

Maintenance Dredging at Port of Townsville

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Abstract—The Port of Townsville conducts regular annual maintenance dredging to maintain depths of its harbor basin and approach channels for the navigational safety of the vessels against the natural accumulation of marine sediments. In addition to the regular maintenance dredging, the port undertakes emergency dredging in cases where large quantities of sediments are mobilized and deposited in port waters by cyclone or major flood events. The maintenance dredging material derived from the port may be disposed at sea or on land in accordance with relevant state and commonwealth regulations. For the land disposal, the dredged mud slurry is hydraulically placed into containment ponds and left to undergo sedimentation and self-weight consolidation to form fill material for land reclamation. This paper provides an overview of the maintenance dredging at the Port of Townsville and emphasis on maintenance dredging requirements, sediment quality, bathymetry, dredging methods used, and dredged material disposal options.

Keywords—Consolidation, dredged material, maintenance dredging, marine sediments, sedimentation.

I. INTRODUCTION

ESTABLISHED in 1864[1], the Port of Townsville is located in Cleveland Bay, faces Magnetic Island, and borders the Great Barrier Reef Marine Park at its seaward limit line. It is considered to be Northern Australia's premier port and North Queensland's gateway to Europe, Asia and Pacific Rim markets. The port serves as a major trade link for mineral producers and manufacturers in Northern and Western Queensland and plays a crucial role in the region's economy. Since the early days of Port of Townsville, vessel sizes and trade volumes have increased, and in return, the port facilities have been developed accordingly to keep up with demand.

Navigation access to Port of Townsville is via the outer Sea, Platypus and Ross River Channels. The port has conducted regular annual maintenance dredging since mid 1970's [2] to maintain the harbor basin and approach channel depths for ongoing operational efficiency and navigational safety of the vessels against the natural accumulation of marine sediments. In addition to the regular maintenance dredging, the Port of Townsville conducts emergency dredging in cases where large quantities of sediments are mobilized and deposited in port waters by cyclone or major flood events. Analysis of historical maintenance dredging records showed that average annual maintenance dredging volume at the Port of Townsville has been in the order of 95,000 cubic meters per year [3].

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Whilst the maintenance dredging is a common requirement for many ports and harbours around the world, the Port of Townsville is somewhat unique, particularly in relation to sediment quantities, frequency of maintenance dredging and sensitivity of the receiving environment. The Port of Townsville is geographically located at the Cleveland Bay where the wind-induced currents influence the sediment transport and settling during dredging activities [4]. Moreover, the port is situated at the mouth of the Ross River and Ross Creek, the two primary waterways in the Townsville region; these two waterways pour sediments from the wider Townsville catchment area into the port waters every wet season.

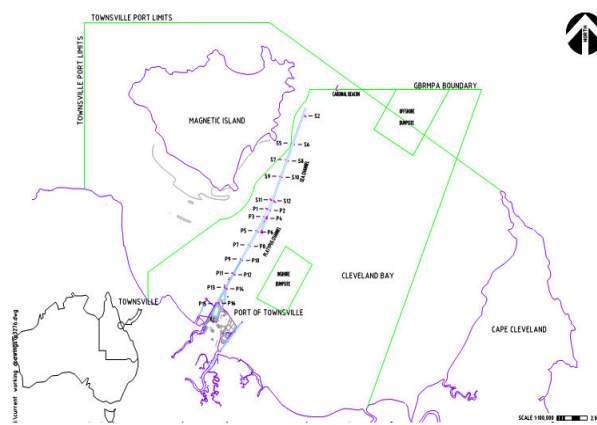


Fig. 1 Port of Townsville location plan

II. MAINTENANCE DREDGING REQUIREMENTS

To ensure navigational safety, the port monitors sediment accumulation in the access channels and the swing basin on a quarterly basis through hydrographic surveying [5]. These surveys allow an assessment of navigable depths, which is communicated to the stakeholders via Queensland Maritime Safety Notices to Mariners channels.

The maintenance dredging and the associated dredge material disposal comprise a significant component of the port's annual maintenance budget. The annual maintenance dredging requirements are considered against a variety of operational, environmental and commercial factors to ensure the most appropriate dredging and dredge material disposal management plan is adopted [6]. Quantities and distribution of sediments throughout the port area defines recurrence of the maintenance dredging and type of dredge vessel to be utilized in dredging campaigns. The Maintenance dredging operations frequency and extent is influenced by a number of factors which include [5]:

- environmental parameters and sediment movement within Cleveland Bay;
- weather patterns (cyclones, heavy rains, flooding events);
- visiting vessel sizes;
- channel and berth pocket depths;
- physical characteristics of the marine sediments;
- economics;
- contamination status of the marine sediments; and
- dredge vessel availability.

