

June 2018

Sediments and Dredging at GBR Ports

Reef 2050 Long Term Sustainability Plan

The Great Barrier Reef is over 2000 km long and covers an area of approximately 350,000 square kilometres. It is a unique environmental system made up of coral reefs, islands, coastal tidal habitats and open water. It requires special protection and management.

The Reef 2050 Long Term Sustainability Plan (Reef 2050) sets out strategies for protecting and managing this world heritage listed natural asset.

As part of Reef 2050, Queensland Ports are leading Water Quality Action No. 17 (WQA17), which has the objective to:

“Understand the port sediment characteristics and risks at the major ports and how they interact and contribute to broader catchment contributions within the World Heritage Area.”

This knowledge helps to manage port operations in a sustainable way that does not adversely affect the Great Barrier Reef (GBR). At the same time it helps keep our ports open and trading effectively to support our economy, communities and way of life.

GBR Sediment Summary

The evolution of the GBR has occurred over millions of years as a result of tectonic activity, sediment movements and coral reef growth. This has resulted in a series of islands, outer and inner reefs and a large, relatively protected inner lagoon (open water). The seabed area of the lagoon and inshore areas in particular are made up of varying sediment types including rock, gravel, sand, silts and clay.

Today, and continually over time, the seabed of the lagoon is moving and being suspended in the water column by winds and tides that drive waves and currents. At the same time large storm events, especially cyclones, move large amounts of sediment and the subsequent river runoff from flood rain brings further sediment into the system.

Sediment transport processes on the inner shelf of the lagoon are driven primarily by tidal and wind-driven wave resuspension. The south-east trade winds are dominant between March and October, these winds generate waves which resuspend coastal sediments and also result in a general movement to the north-west. Suspended sediments then become trapped in a turbid nearshore coastal layer that contains higher suspended sediment concentrations than adjacent offshore waters.

As show in the figure below, there is 90 billion tonnes of sediment within the GBR system with 9 million tonnes entering from catchments every year. Of this around 150 million tonnes is suspended within the water column by waves and currents on an annual basis. Approximately 900,000 tonnes settles out in port shipping areas such as channels, berths and swing basins. Two thirds (~600,000 tonnes) of this may resuspend in the water column during dredging operations to settle out somewhere else – usually in close proximity to the port.

Great Barrier Reef Inner Shelf

Sediment resuspension - tonnes per year (t/yr)



Weather events such as storms and cyclones can also contribute significantly to resuspension levels



