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Sediment and Hydrodynamic Assessment of the Lower Myall River Estuary and Preparation of Management Recommendations

Final Report

September 2011

Great Lakes COUNCIL

DOCUMENT CONTROL SHEET

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Title :	Sediment Hydrodynamic Assessment of the Lower Myall River Estuary and Preparation of Management Recommendations
Author :	David Wainwright, Dr Emma Gale, Dr Philip Haines, Luke Kidd
Synopsis :	A study report detailing an assessment of hydrodynamics and morphology of the Lower Myall River. The first part of the study identifies management issues through background data review, data analysis and community consultation. The study then involved development of hydrodynamic and morphodynamic numerical models of the Lower Myall River and entrance areas. Options for improving the condition of the river entrance were developed and were evaluated using the numerical models.

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EXECUTIVE SUMMARY

The entrance of the Lower Myall River is highly dynamic. Ocean storms, swell waves, wind waves, tides and catchment runoff all contribute to regular changes in sand shoals and channels in and around the entrance area. Navigation through the entrance has been maintained by periodic and selective dredging of the Northern Channel, behind Corrie Island. The Eastern Channel, however, has not been dredged in recent years, and has progressively shoaled, particularly over the past 10 years or so.

This report investigates the shoaling of the Eastern Channel; its causes, its ramifications; and possible options for manipulation. A companion investigation, undertaken by DECCW in 2010, has explored the current ecological health and water quality of the Lower Myall River.

Recent shoaling of the Eastern Channel is linked to acute erosion of the Winda Woppa shoreline west of Barnes Rock, where a small wetland is now under threat. In this location, ocean waves have eroded the shoreline and are pushing sand westward toward the Eastern Channel (i.e. longshore drift). Analysis of beach data suggests that the shoaling in the Eastern Channel is unlikely to be linked to erosion on Jimmy's Beach, to the east of Barnes Rock.

Gauging and hydrodynamic modelling indicate that as the Eastern Channel has become constricted, more tidal flows are directed through the Northern (Back) Channel. Total tidal flows and levels upstream of the confluence of the two channels remains unchanged. What has changed, however, is the effectiveness of oceanic flushing within the lower reaches of the River. The Northern Channel is connected to Pindimar Bay some distance from the ocean, whereas the Eastern Channel is connected directly to the expansive Port Stephens flood tide delta. Therefore, water exchanged through the Eastern Channel is typically 'clean' seawater, whereas water exchanged through the Northern Channel is 'residual' Port Stephens water.

The DECCW (2010) study showed that Pindimar Bay and the Lower Myall River do not have poor water quality. Indeed the water quality is typical of estuarine environments, while the ecological health is considered very good, and comparable to other nearby estuarine locations in Port Stephens. The recent constriction of the Eastern Channel therefore has not manifest in wider environmental impacts within the River to date.

The shift in tidal flow preference from the Eastern Channel to the Northern Channel may, however, help to explain the perception of reduced water clarity and salinity within the River, which has been reported anecdotally over the past few years. Flushing analysis suggests that when the Eastern Channel dominates tidal exchange, environmental conditions in the lower Myall River would tend to be more oceanic/marine, whereas when the Northern Channel dominates, the conditions would tend to be more estuarine/brackish. Given the recent shoaling and associated shoreline erosion, it is conceivable that the Eastern Channel may eventually close completely. The timeframe for this to occur is unknown, and it may also require a catalyst, such as a large coastal storm. If and when the channel does close, it is likely that the Lower Myall River will become more estuarine (given 100% of tidal flows through the Northern Channel). Subject to further assessment, it is considered unlikely that complete closure of the Eastern Channel would have a detrimental impact on ecosystem health, although it may become less preferable for more marine-dependent species. There may also be a change to the aesthetics and amenity of the River, with a possible reduction in water clarity and effectiveness of seawater exchange.

