TWEED RIVER ENTRANCE SAND BYPASSING PRECOMMISSIONING DREDGING WORKS

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Abstract

The Tweed River Entrance Sand Bypassing Project (TRESBP) was aimed at establishing and maintaining a clear navigation channel and restoring the beaches north of the entrance. While the permanent bypassing jetty was being designed, constructed and commissioned, these objectives were met by dredging only. The Tweed River Entrance is in an area with high wave energy and longshore sediment transport averaging 500,000m^3/year. In this environment, the effectiveness of the dredging was heavily dependent on consideration of coastal processes in determination of operational procedures. Regular surveys and data analysis was needed to respond to changing conditions. Storm periods with high sand transport rates created bars across the entrance but surveys showed that the infilling into the channel area was not as high as expected and natural bypassing in these events was still significant. After storms, the dredge was able to re-establish a channel quickly.

1. Introduction

The Tweed River entrance is situated in New South Wales, just south of the Queensland border (Figure 1). To improve navigation within the entrance, the training walls (constructed in the 1890's) were extended on both sides of the channel in 1962. While this improved navigation for a short period, shoals quickly re-established across the entrance. In addition, significant accretion occurred to the south of the trained entrance and the interruption of predominant northerly littoral drift led to significant erosion of the beaches to the north.

The location of the state border between the dredge area and deposition areas has added to the project's complexity, giving both navigation and beach nourishment objectives high priority.

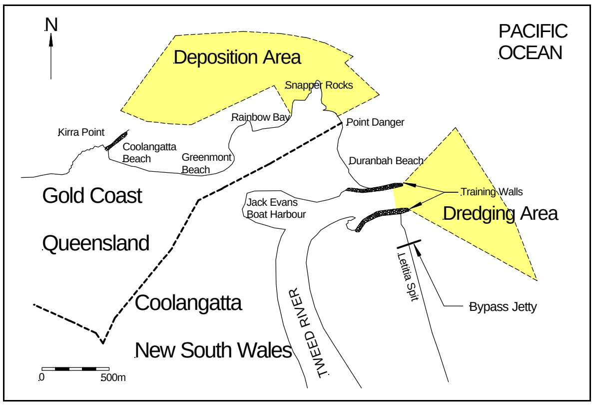

Figure 1 : Map of Region highlighting Qld-NSW border

The objectives of the Tweed River Entrance Sand Bypassing Project (TRESBP) are to:

- establish and maintain a clear navigation channel
- supply sand to the southern Gold Coast beaches at a rate consistent with natural littoral drift, in addition to that required to restore the beach's recreational amenity.

Implementation of the permanent bypass structure has been a lengthy process due to the complex coastal and political processes. As a result, interim bypassing from 1995 to 2001 has been completely by dredging. After commissioning, some dredging to remove leakage is expected.

The initial dredging works (Stage 1) were aimed at clearing the 30 years of sand accretion on the ebb delta, and re-establishing the eroded beach and nearshore shoals along Rainbow Bay and Coolangatta beaches to the north. Stage 1 dredging works were implemented directly by the NSW and Qld state governments.

Dredging in Stage 2, the pre-commissioning stage, was implemented by the contractor, McConnell Dowel, as part of the bypassing contract. Stage 2 dredging has been focused on providing and maintaining the entrance channel to specified minimum dimensions, with the sand deposited nearshore along the restored beaches.

The dredges utilised on Stages 1 & 2 of the project have varied considerably, with capacities as below ranging from 17,000m^3 to 320m^3.

<u>Stage 1a – 2.3Mm^3</u>
Contractor: Dredeco
Dredges: Pearl River, Ngamoto & Krankeloon
Dredge capacities: 17,000m^3, 490m^3, 700m^3
Lengths: 144m, 61m, 94m
Drafts: 7-10.4m, 2.5-3.5m, 4.5-6.5m

<u>Stage 1b – 800,000m^3</u>
Contractor: McQuade Marine
Dredges: Port Frederick & Faucon
Dredge capacities: 450m^3, 320m^3
Lengths: 49m, 42m
Drafts: 2.2 - 3.6m, 1.6 - 3.1m

<u>Stage 2 – 750,000m^3</u>
Contractor: McQuade Marine
Dredges: Port Frederick (Figure 2)
Dredge capacities: 450m^3
Lengths: 49m
Drafts: 2.2 - 3.6m

2. Site Conditions

The Tweed River entrance is in an area with high wave energy, tidal flows and longshore transport (averaging 500,000m^3/yr), making conditions difficult for dredging, particularly in the vicinity of the rock training walls. As the Port Fredrick is a shallow draft dredge with thrusters, dredging through the bar and near the walls was possible. The shallow draft also enabled the sand to be placed nearshore in the active zone, without the cost and safety issues associated with pumping ashore.

