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ECONOMICS ADDENDUM

Updates to the Lake Macquarie Dredging
Benefit Cost Analysis

April 2013

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Prepared by
Umwelt (Australia) Pty Limited

on behalf of
NSW Crown Lands

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Report No:	**3089/R02/Final**
Date:	**April 2013**

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1.0 Introduction

1.1 Background

The reliability of boating access into Lake Macquarie through Swansea Channel has been an issue for many years. The shoaling of the inner channel due to sedimentary estuary processes, shallows water depths and creates navigation challenges. Dredging has been essential in the past to allow for commercial ships to enter the lake. The dredging campaigns began in the late 1800s and have continued ever since, at considerable cost. In recent times maintaining a deeper channel has primarily been to allow for passage by keel yachts and larger motor cruisers. Other options have also been implemented to limit the supply of sediment to the inner channel areas. These have included the erection of groynes in the outer channel to reduce the amount of eroded material from Salts Bay migrating into the inner channel.

The scope of this project is not to re-evaluate or remodel the technical options, or suggest further works in the outer channel to limit sediment supply to the inner channel. It is to consider how processes have changed in recent time and what minor changes may be necessary to make the previous options more appropriate in today's setting, especially economically, moving forward. It is also to identify and resolve the constraints, to produce a 'road map' of how to get things done within a new framework.

WBM (2003) presented an investigation into the hydrodynamics of the channel and the most appropriate mitigation options to ensure a passable channel for years to come. These six options included:

1. large scale channel dredging of the existing channel from Pelican to the drop-over;
2. dredging the airforce channel and construction of training walls across the main channel;
3. dredging and reclamation at the southern entrance to Swan Bay (with and without gaps in the entrance channel);
4. dredging and groyne construction in the vicinity of the southern entrance to Swan Bay;
5. dredging and training of the western shoal channels; and
6. removal of the channel islands to reinstate the natural form of the channel.

Previous economic assessments have been undertaken based on these channel management options. WBM (2003) undertook the cost-benefit analysis based on the technical and environmental aspects of the options, whilst the socio-economic assessment was undertaken by Gillespie Economics and Hassall & Associates Pty Ltd (2003). The preferred option was Option 1, which was then supplemented with the reclamation and partial closure of the southern entrance to Swan Bay. Another option that was ranked relatively highly was Option 5, however, the significant training works made the option somewhat cost prohibitive. There were also issues with the e-folding time of Option 5, which is a measure of water quality, and tidal flushing capacity. Two adaptations of this option are being tested to determine whether they would be financially more viable by making the structure out of low cost materials, and having it permanently submersed.

1.2 Purpose of This Report

The previous technical and economic appraisals were undertaken in 2003, almost ten years ago. To ensure the most up to date information and costings are considered in decision making, any values previously used need to be revised (where possible). The scope of this work is not to repeat the previous assessments, but to update values where possible. This is done in two ways:

- By incorporating any new relevant information into the assessment, such as:
    - updated dredging cost estimates;
    - updated benefits;
    - updated boat owner numbers and potential revenue;
    - updates on the amount of money spent on boating and boating related infrastructure; and
    - updates related to the socio-economic aspects of the project.
- Where new information is not available, previous values may be updated to today's prices to account for inflation.

The three options considered for economic assessment in this report are

1. Large scale channel dredging (and various depth/width permutations).

   The difference in depth and width are being investigated to determine the financial implications of dredging the channel deeper to accommodate larger draught vessels.

2. Dredging and infilling of the western shoal channels.

   This options serves two purposes 1) providing a nearby, thus low cost, location to deposit the dredged material and 2) to increase the amenity value of the shoal areas.

3. Dredging and partial training of the western shoal channels.

   This option is intended to minimise the amount of future maintenance dredging but forming a partial barrier across the western shoals with low cost material. This will subsequently encourage sedimentation in these areas thereby increasing the amenity value similar to the previous option, but at a slower rate.