Works within the Eastern Channel would be required to reduce the likelihood of complete closure, or to re-open the channel once closed. Depending on the scale of these works, seawater exchange could actually be increased within the river compared to existing conditions. But ultimately, such channel works would only primarily address aesthetics and amenity, through an increase in water clarity and seawater exchange. There is currently no over-arching environmental justification for undertaking channel works. But conditions should continue to be monitored closely in the future as the channel approaches closure. Any decision to undertake intervention works in the Eastern Channel would need to consider all benefits and costs, as well as the perspectives of all potential stakeholders, including the community.

Works in the Eastern Channel would essentially involve dredging. There is an opportunity for dredging of the Eastern Channel to be used as a source for future sand nourishment of Jimmy Beach. Recent nourishment works at Jimmys Beach have involved extraction of sand from the nearshore zone in an area near Yacaaba Headland. It is understood that the Yacaaba source may not be able to meet on-going nourishment demands in the future. The Eastern Channel therefore could be considered as an alternative or additional source for nourishment, subject to further investigations.

Any dredging program within the Eastern Channel would need to consider how quickly sand would re-fill the channel, and how often follow-up dredging may be required (if the channel is to remain open). Based on estimates of longshore drift, the channel would continue to infill at a rate of between 10,000 and 20,000m^3 per year. This rate could be reduced through the construction of a groyne at the western end of Winda Woppa Spit. A groyne would trap sand that continues to be eroded from the shoreline west of Barnes Rock and would help to maintain an open channel. The fillet of sand that builds in front of the groyne could also be used as a land-based source of sand for on-going nourishment.

If a groyne is not built, sand would need to be extracted subaqueously from the channel. This could be done using a mobile dredger as part of discrete dredging campaigns, or by using fixed-in-place infrastructure (such as a Sand Shifter device), where sand is fluidized, sucked into buried inlets and pumped ashore (this is currently done in the Noosa River and other locations for continuous nourishment of adjacent beaches).

Given that sand moving into the Eastern Channel is primarily the result of shoreline recession west of Barnes Rock, there may also be a need to return some sand to the eroded beach profile, particularly if access to the end of Winda Woppa Spit is to be maintained or the currently eroding wetland is to be protected. Excess sand removed from the channel by capital dredging could be stockpiled locally (e.g. at the end of Winda Woppa Spit) and used for nourishment as needed.

Initial capital dredging of the Eastern Channel would likely cost in the order of $1.5 – 2.5 million, depending on the volume of sand removed (volumes of 55,000m^3 and 95,000m^3 have been investigated to date). The establishment of fixed-in-place infrastructure for permanent sand pumping from the channel would cost less than $1 million, with on-going pumping costs of approximately $150,000 per annum (delivering sand to Jimmys Beach at a rate of about 15,000m^3 per year).

By comparison, approximately $1 million has been spent recently by Council and State Government nourishing Jimmy's Beach (total volume approximately 80,000m^3) as part of a 3 year nourishment trial (Jelliffe Consultants, 2003). Some 372,000m^3 of sand was previously (1984-1998) placed on Jimmy's Beach to mitigate erosion risks (Watson, 2000), giving an average beach nourishment of about 17,000m^3 per year over the past 25 years.

Background and History

The area of Port Stephens in the vicinity of the Eastern Channel (known locally as "Paddy Mars Bar") is ever-changing. The dynamism of the area is highlighted by the fact that Myall Point, a previous 2km long finger of sand extending south from the end of Winda Woppa, was completely destroyed during coastal storms in 1927 and 1929. Dredging of a navigable channel north of Corrie Island, dating back to the early 1900s, has also affected the pattern and distribution of tides and flood flows into and out of the Lower Myall River.

For the area west of Barnes Rock, coastal processes are continuing to push sand westward along Winda Woppa Spit. This sand has encroached into the Eastern Channel, which has responded by migrating westward and eroding the eastern shore of Corrie Island. Over the past 50 years, Corrie Island has receded by more than 100 metres. The rock wall in the Eastern Channel used to be the western (Corrie Island) edge of the channel - it now forms the eastern edge of the channel.

Consultation and Community Perspectives

Although the Eastern Channel has always been dynamic, it has become increasingly shoaled since about 2001. Local community members have raised concerns with all levels of Government regarding a perceived reduction in water clarity and water quality within the Lower Myall River.