Figure 2 : Port Fredrick dredging the entrance on a mild day.

Considerable long-term coastal process data is available for the site, and this has been used to optimise the dredging and deposition locations and operational methods. A wave rider buoy had been established as part of the coastal process investigations, and real time data was available to the dredge contractors, initially by a dial up connection and later through the Internet. With the variability of wave climate in the area, access by the dredge to current wave measurements and trends was essential so that dredge stand down time could be minimised, and also to ensure the safety of dredging operations.

During the bypass commissioning, estimated daily sand transport rates were calculated by the Project Managers, Brown & Root. During this period, 1 - 25 March 2001, modelled daily sand transport rates varied from 442m^3/day to 24,696m^3/day. Wave heights are similarly variable and over the contract period Hs has ranged from 0.67m to 4.73m.

The dynamic environment and variability of the site, combined in the later stages with the interaction with the bypassing system, has led to the need for a higher awareness and responsiveness to coastal processes than more typical, straightforward dredging operations.

3. Channel and Nourishment Requirements

A clear navigation channel is defined in the contract as a region, within specified boundaries, comprising of straight sections of channel at least 200m in length and with a maximum change of alignment of 20°. It is required to be at least 70m in width and 4.4m below AHD.

Although payment was on a cubic metre basis, the dredging has been aimed at efficiently achieving and maintaining the objectives as quickly as possible, rather than just moving sand from the dredge area to the deposition area. In the dredging area, dredging was aimed at cutting a channel through the bar as quickly as practical. This approach succeeded in intercepting the infilling sand and quickly removed bars formed across the channel during storms.

While this approach has meant working through the breaking wave zone between the training walls rather than at the seaward extent of the allowable dredging zone, the efforts were effective in establishing and maintaining the navigation channel.

In some conditions, dredging needed to be restricted to high tides. As it is a small dredge with thrusters, manned by a relatively small crew, it was possible for this to be done both effectively and efficiently.

Achieving the objectives has required transporting an average of at least 40,000m^3 each month and working, as far as practical, in high transport conditions (ie Hs >1m). To the end of July 2001, as shown in Figures 3 and 4, the dredging has matched the infill rate and significant reduction in the target volume is expected prior to the summer storm period. During storm periods, it was observed that sand infill into the dredge area generally tended to form bars partially, or fully, across the entrance near the seaward end of the training walls. However, the quantity in these bars was not high and could be removed usually within 3–5 days. Downtime has needed to be minimised and dredging has generally been able to safely continue in significant wave heights up to 2m.

Surveys have indicated that much of the sand transport is spread out within the dredged area and a significant quantity is bypassed in storm conditions.

