specifically the sediment at the Port of Mackay comes from, what impact it has on port operations, whether accumulation can be eliminated or reduced, and what alternatives are available to reuse or dispose of any sediment that might need to be dredged.

The SSM assessment has determined what is the best long-term approach to managing sediments within the Port. **This includes investigation and consideration of:**

- The source and nature of the particular sediment at the Port.
- The requirements for management of the sediment in the short and longer term.
- Whether sediment can be managed without dredging while maintaining port operations and meeting legal requirements.
- The feasible alternatives for use or placement of material if dredging is required.
- The best package of measures to provide for long-term (25-year) sustainable management of marine sediments at the Port.

The work has provided valuable context for long-term management at the Port, including understanding the economic effects of sedimentation and development of a long-term sediment management strategy.

SSM method

A central component of the SSM assessment is a structured decision-making process that has focused on what is important to all stakeholders, not just the port authority and port customers. Contained within this structured process is a detailed comparative analysis of the various alternatives that are available to manage sediment to determine the best long-term strategy.

The decision-making process for the SSM assessment is a complex task dealing with social, economic and environmental factors. The principles of Structured Decision Making (Gregory *et al*, 2012) were used to provide a robust method for the assessment. The process involved the following five steps:

Avoidance and reduction

The SSM assessment considered a range of possible alternatives to avoid or reduce the volumes or rates of sedimentation occurring within the navigational areas of the Port, as this would be the first and potentially ideal way to manage sediments in the port area.

The SSM studies undertaken have:

- Described the sediment and hydrodynamic environment at the Port of Mackay in the context of possible solutions to 'keep sediment out' or 'keep sediment moving'.
- Identified both engineered and technological solutions to avoid or minimise future maintenance dredging and consider their feasibility based on the Port of Mackay environment, port layout and infrastructure design.
- Undertook a comparative analysis of the solutions for any feasible alternatives.
- Estimated the potential impact of any feasible solutions to existing and future maintenance dredging at the Port of Mackay.

Three broad strategies that can be implemented to reduce siltation at ports and harbours are to keep sediment out, keep sediment moving and/or keep sediment navigable. The potential applicability of approaches to reduce sedimentation must be considered on a case-by-case basis as the suitability is dependent on the port configuration, sediment type, natural environment and processes.

The range of possible approaches is provided in Table 8.

Strategy	Approach	Example
Keep Sediment Out	Control sediment sources	Reduce sediment inputs through better catchment management
	Divert sediment-laden flows	Divert river inputs away from port
	Trap sediments before entering port	Sediment traps and insurance trenches
	Blocking sediment entry	Pneumatic barriers, silt screens, barrier curtains
	Habitat creation	Seagrass, saltmarsh, mangroves to stabilise and promote accretion away from port areas

Strategy	Approach	Example
Keep Sediment Moving	Structural solutions to train natural flows	Training walls to divert flow and prevent local deposition of sediment.
	Devices to increase bed shear stresses	Hydraulic jets, mechanical agitators
	Methods to reduce sediment flocculation	Adopting designs that reduce turbulence and therefore flocculation (e.g. solid wharf walls instead of piling supported wharfs).
Keep Sediment Navigable	Adopt a 'nautical depth' navigation approach which includes fluid mud	Nautical depth is the distance from the water surface to a given wet density, typically in the range of 1,100 to 1,300 kg/m^3.

TABLE 8: OUTLINE OF APPROACHES TO AVOIDING OR REDUCING SEDIMENTATION

Ports and Coastal Solutions (2021) examined the options and found that many were simply not achievable in an enclosed harbour such as the Port of Mackay. **The options that were considered potentially achievable at the Port of Mackay included:**

- Traditional maintenance dredging.
- Constructed sediment traps.
- Using a drag bar for seabed levelling.
- Use of propeller wash agitation.

For each of these alternatives an estimate of the associated costs and greenhouse gas emissions (tonnes/CO^{2}eq) was calculated. In addition, a constraints analysis for each of the alternatives has been developed to get an understanding of environment impacts, operational impacts, ongoing maintenance requirements, the confidence in achieving the desired outcomes and consideration of the regulatory pathways or approvals.

A summary of the comparative constraints analysis for the potentially feasible solutions is provided in Table 9.

Approach	Environmental impacts	Operational impacts	Ongoing maintenance	Effectiveness	Legal risk	Cost	GHG (CO_2e tonnes)
Maintenance Dredging	Low	Low	No	High	Low	$8.0M	7,950
Sediment Trap	Low	Low	No	High	Medium	$7.3M	9,380
Drag Barring	Low	Moderate	No	Medium	No	$9.2M	30,530
Propeller Wash Agitation	Low	Moderate	No	Low	No	$12.4M	26,160

TABLE 9: SUMMARY OF THE CONSTRAINTS ANALYSIS.

Due to the processes that control the sedimentation and the configuration of the dredged areas at the Port of Mackay, the assessment was not able to identify any feasible engineered or technical solutions that could significantly reduce the natural sedimentation at the Port.

Continued utilisation of the existing constructed siltation trench was found to be the best mechanism to reduce maintenance dredging needs at the Port of Mackay, assisted by utilising devices to increase bed shear stresses, specifically periodic drag barring.

The predicted dredge volumes and frequencies for maintenance dredging and the sediment trap solution are as follows:

- Maintenance Dredging: 500,000 m^3 removed every 10 years, with maintenance dredging occurring approximately every three (3) to five (5) years with bed levelling.