As part of this project, a series of workshops were held with the Myall River Action Group (MRAG) to gather local perspectives. The first workshop involved clarification of the key community issues associated with Lower Myall River. At this workshop, the MRAG highlighted several areas of erosion and sedimentation as well as concern for reducing water clarity and water quality within the river, and in Pindimar Bay. As outlined above, the DECCW (2010) study showed that water quality and ecological health in the Lower Myall River and Pindimar Bay are typical of estuarine systems.

Areas of erosion and accretion raised by the MRAG included:

- Erosion of Corrie Island eastern shore;
- Erosion west of Barnes Rock into protected wetlands;
- Accretion along the edges of the Northern Channel;
- Accretion within the Lower Myall River main channel;
- Accretion in the vicinity of Singing Bridge.

The second workshop was carried out following background investigations and preliminary modelling of tides and oceanic flushing. The workshop put the previous MRAG issues into a scientific context, and helped explain why particular processes are occurring.

The third workshop was aimed at identifying a range of potential options that could address the initial issues of concern. The options were developed taking into consideration the science behind the issues, and practicalities of implementation and feasibility of outcomes. Although tabled initially, a number of grand-scale options like rebuilding Myall Point were rejected as impractical during the workshop.

It is envisaged that there may be a range of alternative community views on this topic, and wider community engagement is proposed through the public exhibition of this document.

Evaluation of Intervention Options

The ecological health of the Lower Myall River is currently not compromised by the shoaled condition of the Eastern Channel. Intervention options for the Eastern Channel were therefore evaluated on the basis of improvements to aesthetics and amenity of the river, which fundamentally were the concerns of the MRAG.

Options that were initially considered to have excessively high capital costs (e.g. a fully trained entrance or rebuilding Myall Point) or unacceptable environmental or social impacts (e.g. infilling of the Northern Channel) were excluded from detailed analysis. Remaining intervention options focused on dredging within the Eastern Channel, with and without a groyne at the end of Winda Woppa spit, which could potentially improve the longevity of a dredged channel.

As part of the evaluation process, consideration was given to the 'do nothing' option. For this option, it was assumed that the Eastern Channel was completely closed. In the absence of any intervention works, there is a reasonable likelihood that the channel would eventually close (although the timeframe for this to occur is unknown).

Computer modelling of the options confirmed that dredging within the Eastern Channel would increase tidal flows through the Eastern Channel, while reducing tidal flows through the Northern Channel. The ratio of flows between the Eastern and Northern Channels would return to about 3:1, which is comparable to the ratio measured in 1975 (this compared to the most recent flow gauging in 2009 when the ratio was approximately 1:1). Tidal flows upstream of the confluence would remain unchanged.

The increased flow through the Eastern Channel resulting from dredging would improve oceanic flushing in the lower reaches of the River. This is because tides in the River would exchange more with 'cleaner' seawater nearer the entrance to Port Stephens, and less with Pindimar Bay. There was no significant difference in flushing for the different dredging options modelled – all options gave a similar level of improvement.

Analysis of longshore drift along the shoreline west of Barnes Rock was used to determine the potential rates of infill for a dredged channel. A longshore drift rate of between 10,000 – 15,000m^3/yr has been calculated. For channel dredging of 55,000m^3, approximately 50% of the dredged material will return within about 3 years, while for dredging of 95,000m^3, 50% infill would take roughly 5 years. A groyne at the end of Winda Woppa spit would improve the longevity of dredging, but comes at a high capital cost given the length of the structure required. A groyne would also be a very prominent 'hard' feature of the landscape, and its wider environmental and social impacts would require careful consideration. Within such a dynamic environment, it would be difficult to ensure that the groyne remains functional in the future.

An alternative and possibly more pragmatic option may be a permanent sand pumping system, which can be modified and adjusted to suit specific requirements (including alternative disposal locations). This adaptable and flexible approach could also accommodate potential future variability associated with sea level rise and climate change impacts. It would require, however, an on-going financial commitment as part of a continuous maintenance program. This option would be particularly suited if sand pumped out of the channel could be directed onto Jimmys Beach as part of a permanent nourishment solution. Placement of sand onto Jimmy's Beach would need to be supported by an environmental assessment of the impacts of introducing 'new' sand to this part of the shoreline.