Option 1 is the previous preferred option. This report will look at whether this is still the case and which depth and width permutation is the most appropriate based on the updated dredge volumes, costs and benefits. Options 2 and 3 are investigated to supplement Option 1. The socio-economic assessment determines the financial benefits of the various dredge depth permutations of Option 1 (which is part of Options 2 and 3 also). This will determine whether the deeper dredge depths are justified based on the number of channel users (local and non-local), and the general economic benefits the dredging may contribute to the wider community. The potential revenue from sale of the dredged sand is also investigated.

1.2.1 The Basics of Economic Appraisal

In Australia the majority of coastal and estuarine management schemes and dredging campaigns are funded by local councils, and the State government. There is therefore a requirement to demonstrate that any options considered for implementation are economically viable and represent good value for money.

The underlying process of economic appraisal is cost-benefit analysis. It determines how much economic benefit an investment (or cost) would attract. For management schemes to be economically viable, the benefits should be more than the costs, or at least break even.

Economic appraisals also enable the selection of the most economically sustainable options over an appraisal period, and provide transparency, some accountability and quality assurance in State and Local Government spending.

1.3 Economic Issues in Swansea Channel

The key focus of the economic assessment is justifying the cost of keeping the channel open for recreational vessel use, and as stated, this has been done primarily through continual maintenance dredging of the channel bed. The maintenance works were never intended to resolve the shoaling problem, just to maintain navigation. The management process, however, has been more suited to individual dredging campaigns, rather than an ongoing program of works. Another key issue is the limited funds to manage and maintain the channel and the number of users that the high cost facilitates.

The ad-hoc nature of the dredging campaigns and lack of long term management planning has resulted in considerable amounts of public money being spent over the years, upwards of a million dollars. **Table 1.1** presents the economics issues that require consideration in the analysis of options for a more sustainable framework. This report considers how these issues contribute to the aggregate costs and benefits for channel management for recreational navigation. Although the dredging may attract other benefits, e.g. environmental, water quality benefits and/or tidal ventilation, the dredging is considered to have little influence on these additional outcomes, therefore they have not been enumerated, however they have been considered in the relative benefits assessment as part of Option 1 (**Section 3.2**).

1.3.1 Uncertainty

For an economic appraisal to be effective a lot of background information is required and as with all economic assessments, the accuracy of the stated values is only as accurate as the available information. This report addendum presents the new information available to update previous assessments, the assumptions that have made to enable the current updated economics appraisal to progress.

The costs presented are indicative for appraisal purposes, it is therefore anticipated that the client would have detailed cost quotes prepared by a contractor prior to any implementation.

Table 1.1 - Economics and Funding Issues Summary

Issues	Information sources and processes for exploring this issue
High cost of capital and maintenance works has constrained the scope of works in the past	• Update costs to today's prices, and update cost benefit assessments with most up to date information. • Consider all economic implications in the long term, and the potential to distribute costs over the long term to minimise initial capital spend. • Revisit options that could reduce future maintenance costs.
Potential benefits of channel management not up to date or fully scoped	• Review cost benefits analyses for previous dredging and for marina expansion. • Consult with user groups and businesses. • Review estimates of usage change with a reliably navigable channel.
Investigate other dredging models for similar locations, and how/why they were able to get funding e.g. Port Hacking	• The Port Hacking funding model is the result of a long standing agreement, which has not been changed, but OEH suggests it is unlikely to be repeated in other waterways. It is delivering sand for beach replenishment and surfing breaks at Cronulla. Other previous models to consider include Lake Illawarra and Tuggerah Lakes – but in both cases funding priority has been driven by serious lake health issues. Lake health issues and poorly developed interagency partnerships (at the time) also underpinned the Office of lake Macquarie and Catchment Co-ordinator model that operated for ten years in Lake Macquarie. All of these organisations have invested some funds in navigation dredging, but not as the primary driver of management.
Competition between Lake Macquarie and other recreational waterways for investment to support navigation	• Document how Lake Macquarie compares with other recreational waterways with trained entrances, or with ongoing navigation maintenance issues and how its position can be improved with careful analysis of all risks and potential benefits.
Community perception that Lake Macquarie is not receiving its fair share of waterway investment	• Review how much waterway users already pay and the status of investment in Lake Macquarie waterway for environmental, navigation and recreational purposes over the last decade. For instance, RMS notes that Lake Macquarie has done well from the Better Boating Program because of a proactive Council and capacity to generate funds to match grants. • Review the agencies most likely to benefit from increased boating that would flow from a reliably navigable channel and consider appropriate contributions relative to budget benefits.
Loss of income issues as commercial vessels run aground or are unable to pass through the channel	• Consult with commercial users about how navigability affects business risks.
Sale of the dredged material – is it feasible for sand from the channel; what markets, what competition, what infrastructure and approvals are necessary to facilitate market value?	• Confirm State government statutory requirements for sand use. • Review previous cost and value obtained from sale of sand (and what it can be used for). • Review current market value of sand sold for different purposes. • Consider value of sand for environmental or social purposes, including replenishment of Salts Bay, Blacksmiths or Nine Mile dunes. • Consider options and value if sand for foreshore management and to enhance aquatic recreation areas within the channel (clear water, sandy bed, low current velocity).
Ownership and management of a dredge to conduct maintenance – which organisations; the real cost	• Review costs and benefits of different ownership and contractual models, considering the type of dredge (capacity), mobilisation costs, operator costs, training and maintenance costs and benefits.