5.4. Examination of reuse, recycle and placement options

As the avoid and reduce analysis showed, eliminating the need to conduct maintenance dredging at the Port of Mackay is not a feasible option if port operations and safety are to be maintained at efficient levels. Accordingly, the SSM assessment then moved to determine the most suitable use or placement location for any dredged material.

A workshop was held with the Port of Mackay Technical Advisory and Consultative Committee (TACC). From this, 11 objectives and 14 performance measures were established. The objectives and performance measures developed as part of the Port of Hay Point SSM assessment were considered appropriate to adopt for the Port of Mackay SSM assessment (Table 10). The TACC considered that the objectives and performance measures continued to be of relevance and importance to the Mackay region. The TACC did not identify any new values or measures specific to the Port of Mackay assessment.

Theme	Objective	Measure
Environment	Avoid and minimise impacts to coastal ecosystems	Predicted performance in relation to avoidance and minimisation of impacts to coastal ecosystems
		Predicted risk on dredge material placement plumes and/or tailwater discharge exceeding ambient variation (percentile above median ambient TSS)
	Minimise carbon emissions	Forecast Greenhouse gas emissions
Cultural heritage	Minimise impact on cultural heritage	Nature and scale of any impact on cultural heritage
Port economics and operation	Maintain effective and efficient port operations	Number of days disruption to operations
		Predicted lead time to dredge material placement
		Capacity to provide a long term solution for the Port
	Avoid significant loss of future port expansion opportunities.	Predicted performance in terms of facilitating or constraining future port expansion
	Ensure solution is cost effective	Assessment of costs
Health & safety	Avoid or mitigate health and safety risks	Relative risk
Social	Minimise interference to social activities	Scale and duration of any impacts on social activities
	Provide increased economic and social opportunities	Predicted number of FTE jobs created
Innovation	Promote innovation in port management	Ability of a solution to advance current dredging practice information, technology and techniques
World heritage	Avoid and minimise impacts to the Great Barrier Reef World Heritage Area	Scale and duration of activity within the Great Barrier Reef World Heritage Area

TABLE 10: SSM OBJECTIVES AND MEASURES.

Six (6) discrete alternative options for reuse and placement were identified across four (4) categories (at-sea, onshore, land reclamation and habitat creation) and an analysis of the performance of these options undertaken. Table 11 summarises the weighted scores (max 100) for each option across the six weighting scenarios. For the 'Equal' weighting column all performance measures were compared on an equal weighting. For the five (5) other weighting columns, a 75% weighting was given to performance measures in a particular theme/value, e.g. the 'Environment' weighting gave a 75% weighting for the environment performance measures (coastal ecosystems, dredge plumes/tailwater discharge and greenhouse gas emissions).

	Equal	Environment	Port operations and economics	Social	Cultural	World heritage
At sea Mackay DMPA	77	72	90	58	94	76
At sea Hay Point DMPA	73	66	86	57	93	65
At sea Mid-shelf DMPA	72	74	77	58	92	56
Mackay Onshore	49	60	48	43	62	59
Mackay Onshore	43	36	43	60	72	30
Mackay Onshore	67	89	52	64	91	82

TABLE 11: PERFORMANCE MEASURE OUTCOMES.

Offshore placement at the existing Dredged Material Placement Area (DMPA) consistently performed the best. It was the strongest of the three (3) best performers and on balance, is considered to be the preferred solution. It provides both a short and long-term solution, is well understood, and performs strongly in a range of scenarios.

5.5. Selected dredging and placement strategy

Based on the SSM assessment, a clear preferred 25-year maintenance dredging strategy is now established that involves:

1. Use of operational measures to extend periods between maintenance dredging programs.
2. Use of traditional dredging to maintain navigational areas at safe design depths – approximately every 3-5 years with volumes of between 120,000 to 150,000 cubic metres.
3. Placement of dredged material at sea – at the existing dredge material placement area.

5.6. Future dredging requirements

The SSM Project concluded that:

- Traditional maintenance dredging is the only feasible means of removing accumulated material.
- Operational measures may reduce the frequency of future maintenance dredging needs but it is expected that traditional maintenance dredging will be required to remove approximately 120,000 to 150,000 m^3 every 3-5 years.

This LMDMP is proposed to maintain effective navigational depths at the Port over a 25 year period.

Other findings and recommendations of this LMDMP are:

- Siltation at the Port is a result of natural sediment transport processes (predominantly littoral drift) that is unable to be avoided.
- Bathymetric modelling showed that siltation would continue to occur in the swing basin and berth pockets.
- The continued use of drag barring and the siltation trench can extend the periods between dredging.

Dredging will most likely be undertaken using a Trailer Suction Hopper Dredge (TSHD), such as the *Brisbane*, and each program is likely to last for 1-2 weeks with dredge material being placed in the existing Port of Mackay DMPA.

6.0 Risk assessment framework

Depending on the scale and frequency, dredging and dredge material placement activities have the potential to adversely impact on sensitive environmental receptors, social or cultural values associated with the Port.

Impacts can occur over a short or long term and can be direct or indirect. Dredging related impacts can result from:

- The direct removal of benthic habitat in the vicinity of the dredged area.
- Smothering of benthic organisms in offshore dredge placement locations.
- Changes to marine water quality from increased turbidity and sedimentation.
- Mobilisation of contaminants released from dredged sediments.
- Collisions and disturbance from vessel movements.
- Increased noise and lighting from dredge vessel operations.

Prior to each dredging program a risk assessment of potential impacts to environmental, social or cultural values should be undertaken. The assessment will help to determine the level of potential harm that environmental, social or cultural values are at from the proposed dredging program. The assessment will assist in refining where management measures to avoid, reduce or mitigate impacts are needed. Identified measures can then be incorporated into revisions of the Maintenance Dredging EMP. This process is outlined in Figure 12.