Benefit Cost Analysis

Undertaking intervention works in the Eastern Channel would likely improve the aesthetics and amenity of the River (through improved water clarity and oceanic flushing), but any wider benefits would be limited. When considering the possible dual function of supplying sand for on-going nourishment of Jimmys Beach, the benefit cost rate becomes more attractive. Indeed there may only be a marginal cost difference, if any, for extracting nourishment sand from the Eastern Channel compared to the current reserve adjacent to Yacaaba Headland, when considered over longer time periods (i.e. 20 years +). Again, this assumes that there would not be any detrimental impacts associated with using this sand on Jimmy's Beach.

Recommendation

A sand scoping study is being considered that will investigate long-term management and nourishment of Jimmys Beach (including sand sourcing, delivery and placement). It is important that the option of sourcing sand from the Eastern Channel, either via a permanent sand pumping system or discrete dredging campaigns, be included and evaluated in this context, as well as alternative sand sources such as the Yacaaba sand deposit that has been used for most recent nourishment works.

The ecological impacts of erosion on the eastern shore of Corrie Island as well as the small wetland to the west of Barnes Rock should also be assessed, and an alternative management strategy be developed if dredging of the Eastern Channel is not to be pursued in the near future.

If (and when) the Eastern Channel closes, the ecosystem health of the Lower Myall River should be re-assessed to examine any wider environmental impacts of the channel closure.

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1 INTRODUCTION

1.1 Study Area

The Port Stephens / Myall Lakes estuary is located approximately 50km north of Newcastle, NSW. The Lower Myall River enters Port Stephens from the north, while the other major tributaries to the estuary, the Karuah River and Tilligerry Creek, enter from the northwest and south, respectively (Figure 1-1).

The Myall Lakes are located north of Port Stephens, connected via the Lower Myall River. The Lakes comprise a series of three interconnected lakes (Bombah Broadwater, Boolambayte Lake and Myall Lake). The Lower Myall River is around 30 km long extending from Bombah Broadwater to Port Stephens. The River enters Port Stephens through a channel between Corrie Island and Winda Woppa spit (the eastern or "Shortcut" Channel), and also through a channel to the immediate north of Corrie Island (the northern or "Back" Channel) into Pindimar Bay (Figure 1-2).

An extensive marine flood tide delta covering an area of some 22.5 km^2 extends across the entrance to Port Stephens and includes area adjacent to Winda Woppa and the Eastern Channel (Austin *et al*., 2009). This delta has been formed during the Holocene period by the complex interaction of tides, waves and minor flows from the Lower Myall River. The delta is shallow, typically less than 4 to 8 metres below mean sea level. A steep dropover at the distal edge of the delta into deeper water extends roughly north-south from Corlette Head to the western side of Corrie Island. West of the dropover, water depths increase to 20 metres (MHL, 1999).

Interactions between tidal currents, swell waves, wind waves and occasional fluvial flows from the Myall River continue to rework the sand shoals (e.g. Paddy Marrs Bar, Middle Ground), channels and islands (e.g. Corrie Island) of the flood-tide delta and adjacent shorelines. Episodic erosion of the eastern side of Corrie Island occurs during storms with large ocean waves. Tidal flows are also presently eroding the eastern side of Corrie Island.

An estuarine beach complex extends 4.2 km westwards from Yacaaba Headland to the Myall River mouth, including the Yacaaba barrier, Jimmys Beach and Winda Woppa spit. Detailed investigations are ongoing and aim to better understand morphologic changes of the flood-tide delta and these adjacent estuarine beaches. A recent report by Vila-Concejo *et al*. (2008) concluded:

- a sand wave at Yacaaba Barrier has undergone various cycles of accretion and erosion, with westerly migration of up to 70 metres per year between 1993 to 2003 followed by relative stability, with occasional storm events (e.g. June 2007) allowing for accretion of the sand wave;
- Ongoing recession of Jimmy's Beach, to the east of Barnes Rock, threatens a number of residences along The Boulevard. Recession has occurred at an average rate of 1 metre per year between 1951 and 2006.
- The shoreline between the western end of the sand wave near Yacaaba headland to the recession area has been stable over the medium to long term; and

Title:

Locality Plan

Figure: 1-1

Rev: A

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Approx. Scale

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Title:
Study Area

Figure: 1-2

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- Winda Woppa spit is subject to ongoing retreat and westward extension (approximately 800 metres since 1951).