2.0 Information Collation

2.1 Previous Economics Work

The previous economic appraisal for Swansea Channel was undertaken in 2003. Since then new information has become available, sand volumes (and therefore costs) have changed and numbers of boat users have generally increased. These new circumstances have to be considered when updating the economic values for the current Framework project.

2.1.1 Technical Cost-benefit Analysis

WBM (2003) assessed six options against a baseline case. The baseline case represented a minimalist approach similar to the current management regime. The costs and benefits of each option were evaluated as part of the options appraisal process. The appraisal considered the following economic aspects of the technical options:

- Capital costs, maintenance costs, 10 and 25 Yr total PV Costs for the six dredging depth/width options.
- Benefits - 11 criteria including hydrodynamics, need for ongoing maintenance, accretion and erosion patterns, flushing and impacts on seagrass etc.
- Benefit scores assigned and weighted the applied as a percentage of the costs to get an indicative ratio value.
- Final option ratios ranked to determine the preferred option from a cost-benefit perspective.

The analysis showed that the large scale dredging of the channel was the preferred option. Further analysis of the various dredge depths and social and recreational benefits associated with each was subsequently undertaken.

2.1.2 Socio-Economic Analysis

This assessment is different to the cost-benefit model enumerating costs versus perceived/potential benefits; rather, it considers the wider implications of the costs against the (somewhat indirect) benefits to the local and regional community. Thus, the assessment methodologies make different assumptions and take different factors into consideration. The socio-economic impacts of the preferred channel dredging option were investigated by Gillespie Economics and Hassall Associates Pty Ltd (2003) to determine:

- the costs and benefits to the community of the dredging options;
- the financial feasibility of dredging operations, which examined the revenues and costs associated with dredging, processing and sale of sand; and
- the regional economic impacts, which examined the additional stimulus to the Lake Macquarie economy from the expenditure of visiting vessels and dredging operations.

2.2 New Information and Other Recent Relevant Economic Studies in the Region

The following information was available to aid in updating the framework economics:

- RMS boating information from 2002 to 2012. The data consists of:
  - annual vessel registration numbers for the Hunter Inland region by hull type and size from 2002 to 2012. Lake Macquarie is part of the Hunter Inland Region;
  - annual mooring numbers - categorised by vessel type and length from 2002 to 2012;
  - Swansea Bridge openings and vessel movements from 2002 to 2012.
- NSW Boat Ownership and Storage: Growth Forecasts To 2026 (RMS, 2010). This report was released in 2010 and documents past trends in boat ownership in NSW. The report also projects growth in boat numbers to 2026.
- Social and Economic Impact Assessment - Proposed Redevelopment of Yacht Club Site, Belmont (Insite, 2009). This report presents number in local boating trends and berth demands, as well as some wider implications of redevelopment of the Yacht Club.
- Economic Development Opportunities in the Swansea Area (Buchan Consulting, 2009). This report covers the southern Lake Macquarie area from Swansea to Catherin Hill Bay. It identifies the long term impacts of population change and the notes some economic development opportunities.