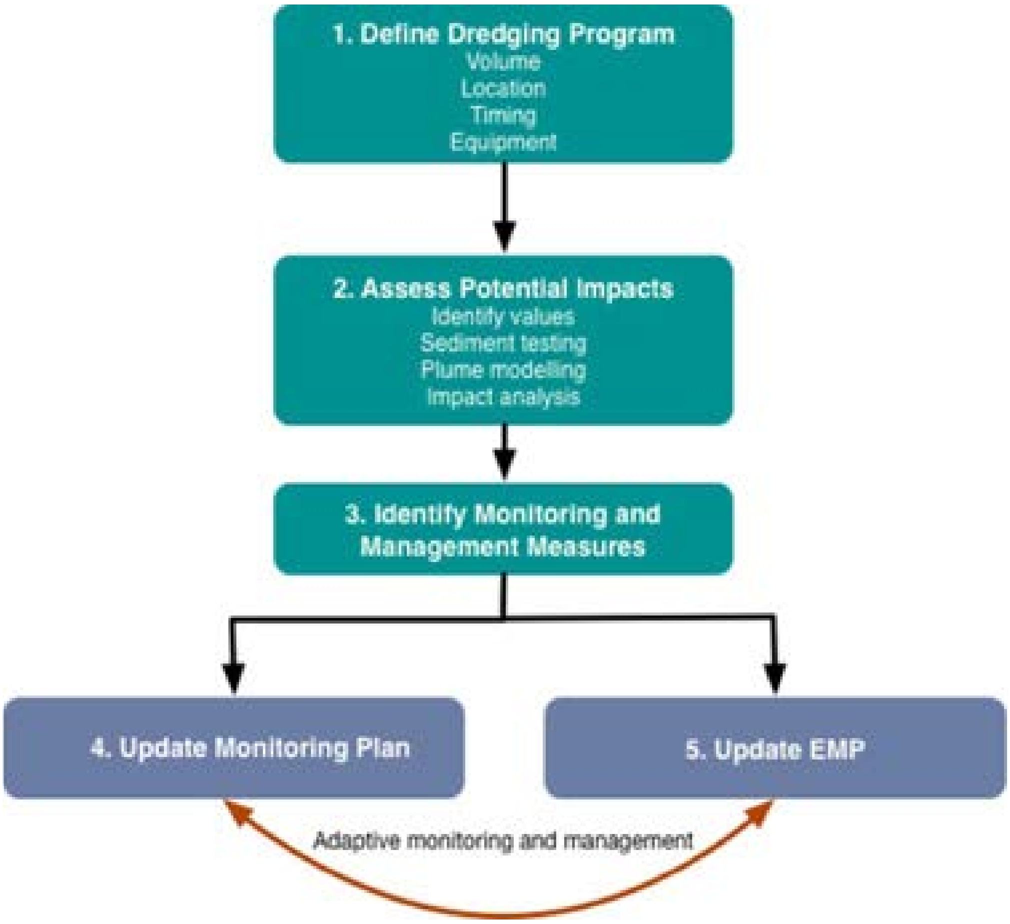

FIGURE 12: PROCESS FOR IDENTIFICATION OF POTENTIAL IMPACTS AND MANAGEMENT MEASURES

Information needed to inform the risk assessment should include:

- Up to date environmental values information, including data from ambient surveys of coral, seagrass and water quality.
- Dredging program design including: dredge type, volumes, locations, duration, seasonal timing.
- Sediment characteristics: particle sizes, contamination results.
- Sediment plume modelling.
- An environmental impact assessment, including an EPBC act self-assessment against significant impact criteria.

Initial assessment

To inform the development of this LMDMP an environmental risk assessment has been undertaken.

As outlined in Section 4, there are a number of environmental values that occur in the vicinity of the Port of Mackay. Whilst there is potential for some of the values to be impacted by maintenance dredging, the risk assessment undertaken has indicated that any impacts are highly unlikely to be residual or significant from maintenance dredging.

Generally, the proposed maintenance programs will consist of 3-5 yearly dredging of volumes in the order of 120,000 to 150,000 cubic metres. Programs will be short-lived in duration (1-2 weeks) and will include a range of impact avoidance and reduction measures that will further reduce impact risks. Any dredging program that is substantially different to the parameters assessed should be subject to a new specific detailed risk assessment.

The key findings of this risk assessment are:

1. 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 impacts to sensitive environmental values under any dredging scenario, including modelled volumes as high as 1,000,000 m^3 in a single campaign
2. Water quality monitoring results and numerical modelling of sediment transport demonstrates that natural day-to-day (e.g. excluding extreme weather events such as cyclones) SSC levels are much higher than those generated by maintenance dredging.
3. Risks to sensitive communities are likely to be low for seagrass and medium for benthic macro-invertebrate 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.
4. Other sensitive communities, such as coral and mangroves, lie outside of the area predicted to be impacted by turbidity and sedimentation and the risks from maintenance dredging are negligible.
5. Protected species are also unlikely to be significantly impacted by maintenance dredging. The Port of Mackay does not support important populations of marine species and disturbance to habitats (including critical habitat for one marine turtle) will be low. Indirect disturbances can be effectively managed via best practice dredging operations. The short timeframe of each campaign will also reduce risks.
6. Other port users may experience short-term disruptions to their activities, but these disruptions will not be significant.

The activities associated with maintenance dredging are well tested and understood. It is considered that there would be limited ongoing management and monitoring requirements once the placement of dredged material has been completed, however NQBP will continue their ongoing ambient water quality program.