Earlier work by Vila-Concejo *et al*. (2007) also notes that sediment transport patterns inside the Port Stephens estuary are not clear and that future investigation should be undertaken, using a morphodynamic model to represent the key processes. To improve management of the system, Vila-Concejo *et al*. (2007) highlight that sediment exchanges need to be quantified to better understand and protect public and private assets.

Historically, the main entrance to the Lower Myall River was the Eastern Channel between Corrie Island and Winda Woppa. Anecdotal evidence indicates that ships previously unloaded ballast rock within the channel prior to traversing the shallower depths to Tea Gardens (with the rock still evident today). The former Myall Point is claimed to have extended from the northern foreshore to within approximately 100 metres of the southern foreshore of the estuary (Umwelt, 2000), although historical mapping presented in Thom *et al*. (1992) suggests that this claim is unfounded, at least in contemporary times, with some 2.5km between the southern tip of Myall Point and the Port Stephens southern shoreline in 1920.

Myall Point was still nonetheless an historical sand feature extending southwards from Winda Woppa, parallel to Corrie Island extending the Lower Myall River well into the Port Stephens waterway. Myall Point was destroyed during severe storms in 1927 and 1929 (Umwelt, 2000). In addition, dredging to form the Northern Channel is believed to have commenced around the turn of the 20th century to assist with navigation between Pindimar Bay and Tea Gardens. Both these events are reported to have initiated major changes to the entrance configuration of the Lower Myall River (MHL, 1999).

The changes to the Lower Myall River entrance include shoaling of the Eastern Channel, which has now become less tidally dominant compared to the Northern Channel. The Eastern Channel has become restricted to the point that access is only possible at high tide by experienced navigators. The Northern Channel has become the main navigable entrance to the Lower Myall River.

In the past, there has been pressure to dredge the Eastern Channel between Corrie Island and Winda Woppa spit, and subsequently use the dredged spoil to nourish Jimmys Beach. However, there is doubt that river flow would be able to naturally maintain such a channel, thus necessitating on-going dredging of the channel (MHL, 1999).

Shoaling of the Northern Channel has also been an ongoing issue, causing additional problems for navigation into the Lower Myall River. It has been necessary to dredge this channel to maintain navigation, particularly for the larger boats – dredging has most recently been carried out in late 2010.

The continued shoaling of both channels means that ongoing dredging has become a logistical and financial issue for Council and the State Government. Other issues associated with changes to entrance conditions include the cost of relocating navigational markers, risks to commercial and recreational vessels as they cross the shoals and potential loss of tourism into the Tea Gardens and Myall River due to difficulties with navigation (Umwelt, 2000).

1.2 Detailed Study Area

The present study focuses on the Lower Myall River downstream of the Singing Bridge (between Tea Gardens and Hawks Nest) and its entrance into Port Stephens (refer Figure 1-2). It includes the Northern (Back) Channel, the Eastern (Shortcut) Channel, Corrie Island, and Winda Woppa Spit to the west of Barnes Rock.

The issues of concern within the focus area are influenced by coastal and estuarine processes in adjacent areas, such as the Lower Myall River upstream of the Singing Bridge, Jimmy's Beach to the west of Barnes Rock and the broader flood tidal delta which occupies much of Port Stephens to the east and south of Corrie Island. In turn, processes and morphodynamic responses in those areas are influenced by hydrodynamics and wave processes in Port Stephens, the Myall Lakes and the ocean beyond Yacaaba and Tomaree Headlands.

While the issues of concern to this study apply to the detailed investigation area, the broader processes affecting those issues have been considered where appropriate.