III. SEDIMENT QUALITY ASSESSMENT

In order to detect any contamination risk posed by maintenance dredging material disposal to Cleveland Bay and environment surrounding the reclamation area, the Port of Townsville closely monitors quality of sediments in accordance with National Assessment Guidelines for Dredging (NAGD) [7]. Several geochemical studies have looked at bioaccumulation of contaminants in the dredge disposal site and an urbanised catchment. Cores and grab samples have been collected and chemically analysed and assessed for potential of heavy metal contamination by comparing sediment contaminant concentrations to NAGD screening levels. Sediments samples were analysed for a suite of trace metals Cd, Cr, Cu, Ni, Pb, and Zn [8]. Bioavailability and elutriate testing is conducted on sediments where contaminant concentrations exceed the specified thresholds. Materials with potential to pose unacceptable risk are taken to sediment pond ashore, chemically and structurally stabilized and used as land reclamation fill [5]. Despite a long history of disposal at the designated ocean dump site, analyses of whole sediment indicated that trace metals in sediment were not enriched above background levels.

IV. BATHYMETRY

The Port of Townsville undertakes bathymetric surveys on a quarterly basis in its maintenance dredging areas and the ocean disposal ground both pre and post dredging campaigns to monitor changes in the bathymetry. Detailed hydrographic surveys allow assessment of navigable depths between dredging campaigns and to detect any objects in the navigational pathways. The outcomes of these surveys are communicated to port users by Maritime Safety Queensland to ensure safe navigation. The surveys are approved by the Port of Townsville, where the final depth declarations are confirmed by the regional harbor master.

For dredging accuracy, the Port of Townsville has invested in state of art positioning and depth recording equipment. The equipment includes multi beam echo sounder, geographic position system (GPS), and transducer all of which are complemented with computers and the associated software. This integrated up-to-date survey system is mounted on survey vessel suitable to most of weathers and capable to produce accurate same day survey information for the dredge and sounding plots of the surveyed areas.

V. MAINTENANCE DREDGING LOCATIONS

The Port of Townsville uses various types of dredging vessels for its maintenance dredging operations. Efficiency is a determining factor in selecting the dredging vessel that best suit each of the port's six maintenance dredging locations. However, the efficiency of a dredge vessel is largely influenced by the configuration of the port area to be dredged (geometry and depth), the dredged material transport and placement requirements as well as sediment contamination condition.



Fig. 2 Port of Townsville maintenance dredging locations

TABLE I
 CHARACTERISTICS OF PORT OF TOWNSVILLE MAINTENANCE DREDGING
 LOCATIONS AND DECLARED DEPTHS

Location	Geometry	Depth* (M)	Sediment Type	Suitable Dredge
Ross Creek	tight corners	no declared depth	free flowing silt	grab dredge
Inner Harbour	open basin with some tight corners	11.3	free flowing silt	trailer suction hopper and grab dredge
Platypus Channel	long continuous runs	11.4	free flowing silt	trailer suction hopper dredge
Sea Channel	long continuous runs	11.5	free flowing silt	trailer suction hopper dredge
Outer Harbour (Arrival)	open basin with some tight corners	6.1	fine sand, free flowing silt	trailer suction hopper dredge
Ross River Channel	long continuous runs/open basin with tight corners	2.2	coarse sand, free flowing silt	small size cutter suction dredge

* Declared by Maritime Safety Queensland via Notices to Mariners [9]

VI. DREDGING METHODS AND EQUIPMENT

The Port of Townsville uses its grab dredge for maintenance dredging of Ross Creek area that has characteristics of shallow draught, tight corners and smaller volumes of sediments accumulation. For the inner harbor, platypus channel, sea channel and outer harbour areas with open basin, continuous long runs, deep waters and substantial amounts of sediments to be dredged, large trailer suction hopper dredge is ideal. Accordingly, the Port of Townsville has entered into a long term contract with Port of Brisbane and hired Port of Brisbane owned trailer suction hopper dredge (TSHD) 'Brisbane' to undertake annual maintenance dredging works at these areas of the port towards the end of each year. The timing of the works usually fall in-line with dredge 'Brisbane's' scheduled annual trips to north ports (Weipa and Cairns).

Though it has long straight geometry, Ross River channel has a shallow depth of 3 m that not accessible by the large size TSHD 'Brisbane', thus only accessible by small size TSHD. As there is no small size TSHD available in the eastern coast of Australia, the Port of Townsville hires services of small size cutter suction dredge (CSD) on as required basis for Ross River and Townsville Marine Precinct mooring area dredging. The maintenance dredging material derived from Ross River area is pumped into containment ponds at port's eastern reclamation area through submerged, floating and land base pipe line. In addition to the grab dredge, TSHD, and small size CSD vessels, the port regularly uses drag beam 'bed leveller' to agitate silt build-up and drag silt into storage areas as well as removal of high spots that left by the TSHD.