A summary of risks is provided in Table 12. This risk assessment is based on the application of standard mitigation measures.

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	Minor Temporary, short-term negative impact	Likely	Medium
Dredging and placement generated sediment plume	Coral reef, seagrass and mangrove communities	Sediment deposition and changes to water quality leading to mortality or changes in cover/ diversity	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 placement	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, marine turtles	Potential for alienation of habitat	Negligible No impact at the population or sub-population level	Rare	Low
Lighting	Inshore dolphins, dugong, marine turtles	Potential for alienation of habitat	Negligible No impact at the population or sub-population level	Rare	Low
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	Unlikely	Medium
Dredge program	Marine users impact	Disruption of activities	Negligible Impact is confined to a small area or interest group	Possible	Low

TABLE 12: SUMMARY OF ENVIRONMENTAL RISK FINDINGS

Overall, the conclusion is that environmental risks from maintenance dredging at the Port of Mackay will be negligible to low. Maintenance dredging is short in duration and impacts 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.

The comprehensive Maintenance Dredging EMP (as outlined in Section 10) will ensure each maintenance dredging program is undertaken in line with best practice, and that impacts 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 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.

7.0 Treatment of key risks

NQBP is committed to minimising and managing potential impacts from dredging and dredge material relocation, as far as practicable.

Based on the results of the initial risk assessment, targeted and ambient monitoring and established best practice, a set of key management strategies and actions to minimise the impact from dredging and dredge material relocation operations will be identified and incorporated into the Maintenance Dredging EMP.

7.1. Environmental management plan

An EMP provides the operational practices required for dredging activities to meet environmental standards. The EMP forms the operational control document to ensure all site specific environmental issues are adequately addressed.

The EMP covers all aspects of the dredging operations specific to Port of Mackay and will contain:

1. Location and description of the activities.
2. Timing of the dredging operations.
3. Measures to meet permit conditions.
4. Standard management measures relating to:
    - Waste management
    - Ballast water management
    - Bunkering of fuel
    - Vessel washdown
    - Introduced marine pests.
5. Adaptive management measures relating to:
    - Water quality
    - Marine fauna
    - Climate conditions.
6. Operation and incident reporting.
7. Emergency procedures and contacts.

7.2. Adaptive management

Adaptive management provides for continuous monitoring, evaluation and adjustment of management response measures based on real-time monitoring and environmental conditions (Figure 13).

Based on an understanding of acceptable environmental conditions and thresholds for impact a series of response levels (triggers) can be established and then monitored to ensure that conditions that may produce environmental harm are avoided or ceased before impacts occur.

FIGURE 13: ADAPTIVE MANAGEMENT CYCLE (CEDA, 2015)

Adaptive monitoring will be implemented for each maintenance dredging program. The program is focused on collection and analysis of data to detect impending environmental harm and undertake corrective action where necessary. This is a key step in impact avoidance and management.

8.0 Environmental management framework

The following framework is designed to provide a repeatable structure for planning and executing maintenance dredging activities at the Port of Mackay.

The framework provides NQBP and its stakeholders with a clear and structured process for identifying, planning and implementing maintenance dredging. This process provides certainty for NQBP staff, TACC members and regulators around how NQBP will plan and manage dredging activities. The framework will also be key to supporting long-term permit applications.

The framework is illustrated in Figure 14. It is comprised of a staged planning and design process. Three key elements feed into the framework including consultation, monitoring and supporting studies. **The framework provides NQBP with:**

1. A technically informed process for the identification of port maintenance dredging and dredge material management needs.
2. A process for identification, risk assessment and management of potential impacts to environmental values from proposed activities.
3. Adaptive management and operational controls to avoid and minimise potential impacts during dredging activities.
4. Ongoing monitoring and management of port needs and values.

Most importantly, the framework provides a process that will be undertaken in collaboration with key port stakeholders. Stakeholder consultation will occur throughout the application of the framework including during any dredging program design, execution and ongoing monitoring and management.

The framework draws on and incorporates aspects of processes outlined in relevant key policy documents. **These include the:**

- The National Assessment Guidelines for Dredging (NAGD) assessment framework for ocean placement (CoA 2009).
- Queensland Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports (SOQ 2016).
- Long Term Monitoring and Management Plan Requirements for 10 year Permits to Dump Dredge Material at Sea (CoA 2012).

Details of each of the steps in the framework are described in the following sections including:

- Identification of port navigation needs, risks and sediment management approaches
- Dredging program design
- Dredging execution and control
- Monitoring and management.