Some of this information was used directly, i.e. boat registration numbers, vessel movements, mooring trends. Some was used to common sense check and confirm assumptions in boating tourism growth, i.e. the projected ownership numbers as no direct boating trend numbers were available from the tourism office.

The design dredge depths are in m AHD. Therefore functional channel depths are different at different times of the tide. The tidal levels are presented to allow for adjustment. These are taken from the previous lake modelling assessment undertaken for Council (WorleyParsons, 2010) and are presented in **Table 2.1** for information. These levels are from 2008, however are considered sufficiently accurate for this assessment. Note, the values for MHW and MLW are the difference between MHWS/MHWN and MLWN/MLWS respectively.

Table 2.1 Swansea Channel Tidal levels (2008) (WBM 2003, WP 2010)

Tide condition	m AHD (Swansea Bridge)	m AHD (Southern entrance to Swan Bay)
MHWS	0.486	0.20
MHW	*0.386*	
MHWN	0.286	0.10
MSL	0.031	0.08
MLWN	-0.224	-0.08
MLW	*-0.267*	
MLWS	-0.315	-0.08

2.2.1 Stakeholder and Community Information

Early in the development of the project, a number of meetings were held with various community and stakeholder groups and agencies. Information (as well as concerns) gathered from these people and groups have been considered in the economics update for the framework project, where necessary and relevant. **Figure 2.1** shows the groups consulted.

NSW Government, Agencies and Local Government

- Crown Lands (DPI) – Coastal/Catchments and Lands Division
- NSW Roads and Maritime Services
- Office of Environment and Heritage coastal specialists and estuary ecology specialists
- Fishing and Aquaculture (DPI)
- LMCC Sustainability, Community Development and Asset Management teams

Council and agency consultation panels

- Swansea Channel Project Steering Committee
- Roads and Maritime Authority – Maritime Panel
- LMCC Aquatic Services Committee
- LMCC Estuary Management Committee

Lake Macquarie political representatives

- Greg Piper, Mayor of Lake Macquarie and Member for Lake Macquarie
- Garry Edwards, Member for Swansea and LMCC East Ward Councillor

Marina operators

- Marks Point Marina
- Marmong Point Marina
- Wyee Point Marina
- Pelican Marina

Community and boating organisations

- Marine Rescue Lake Macquarie
- Lake Macquarie Tourism Association
- Bahtahbah Local Aboriginal Land Council
- Belmont Chamber of Commerce
- Swansea Chamber of Commerce
- Boat Owners Association of NSW
- Royal Motor Yacht Club - Toronto
- Lake Macquarie Yacht Club
- Newcastle Cruising Yacht Club
- Wangi Yacht Club
- Sydney yacht clubs, including Royal Motor Yacht Club in Pittwater, Cruising Yacht Club of Australia
- Concrete industry

Figure 2.1 - Community and Stakeholder Consultees

3.0 Economics Assessment - Technical

3.1 Costs

The costs assessment assigns indicative costs to the capital and maintenance works portions of the project based on available information. Any new information available since the previous cost benefit studies were produced in 2003 has been considered in this update. The sources of the new information are noted in **Section 2.2**. Where new information was not available, previous values have been inflated to current (2012) prices using a local Consumer price index (CPI).[1]

A discount rate of 7 per cent has been used. This is consistent with the previous assessment and NSW Treasure guidelines (NSW Treasury 1999).

3.1.1 Baseline

The economic benefits calculations for any option initially requires an assessment of a baseline case or a ‘do nothing’ case in which maintenance and intervention is all but stopped. The baseline case is consistent with WBM (2003) – the management of the channel to maintain current use. This involves maintenance dredging on an irregular and as-needed basis or emergency dredging once a critical depth is reached.