Fig. 3 Small size CSD dredging TMP mooring -2011

VII. DREDGED MATERIAL DISPOSAL OPTIONS

The maintenance dredging material derived from the Port of Townsville waters may be disposed at sea or on land in accordance with relevant state and commonwealth regulations [6]. The dredged material is to be taken to the designated sea dump site which is located approximately 20 km from the port. For ashore disposal, the dredged material is pumped in slurry form into containment ponds at port's eastern reclamation area and left to undergo sedimentation and self-weight consolidation to form fill material for land reclamation. Selecting either of the two dredged material disposal options is dictated by the following factors:

- type of dredging vessel to be used.
- cost of the dredging operations.
- environmental restrictions in place.
- sediment characteristics
- demand to develop reclaimed land
- economics of land reclamation.
- contamination status of the sediments.

The Port of Townsville conducts geochemical assessments and geotechnical investigations to optimize the above mentioned factors. The port aims to ensure a proactive approach to dredging and dredged material disposal is incorporated into both the daily port activities and long-term strategic planning processes by adopting the following strategies:

- reuse dredged material;
- minimize ocean based disposal as possible ;
- improve sediment quality;
- mitigate environmental impacts resulting from dredging ; and
- minimise the environmental impact at the sea disposal site.

VIII. OCEAN BASED DISPOSAL

Sea disposal of dredge material within Cleveland Bay has been undertaken since 1883 at a number of locations, the material has typically associated with capital and maintenance dredging of Port of Townsville [2]. The current (trapezoidal shaped) designated sea spoil ground is located at the north-eastern corner of the Port of Townsville's exclusion area near

the boundaries of the Great Barrier Reef Marine Park. The ocean disposal ground was chosen to its proximity to the port's key maintenance dredging areas and has typical depth of 11m to 14m; it receives dredge material by bottom dumping of an operating trailer suction hopper dredge.

Disposal of dredge material at Port of Townsville's sea dump is managed under the convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters 1972 (The London Convention) and the 1996 protocol to the London Convention[7]. The 1996 protocol to the London convention is regulated through the relevant commonwealth and state legislations (the Environmental Protection Sea Dumping Act 1982 and the National Ocean Disposal Guidelines for Dredged Material 2002).

IX. LAND BASED DISPOSAL

One of the predominant aims of the 1996 Protocol is to have less and cleaner waste disposed at sea. This aim falls in line with Port of Townsville's strategy of reduction of the amount of dredge material to be disposed at sea and maximizing land reclamation alternative [5]. The current port's land based maintenance dredging material disposal is regulated by Queensland Environmental Protection Agency (EPA). EPA issues permit that outlines the maintenance dredging locations, depths, dredge plant to be utilised, quantities of material to be dredged and disposal locations. The option to have dredge material pumped ashore for land reclamation is created by the lack of land to satisfy the port infrastructure requirements and the need to handle contaminated dredged materials.



Fig. 4 Dredged material placement into port's ERA - 2011

In 1985, the Port of Townsville created 100 hectares external bund wall at its eastern part for development of reclaimed land using material derived from its maintenance and capital dredging campaigns [6]. Over the years, the bund is filled with dredged material and most of the reclaimed land is already used for port infrastructure; however, the land based dredged material placement into eastern end of the reclamation area is still ongoing, where some parts of the area have already reached their fill design levels and currently undergoing self-weight consolidation. The eastern reclamation area is the port's principle location for the land based dredge material disposal; it is located between the existing the Port of

Townsville's infrastructure ,Townsville Marine Precinct and the sea channel section of Ross River.



Fig. 5 Port of Townsville Eastern Reclamation Area -2014

The eastern reclamation area was originally constructed to be used for the port's anticipated infrastructure expansion that driven by trade throughput growth and the associated demand for efficient and reliable services that meet expectations of existing and future port users. To cater for dredged material to be derived from future maintenance dredging campaigns, the Port of Townsville is planning to increase the dredged material receiving and storage capacity of its eastern reclamation area.

APPENDIX: NOTIFICATIONS

Cd	Cadmium
Cr	Chromium
Cu	Copper
CSD	Cutter Suction Dredge
ERA	Eastern Reclamation Area
EPA	Environmental Protection Agency
NAGD	National Assessment Guidelines for Dredging
Ni	Nickel
Pb	Lead
TMP	Townsville Marine Precinct
TSHD	Trailer Suction Hopper Dredge
Zn	Zinc

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