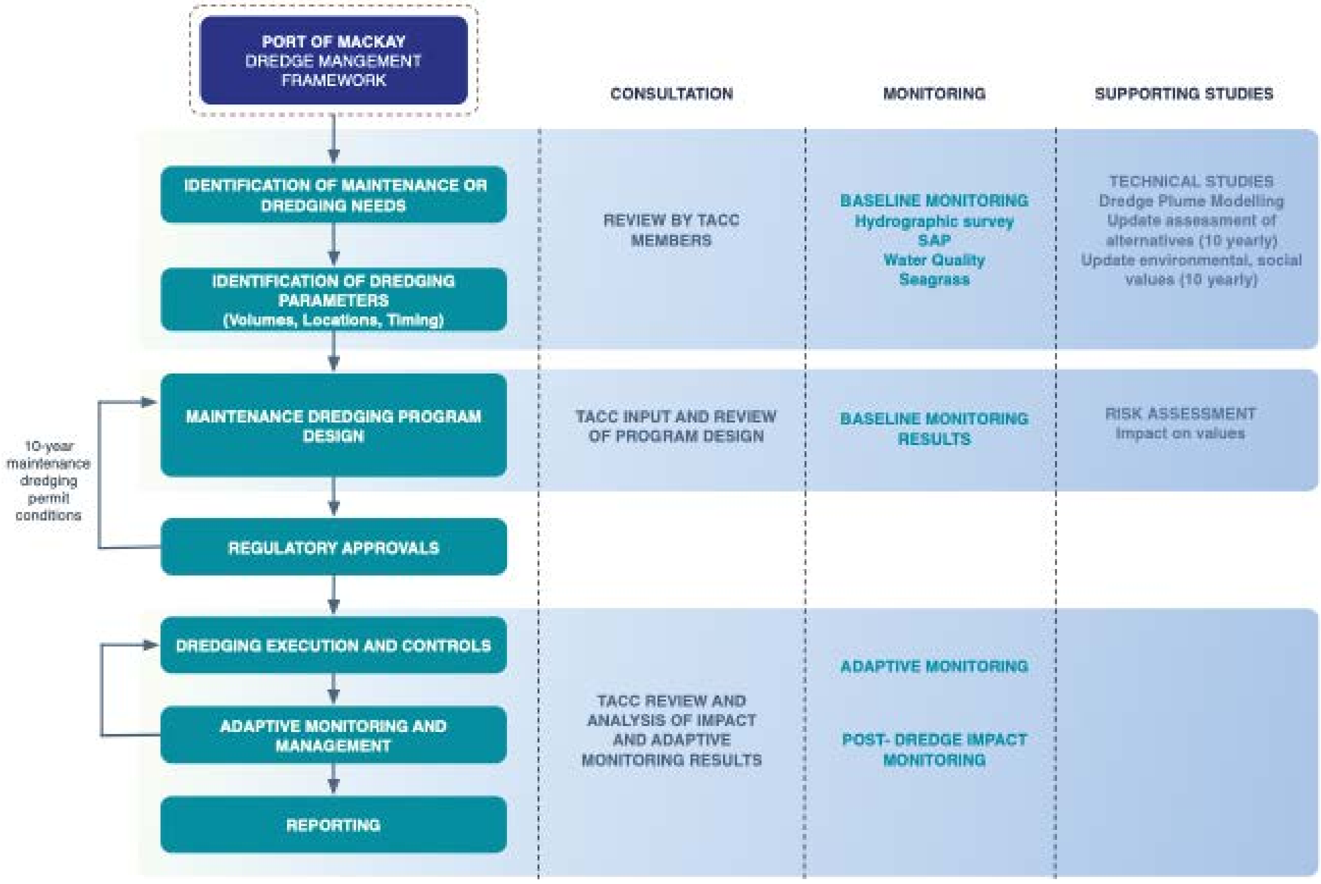

FIGURE 14: DREDGE MANAGEMENT FRAMEWORK

8.1. Identification of maintenance dredging needs

Identification of navigational risks of a port is one of the first steps of the framework process and is key to identifying whether maintenance dredging is likely to be required. Regular baseline monitoring (bathymetric surveys) of the seafloor navigational infrastructure of the Port including berths, swing basins and channels, is required. This monitoring will map sediment distribution within key operational areas. Data from the monitoring will also be able to identify changes in sediment dynamics over time.

Where sediment accumulation may create a potential or future navigational hindrance, a risk assessment should then be undertaken. The aim of the assessment is to determine the level of risk posed to the ongoing safe operation of the Port. The level of risk can then be used to trigger the timing of the further phases of the dredge management framework.

Broad categories of risk are outlined in Table 13. An aim of the framework is to maintain all port areas in the low or medium risk rating at all times.

Status	Description	Response
Extreme	Port vessel access and safety is compromised. Declared depths are above port operational requirements. The full loading of vessels is constrained by berth depths. Loaded vessels cannot depart port or can only depart on high tide.	Sediment management measures are required immediately. Expedite framework planning and actions.
High	Safety and/or access to the Port could be compromised at any time in the near future or access is already significantly tidally constrained. Loaded vessels can only depart on high tide.	Sediment management measures are required immediately. Expedite framework planning and actions.
Medium	Port depths and sedimentation trends indicate that access and/or safety could be compromised within the next 12-18 months (especially in the case of cyclonic activity)	Commence planning for appropriate sediment management action(s).
Low	Sedimentation rates are low, indications are that port access will not be compromised or affected within the next 2 years (depending on cyclonic influences).	Continue to monitor.

TABLE 13: NAVIGATIONAL RISK CATEGORIES

8.2. Identification of dredging parameters

Should an immediate or future navigational risk at the Port being identified, it is necessary to determine the appropriate response in terms of the type of sediment management activity required.

Baseline monitoring data will be required to inform this phase. Up to date information regarding sediment volumes, quality and contamination may be needed. **The specific data required includes:**

1. Sediment Sampling and Analysis Plan (SAP) results. The process for undertaking sampling and analysis of sediments is described the NAGD (CoA 2009).
2. Bathymetric survey data.

Sediment management options

Depending on the scale of sedimentation and level of navigational risk posed a range of management options could be applied. These need not necessarily be stand-alone actions and could be deployed sequentially to reduce and then remove the risk. **Measures include:**

A. **Bed levelling**: using a drag bar, high spots of sediment accumulation can be removed and reduced by shifting them into lower lying depressions in channels and berths. This can help to maintain a suitable declared depth. Rarely is this a long-term solution but it can be used to alleviate immediate risks or to prolong the period between major dredging activities.

B. **Propeller wash agitation** from operating vessels within the port area may be of some assistance in reducing the accumulation of sediment in certain areas. This may be partially effective in berth areas and in the shallower channel areas. Minor variation of the vessel path along the channel may assist in widening the area free of accumulated sediment.