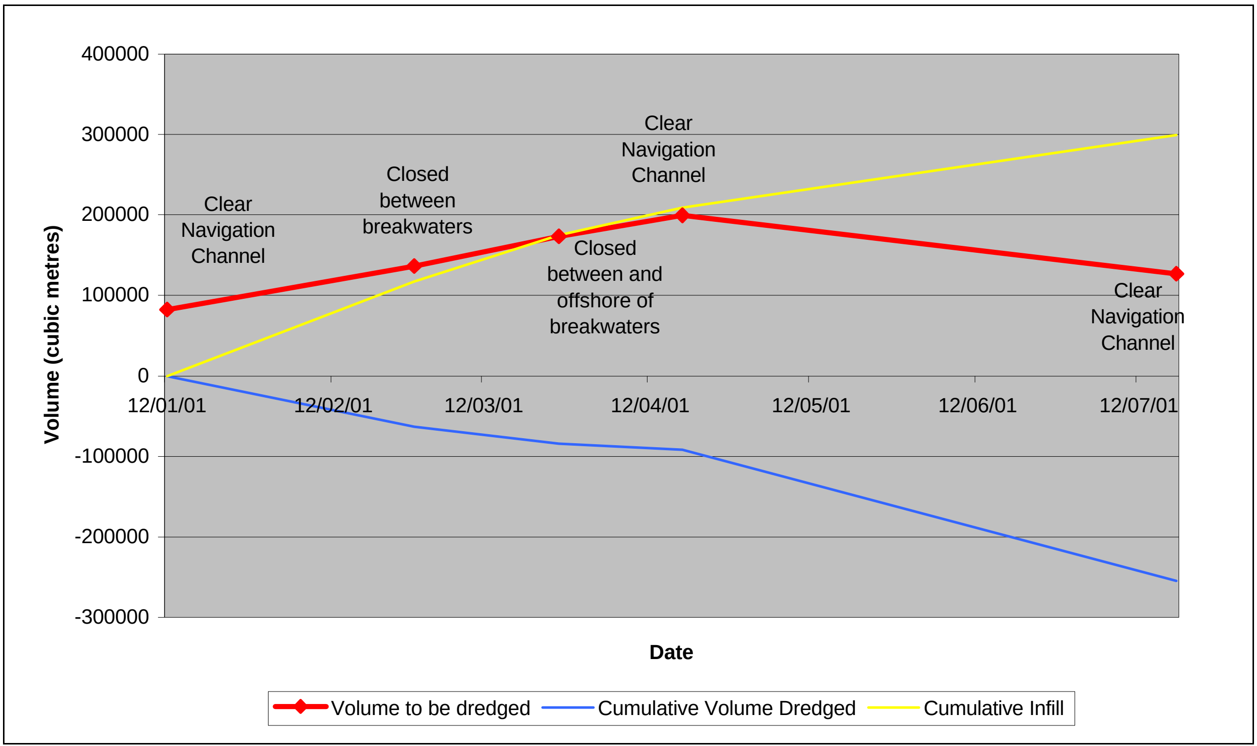

Figure 3: Plot of cumulative dredging volumes, cumulative infill volumes and volume to be dredged over the period 12/1/01 – 19/7/01.

Indeed, quantities for the month of March indicate that approximately 80,000m^3 of the total 140,000m^3 littoral drift bypassed the training walls naturally.

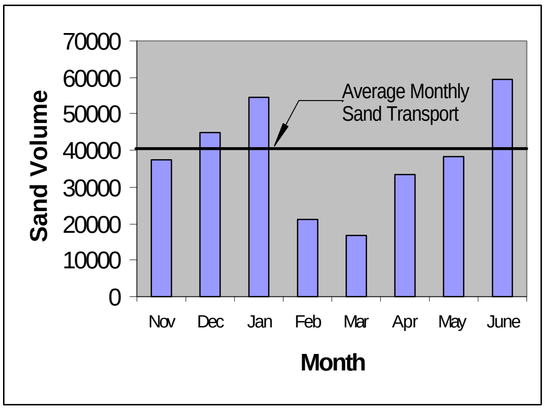

Figure 4: Plot of monthly dredge quantities.

In stage 1 the nearshore shoals and upper beach were re-established. Subsequently, the bypassed sand was deposited nearshore only to maintain the shoals and protect the beaches. The nearshore deposition areas were divided into a large number of dump boxes. After surveys of the deposition areas, the allocations into each dump box was re-evaluated by the client to ensure the optimum benefit to the beaches with least impact on surfing conditions.