1.3 Objectives

The objectives of this study are:

- To undertake a sediment and hydrodynamics assessment of the Lower Myall River estuary that provides specific recommendations for the long term management of navigation, shoaling and river health in the Lower Myall River;
- To incorporate inputs from stakeholders and community concerns particularly regarding the restriction to safe navigation caused by shoaling in the Eastern and Northern Channels and Lower Myall River, and erosion of the Winda Woppa Peninsula west of Barnes Rock;
- To address community concerns relating to hydrodynamic and sediment dynamic processes that influence waterway conditions within the study area noting that maintenance dredging has previously been identified within the Port Stephens and Myall Lakes Estuary Management Plan (2000) as a potential management option; and
- To present a better understanding of key coastal processes influencing waterway conditions (e.g. hydrodynamics, morphology, waves, climate change, and tidal interactions).

1.4 Methodology

A number of tasks have been undertaken to achieve the abovementioned objectives. These tasks have been undertaken broadly in three stages:

- Identifying the issues;
- Validating those issues; and
- Addressing the issues.

The project stages are shown schematically in Figure 1-3 and discussed further in the following sections.

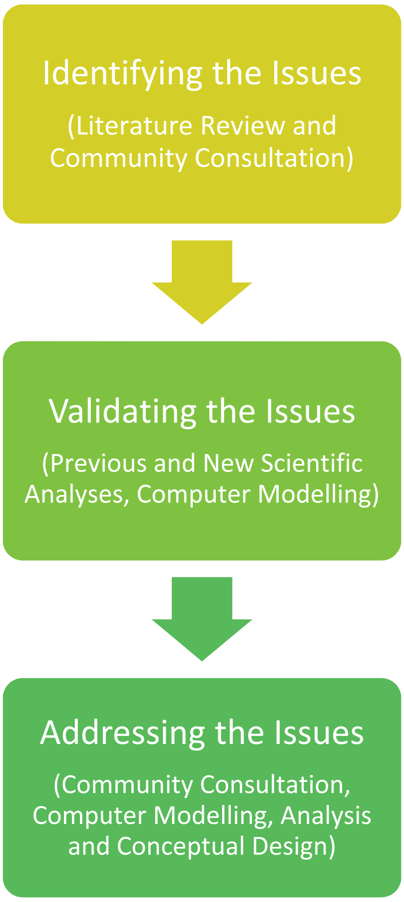

Figure 1-3 Project Stages

1.4.1 Identifying the Issues

Issue identification is described in Chapter 2. The first component of identifying the issues involved review of existing literature to extract those issues raised in the past. During this process, initial contact was also made with the community to highlight issues of present concern.

Following the literature review, local community representatives and other stakeholders were presented with the preliminary list of identified issues and asked to contribute further in refining that list.

1.4.2 Validating the Issues

The issue validation stage aimed to confirm and quantify the identified issues using both previous and new analyses of available data from the study area and surrounds. The background data and previous analyses are presented in Chapter 3, which also contains some further analyses undertaken as part of the present study (excluding numerical modelling, which is documented in Chapter 4).

Chapter 3 provides the building blocks necessary for the development of a computer model capable of simulating hydrodynamics, waves, sediment transport and geomorphology. The development and validation of the computer model to measured data is described in Chapter 4.

The computer model was subsequently used to replicate the processes underlying the identified issues. The computer model's predictive capability enables it to make quantitative assessments of future behaviour. This ability provides further validation of the importance of identified issues. The model can also predict the impact of future climate change (sea level rise, increased storminess). The validation stage has resulted in a refined list of issues that could be targeted by management strategies.

1.4.3 Addressing the Issues

This stage of the project focussed on the development and assessment of potential management options, assessment of those options and recommendation of a future management strategy. Possible options were identified through a process of community consultation, suggestions from the past and the experience of the study team, including insight gained from computer modelling during the validation stage of the project.

The options were shortlisted using a number of criteria including planning constraints, and a qualitative “triple bottom line” assessment of environmental, economic and social factors. The shortlisted options were subjected to further analysis, including computer modelling to determine their efficacy at addressing the identified issues.

The process of addressing the issues is presented in Chapter 5, and a preferred future management strategy and conclusion are presented in Chapter 6.