C. **Hopper dredging**: often considered the more traditional dredging method, use of a trailing suction hopper dredge (vessel) where sediment is collected in the hopper of the vessel and placed at a designated location. This method is necessary for removing larger volumes and areas. Figure 15 provides a cross section of a typical hopper dredge.

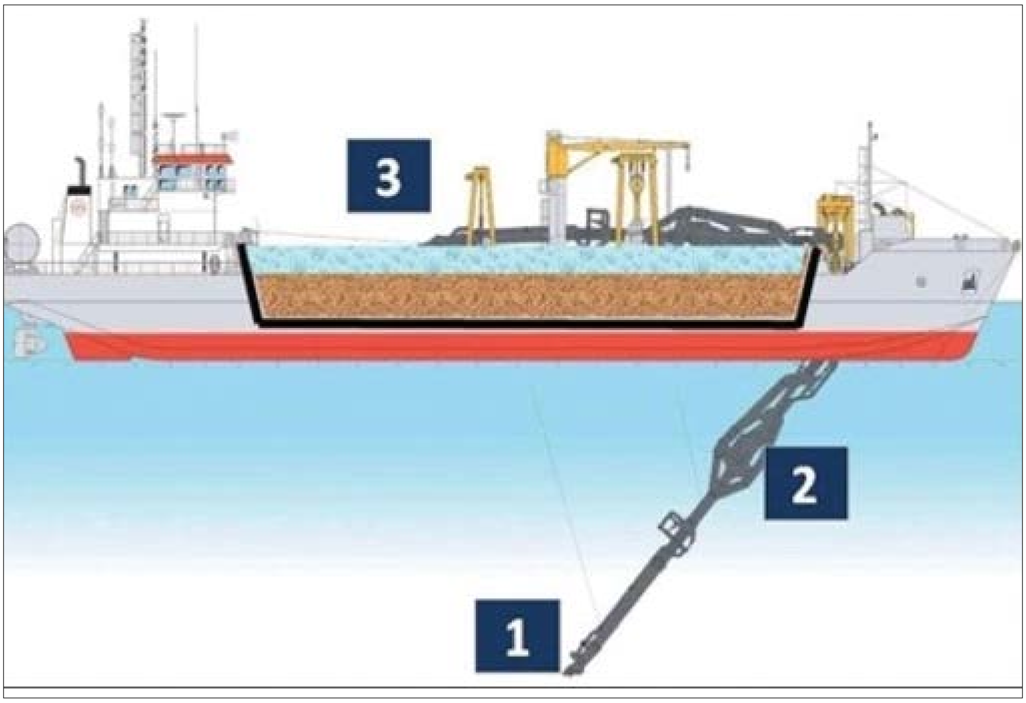

FIGURE 15: CROSS SECTION OF A TRAILING SUCTION HOPPER DREDGE (SOURCE: PORTS AUSTRALIA 2016)

8.3. Dredging program design

Should it be determined that hopper dredging is required then the next stages from the sediment management framework is the design of the dredging program and obtaining of relevant approvals.

Where the need for maintenance dredging and dredge material placement has been identified, planning for all aspects of the program needs to be undertaken. **This includes:**

- Timing and duration of the dredge program.
- Location of dredging areas and volumes.
- Equipment needs and standard procedures (*TSHD Brisbane* or other suitable dredge).
- Identification and assessment of potential impacts to values at dredging and placement sites.
- Mitigation and management measures (including adaptive management) to address potential impacts to values.
- Operational controls.
- Monitoring requirements.

All three input elements of the framework, including consultation, monitoring and supporting studies, will aid in the design of individual dredging programs. Additionally, standard dredging procedures and guidelines will need to be incorporated into the design.

Type of dredge

Depending on the ongoing viability and availability the *TSHD Brisbane* will be used for periodic dredging at the Port. If the *TSHD Brisbane* is not available, a similar and suitable trailer suction hopper dredge would be commissioned and used.

For the purposes of this management plan, the specifications and operations of the *TSHD Brisbane* will form a baseline for dredge specification and operational environmental management. A brief description of the *TSHD Brisbane* operations is provided below.

Material to be dredged is removed through two suction heads, which are lowered into position on either side of the vessel. As the vessel steams slowly at around 1 - 3 knots, large pumps draw water through the heads, which entrain the sediment and transport the water/sediment mixture aboard into a central collection hopper. The capacity of the hopper is dependent on the sediment type, – with volumes (including both sediment and water) approximating 2,800 m^3 for fine silts and 1,700 m^3 for sands (of a maximum hopper capacity of 2,900 m^3). Each extraction run takes approximately 1 hour to complete. Whilst the suction heads are fitted with high-pressure water jets, which can be used to agitate consolidated sediment, they are rarely required for maintenance dredging.

TSHD BRISBANE

The sediment/water ratio of material delivered to the central hopper of the TSHD Brisbane is typically quite low. Whilst it varies depending on the type of sediment being dredged, the sediment concentration is generally in the order of 10 - 30 % solids. To maximise dredge material capacity, these large volumes of water are managed using a central column weir, which is incorporated into the hopper. This arrangement allows excess water to decant from the sediment and overflow to discharge. Overflow occurs only toward the very end of the dredging run as the hopper nears capacity.

Once the dredge has filled its hopper, the vessel will then relocate the material to the designated dredge material relocation ground. Dredged material is discharged below keel level to minimise turbidity generation. Each dredged material placement is manually logged using both satellite navigation and standard bridge equipment, and is electronically fixed using a differentially corrected global positioning system (GPS). The time taken to place material over the dredge material relocation ground is typically about 15 minutes.