Natural resuspension

150,000,000 t/yr



New sediment arriving

9,000,000 t/yr



Sediment deposited

900,000 t/yr

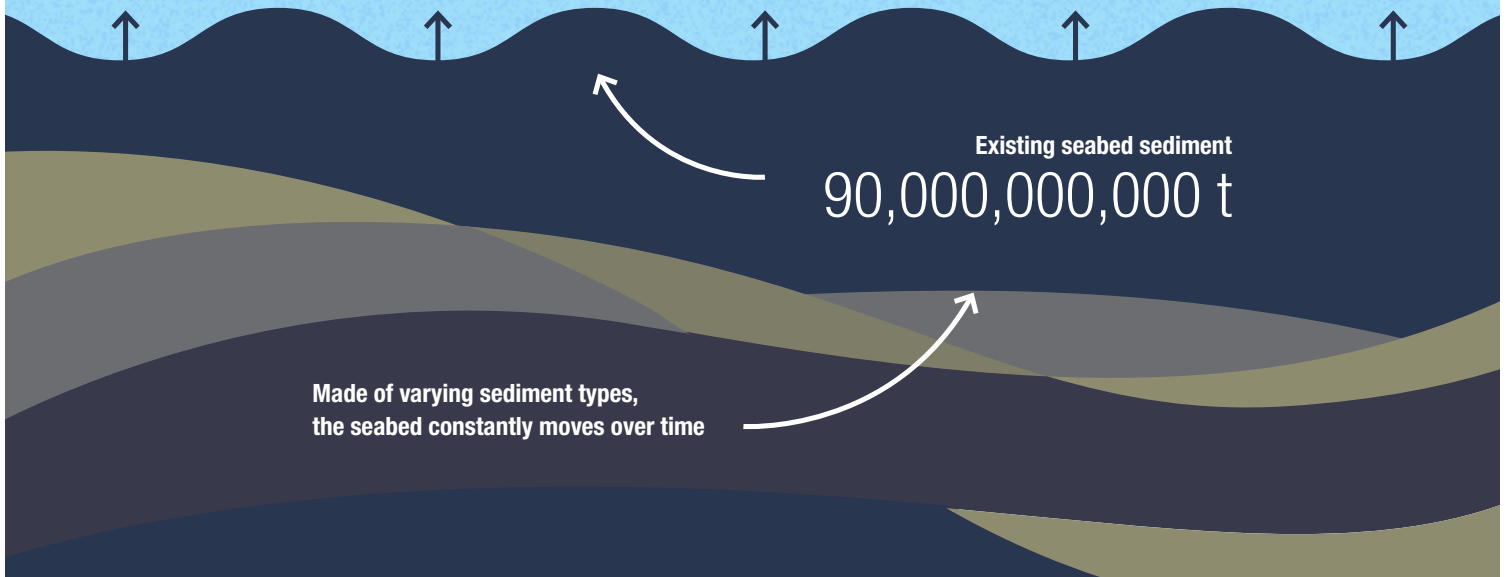


Port related resuspension

600,000 t/yr (0.4%)



Sediment is suspended into the water column primarily through natural processes

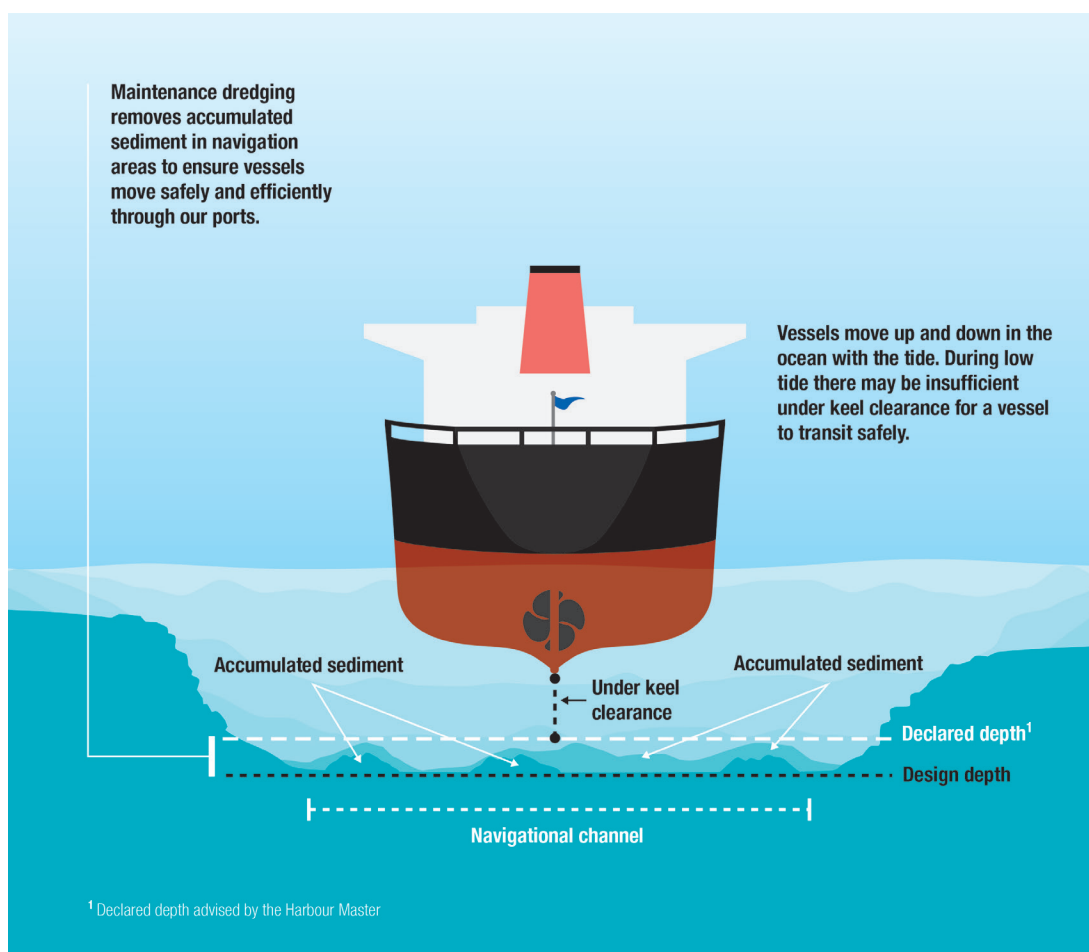


Sediment and Safe Navigation

Ports are vital to maintaining and growing our economy, enabling the export of our agricultural, mineral and manufactured commodities and imports such as food, fuel, cars and household goods that support our way of life.