Rapid smoothing of any mounds in the deposition area was expected during storm wave conditions, but several mounds above the approved crest height of RL –4.5m AHD in the centre nearshore area at the downdrift end of the deposition areas persisted through several storm events. This led to the need to be careful with quantities placed in each dump box. After each survey, the quantities allocated to be placed in each dump box was updated by the Principal's engineers. Scour in the dredge area at times caused concern as to whether the cause was overdredging or periodic scouring during spring tides

4. Data required

For efficient working and contract compliance, collaboration between project engineers and the dredge manager and operators on a regular and often daily basis was essential. It was necessary to regularly monitor the dredge's performance and, to this end, data was regularly collected and analysed with the results sent to both the client and the dredge

Regular and post-storm surveys of the entrance channel and nourishment region have been carried out. The results of these surveys were generally provided as coloured isopacs which were useful for dredge operations. In addition to monitoring progress, the surveys also provided the basis for the calculation of volumes required to bring the dredging and deposition areas to design depth. These calculations are repeated after each survey. Taking into account the sediment inflow into the region and the rate at which the dredge removes sand, the time required to achieve design depths were then estimated. The regular variations to dredge and deposition requirements was a QA challenge that was generally met.

In order to assess the volume of sand being transported in any given load, a combination of a flowmeter reading and a manual method relating depth of sand in the hopper to volume carried was used. Both volumes are recorded on the log sheet. To ensure accuracy, the flowmeter is recalibrated on a regular basis and plots of the ratio of flowmeter reading to manual method are generated. Flowmeter volumes are printed and all mass flow data is retained on floppy disk (Figure 5). This data can be displayed as a spreadsheet.

To ensure the sand is being deposited in the correct location, a DGPS system has been installed on the dredge. As a load is dropped, the coordinates are recorded on the log sheet along with the time of the drop. These are then plotted on a grid showing approved dump boxes to ensure they are within the given area. The position of the dredge is also electronically recorded every minute, allowing the dredge position to be plotted and back up checks to be made. Presently, this file is processed by McConnell Dowel,

the conversion enabling the data to be opened in spreadsheet format.
Synchronising the clocks on all instrumentation allows any recording errors to be checked and corrected. Comparison between mass flow data and dredge position allows the location of the dredge when depositing the load to be determined independently of information recorded on the log sheets.

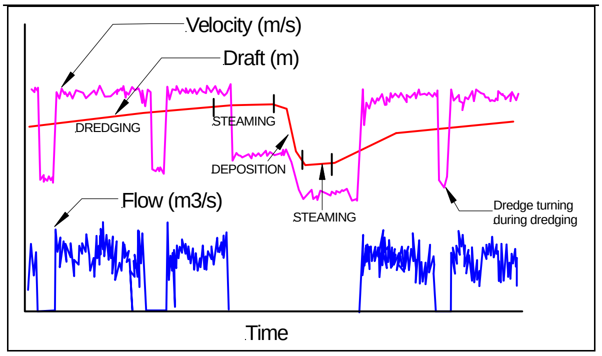

Figure 5 : Plot of Mass Flow data

Water quality data has also been required to be collected at least once per week.

5. Communication of Data

Initially, inspectors were brought aboard the dredge to monitor performance and ensure contract compliance. Despite strict safety procedures, this still resulted in some risk to inspectors transferring to and from the dredge, as well as a loss of dredging time. As dredging times were varied to suit tide and wave conditions, planning for inspectors was difficult. To minimise the need for inspectors, an electronic data logging system has been set up enabling data to be transferred electronically to the client along with the faxing of manual log sheets from the dredge itself on a regular basis.

Log sheets filled in on the dredge (incorporating flowmeter volume, calculated volume, time of dredging and deposition, deposition coordinates, dredging and deposition boxes) are faxed by mobile phone directly from the dredge and input into the computer. Analysis of the data allows trends to be monitored and discrepancies to be identified and either accounted for, or altered to their correct values, by reference to electronic data. Flowmeter data and DGPS data are still kept on disk, but are also uploaded daily onto an onboard laptop at the end of the shift. A password allows these files to be accessed by those involved in the project at any time through dial-up-networking. Files can thus be transferred relatively easily and economically.

By allowing those involved to access these files and monitor performance as required, the need and associated costs of having inspectors on board is effectively eliminated. This was a cost and safety benefit to all parties involved.

6. Conclusions

Despite high sand transport rates and average wave conditions of Hs > 1m, a navigable entrance and the downdrift beaches have been maintained by dredging and nearshore nourishment. The ability to safely and efficiently dredge in conditions up to Hs = 1.8m, and to restore a safe channel quickly after storms has exceeded initial expectations. Once the permanent bypass is completed, it is expected that intermittent dredging will still be required.

7. References

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