The following are considered the minimum standard of specification for TSHDs that will be selected to undertake maintenance dredging works in the Port:

- The dredger will operate under a Maintenance Dredging EMP. The EMP will be revised by NQBP in conjunction with the dredging contractor, and implemented for each maintenance dredging program. The permit conditions, dredge dumping procedures, any associated adaptive monitoring arrangements and corrective actions are incorporated into the EMP. Implementation of the EMP is audited by NQBP environmental staff.
- During the dredging works, electronic logs of each dredge material relocation event will be maintained.
- TSHDs undertaking dredging works at the Port will include the following specifications:
  - Central weir discharge system
  - Below keel discharge point
  - Low wash hull design
  - Electronic positioning system (GPS)
  - Turtle exclusion devices on intake heads.

Introduced marine pests

Introduced marine species are species translocated to regions outside their natural range, typically by the passage of vessels nationally and internationally. Where these species present a threat to human health or environmental and economic values, they are termed a 'pest'. Outbreaks of marine pests are an obvious possible risk at ports trading with international clients. **Translocation of marine pests may occur via:**

- Ballast water - used to control the trim and draft of a vessel
- Fouling - encrusting organisms via fouling of vessels (e.g. hulls, propellers, intake grates etc.).

Any TSHD dredger contracted to undertake dredging works will be required to comply with marine pest protocols, including National and Queensland bio-security 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.

The *TSHD Brisbane* operates in Australian waters only and complies with National standards.

TACC consultation

Consultation with the TACC should occur during the design phase of larger dredging activities, particularly those involving a hopper dredge, sea or land placement. **The TACC should be consulted on:**

- Proposed program specifics such as the location of dredging and placement sites and the timing and duration of dredging and associated activities.
- Results of the risk assessment of potential impacts to values and proposed mitigation and management controls.
- Scope of program monitoring and reporting requirements.

Further details on TACC membership and role is provided in Section 5.

9.0 Monitoring framework

Dredging related monitoring is detailed in the Port of Mackay Marine Environmental Monitoring Plan.

NQBP will oversee the implementation of a monitoring plan, with each component being undertaken by appropriately qualified marine scientists.

Overall, the monitoring plan is made up of a combination of regular ambient monitoring (long-term monitoring) and individual dredging event related monitoring (impact and adaptive monitoring). **The environmental monitoring program aims to:**

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

These aims will be met through the implementation of a three-tiered approach to monitoring (Figure 16). The three-tiers will include ambient, impact and adaptive monitoring. Results from each tier of the monitoring program will be used to inform the relevant stages of the dredging management framework.

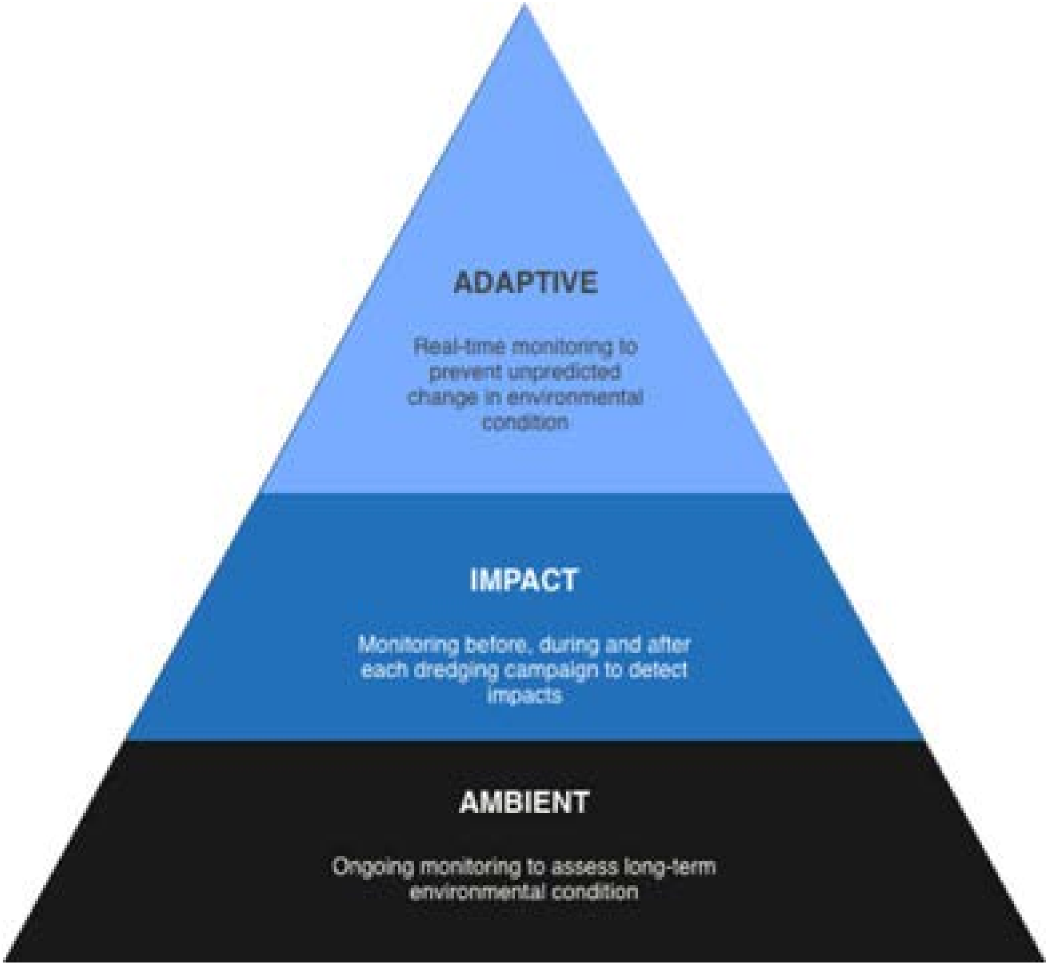

FIGURE 16: TIERED APPROACH TO MONITORING

Ambient

The aim of this monitoring is to provide a long-term environmental health assessment of the Port and nearby sensitive receptors. The ambient monitoring program focuses on water quality, coral, seagrass, sediment quality and invasive marine pests.