Most ports are located in sheltered, shallow inshore areas or river entrances and have constructed channels and berths that provide access for vessels. These deeper areas that allow vessels to move safely also trap mobile sediment as the lower energy in deeper water allows sediment to settle.

Why maintenance dredging is important



As the sediment accumulates it reduces the depth of water that vessels can use. This can mean that larger ships and particularly ships with cargo loads can only enter or leave on higher tides. Ultimately vessels will not be able to enter the port and the port would be forced to close. Keeping the channels and berths open is as important to a port as is keeping the rail and road supply lines open.

Sediment at our Ports

Each of the ports within the GBR are different. Their location, setting and design mean that sediment movement and accumulation is specific to the individual port. The rates of sediment accumulation vary as does the frequency at which action needs to be taken to keep the channel and berths operating effectively. Key sediment budget characteristics for each major GBR port is shown below.

Sediment input and resuspension

A look at each port - tonnes per year (t/yr)

Input



Resuspension

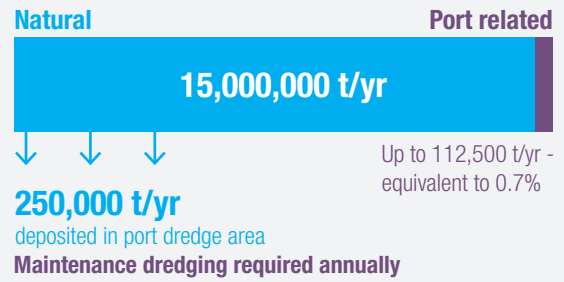


Gladstone

Input



Resuspension

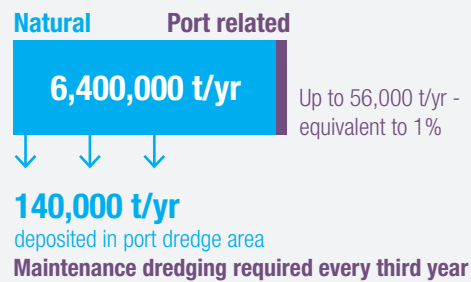


Hay Point

Input



Resuspension

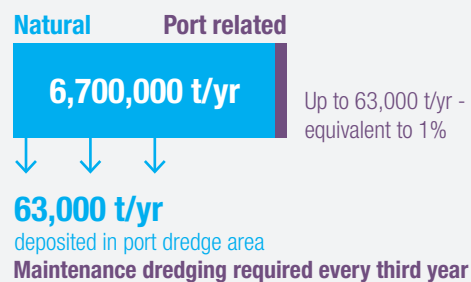


Mackay

Input



Resuspension



Sediment input and resuspension

A look at each port - tonnes per year (t/yr) cont...

Input

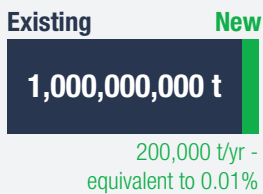


Resuspension

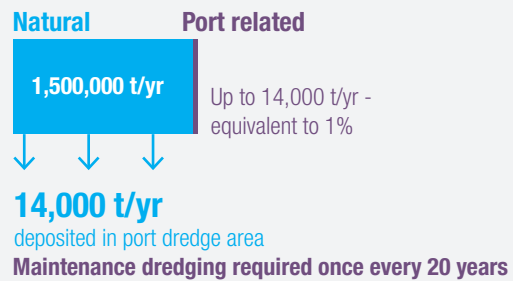


Abbot Point

Input



Resuspension

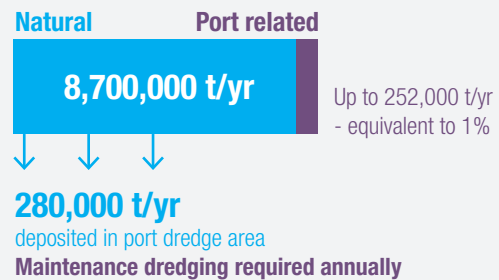


Townsville

Input



Resuspension

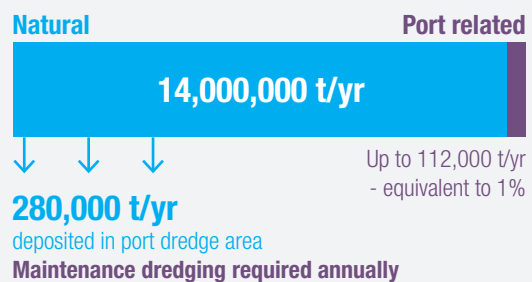


Cairns

Input



Resuspension



Impacts and Management

Ports aim to reduce their maintenance dredging requirements as much as possible and will only undertake dredging when necessary. Maintenance dredging is generally considered an expensive but necessary requirement for many ports, it is avoided if possible.

Optimising the original design of dredged channels, basins, aprons and berths relative to the natural sediment transport and sedimentation processes represents an opportunity to minimise future maintenance dredging. However, these areas have already been created at most ports and there are limited opportunities to further reduce future maintenance dredging requirements through the configuration of existing dredged areas. The design of any future proposed capital dredging works should be considered in terms of the future maintenance dredging requirements and optimised wherever possible.

Port-specific investigations are required to assess the applicability of the approaches on a case by case basis as the suitability is dependent on the port configuration, sediment type, natural environment and processes. There are three broad strategies that can be implemented to reduce siltation at ports and harbours, including:

- **Keep Sediment Out** – keeping sediment out of the area of interest that might otherwise enter and deposit.
- **Keep Sediment Moving** – raising flow velocities in quiescent areas to prevent sediment from settling as it passes through the area of interest.
- **Keep Sediment Navigable** – applicable to sites characterised by high turbidity near-bottom sediment regimes where navigability of fluid mud zones is permitted, thereby reducing the required dredged depth.

However in most GBR ports maintenance dredging is a generally a necessity of port operations due to trapping of sediment by navigation infrastructure including approach channels, berths and swing basins, which subsequently require dredging in order to maintain safety and access.

Any direct contributions from catchment runoff sediment loads will, in most coastal areas of the inner shelf, be overwhelmed by the magnitude of natural wind, wave and current-driven resuspension as the primary contributors towards elevating levels of turbidity. Consequently, whilst reducing catchment sediment runoff would have significant benefit generally, it will not significantly alleviate the volume, frequency and overall need for maintenance dredging at the vast majority of GBR ports.

Improving our Understanding

A broad range of information already exists that helps us understand sediment dynamics in the GBR region This information has previously been developed, compiled and made available by various government and industry organisations. This includes a number of recent publications:

- GBR Maintenance Dredging Strategy (TMR 2017), and the supporting technical information
- Environmental Code of Practice for Dredging and Dredging Material Relocation (Ports Australia 2016)
- Dredging and Australian Ports Subtropical and Tropical Ports (Ports Australia 2014)
- GBRMPA Guidelines for the Use of Hydrodynamic Numerical Modelling (GBRMPA 2012)
- Regional Water Quality Report Cards (various catchment/harbour partnerships, annual)
- Synthesis Report on Effects of Dredging on the Great Barrier Reef by Independent Expert Panel (GBRMPA 2015)
- Dredging Coral Reef Habitats (GBRMPA 2016)

Additionally a specific study was commissioned to develop a quantitative sediment budget related to maintenance dredging at each of the six GBR ports of Gladstone, Hay Point, Mackay, Abbot Point, Townsville and Cairns. These port-scale assessments have been further aggregated into an overall sediment budget for the inner-shelf region of the entire GBR.

This peer reviewed study undertaken by WBM BMT (2018) provides a useful comparison of the sediment resuspension contribution from individual port's maintenance dredging activity with the ambient (natural) turbidity generated by wind, waves and currents. The analysis has primarily been based on measured water quality data collected in the vicinity of the ports along with catchment contributions from the Paddock to Reef program.

While this WQA17 work provides a useful high-level point of reference for comparing the maintenance dredging quantities individually and collectively across the ports, it is only part of the information used by port authorities to inform management of sediment. Each port has ongoing monitoring programs to measure water quality, sensitive values (e.g. seagrass and coral) and dredging activities to ensure they understand their respective environments and risks. A good example of the studies and level of information used by ports is the Port of Hay Point Sustainable Sediment Management Project (refer <https://nqbp.com.au/sustainability/research-and-reports/sustainable-sediment-management-research>).

Future Management

Sensible management of sediment and maintenance dredging is a priority for all GBR ports. The major ports have or are developing long term maintenance dredging management plans in accordance with GBR Maintenance Dredging Strategy. The plans will guide actions to ensure dredging is undertaken sensitive to the environmental values surrounding the port and that our ports continue to demonstrate global best practice.