Impact

Impact monitoring will be implemented for each maintenance dredging program, with the aim of detecting any adverse impacts due to dredging. If the results of the impact monitoring detect changes in the condition of sensitive receptors, the data can be used in conjunction with data from baseline and adaptive monitoring programs to understand likely cause of impact (e.g. was it dredging).

The impact monitoring program focuses on water quality and coral, as the two receptors most likely to be adversely impacted by dredging. The ephemeral nature of seagrass means that as a sensitive receptor is less suited to short term impact assessment monitoring and detection of dredging related changes. A long term seagrass data set is being established which may enable future analysis and correlation of seagrass health with other factors.

Adaptive

Adaptive monitoring and management will be implemented for each maintenance dredging program. The program is focused on collection and analysis of data to detect potential environmental harm and undertake corrective actions where necessary. This is a key step in impact avoidance and management.

Monitoring of water quality and for certain marine fauna will be undertaken. Responses to monitoring results will be required if trigger values occur. The nature of the response will be scaled according to the environmental risk. Triggers and the required adaptive management actions are provided in the *Port of Mackay Marine Environmental Monitoring Plan*.

Monitoring review and updates

The *Port of Mackay Marine Environmental Monitoring Plan* will be reviewed after each dredging program and updated prior to any future dredging.

The review will examine the:

- Effectiveness of monitoring methods.
- Response times and outcomes of adaptive monitoring actions.
- Monitoring results and data.
- Environmental changes and any incidents causing harm.

The review will be undertaken in consultation with the TACC and their feedback incorporated into any future plan revisions.

10.0 Performance review

The *Environmental Code of Practice for Dredging And Dredging Material Relocation* (Ports Australia 2016) identifies that 'transparent and open information sharing is important to improve knowledge and to understand community values, client needs and government expectations. Communication and reporting is an important component of this, to demonstrate performance and provide for community accountability'.

In fulfilment of this principle, reporting under this LMDMP will involve:

- Regular updates to the TACC on any planned or conducted dredging activities.
- Publication (on the NQBP website) of information on:
  - details of any upcoming dredging programs; and
  - report detailing results of any water quality monitoring associated with dredging activities.

For any operations covered by a Commonwealth Sea Dumping Permit, an annual report meeting the International Maritime Organisation's reporting requirements will be submitted to the Australian Government each year. **The report will summarise the dredging and placement monitoring activities undertaken during the year, including:**

- Permit number.
- Permit start and expiry dates.
- Locations and type of material dredged.
- Volume dredged at each location.
- Placement locations used.
- Placement method used.

Record keeping

During dredging activities, NQBP (or their contractors) will keep records which detail:

- The times and dates of when each material placement run is commenced and finished.
- The position (by GPS) of the vessel at the beginning and end of each dumping run with the inclusion of the path of each dredge material relocation run.
- The volume of dredge material (in cubic metres) dumped for the specific operational period. These records will be retained for audit purposes.
- Detail of any spill of oil, fuel or other potential contaminant, details of remedial action and monitoring instigated as result.
- Details of any marine mega fauna observations during dredging activities.
- Time and duration of any alterations to the program, including stop work actions, as a result of any environmental mitigation measure.

Post the dredging program, NQBP will:

- Undertake a bathymetric survey of the dredged area and dredge material placement site.
- Within two months of the completion of the bathymetric survey provide a digital copy of the final survey results to the RAN Hydrographer, copied to relevant regulatory agencies.
- Continue monitoring as per the *Port of Mackay Marine Environmental Monitoring Plan*.

Incidents and contingency arrangements

All NQBP staff, and any contractors involved in dredging related activities, have the responsibility to report any significant incidents and emergencies:

1. In the first instance, reporting should be to the operational works supervisor, but generally, the Environment Manager will have the responsibility to initiate corrective action for environmental incidents.
2. All incidents should be reported to the Manager responsible for the Project, as specified by NQBP.
3. In the case of an environmental emergency, after first notifying the Environment Manager, the operational works supervisor may make contact with NQBP's nominated consultants, who would help co-ordinate and manage a response. Depending on the nature and magnitude of the incident, the Environment Manager may be required to notify government regulators.

Significant environmental incidents should be logged in writing, with all relevant details recorded, after corrective action has been completed.

Should an environmental incident occur during the course of dredging or placement of material, NQBP will take measures to mitigate the risk or impact. **NQBP would report the following information to DES/DAWE, within 24 hours of confirmation of an incident:**

- Nature of incident and type of risk associated with the incident, including (where possible) volume, nature and chemical composition of substances released
- Measures taken to mitigate the risk.
- The success of the measures undertaken.
- Proposed future measures (if required) and monitoring.

Auditing and improvements

NQBP will undertake an internal audit during and after the completion of each dredging program. Audit findings will be provided to the TACC and will be used to inform improvements and revisions to the Maintenance Dredging EMP and Marine Environmental Monitoring Plan.

11.0 Supporting information

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