3.1.2 Option 1

This option refers to large scale capital dredging of the channel to the dimensions shown in **Table 3.1**. Revision of the dredge volumes required to reach design levels was determined by:

- Creating a digital elevation model (DEM) of the channel. This has been produced based on the most recent hydrographic survey data from RMS (May 2012).
- The dredge volumes were determined by increasing the depth and width of the current channel for the required length (**Figure 3.1**).
- Depths -4.5 metres AHD are removed from both width options as it is assumed that the coal seam at the channel entrance is the overarching limiting factor, being at ~-3.0 metres depth (pers comm.). This depth was also not considered to be ideal in WBM (2003).

Table 3.1- Option 1: Dimensions and Volumes

Option 1 dimensions	Calculated dredge volume	Estimated volume of sand required to be dredged (130%)
Option 1a (60 m wide, bed at -3.0 m AHD)	22,100 m^3	28,730 m^3
Option 1b (60 m wide, bed at -3.5 m AHD)	48,100 m^3	62,530 m^3
Option 1c (60 m wide, bed at -4.0 m AHD)	90,727 m^3	117,945 m^3
Option 1d (120 m wide, bed at -3.0 m AHD)	138,000 m^3	179,400 m^3

[1] The price index used is the Australian Bureau of Statistics (ABS) All groups CPI ; Sydney (series ID A2325806K). Note there are no regional NSW indices and no producer price indices applicable to dredging available.

Table 3.1 - Option 1: Dimensions and Volumes (cont.)

Option 1 dimensions	Calculated dredge volume	Estimated volume of sand required to be dredged (130%)
Option 1e (120 m wide, bed at -3.5 m AHD)	221,100 m^3	287,430 m^3
Option 1f (120 m wide, bed at -4.0 m AHD)	324,337 m^3	421,638 m^3

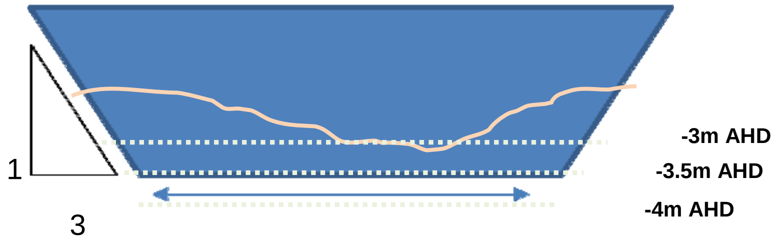

Figure 3.1 - Calculation of Dredge Volumes

Cost rates per cubic meter are determined based on information received from Crown Lands (2012). This information was taken from recent quotes by contractors for the current dredging works being undertaken in Swansea Channel using various plant (A 1,2,3 in **Table 3.2)**. As the type of plant to be used is uncertain at this point, the costs have been averaged across the different methods. These are 'all in' costs that assume removal of the material from the channel. The average rate based on recent quotes was adopted for the costs calculation for the capital dredging. These costs were compared to costs derived from estimates in Moses & Ling (2010) (Compare 1) and the previously estimated dredge costs from WBM (2003) (Compare 2), and are considered reasonable. This also suggests that the CPI rates used are reasonable.

A 15 per cent increase on capital costs will be included to account for design, site investigation and supervision, consistent with WBM (2003). No adjustment has been made for optimum bias.

The maintenance costs are based on the costs presented in WBM, 2003 (**Table 3.3**). The WBM maintenance cost was estimated based on the predicted amount of eroded material from the dredge profile per year, taken from the numerical model. No information is available as to the volume or cost rate of this; however we have assumed that the same erosion rates still apply. Therefore, the yearly maintenance costs presented in WBM (2003) for each option permutation have been uplifted to 2012 prices using changes in the CPI. Note, in the PV calculations the design fees are assumed to apply in Year 1, giving a year for preparation and approvals. The capital and maintenance costs do not apply until Year 2.

The Present Value (PV) costs of each option are then calculated for the short term (10 years) and long term (25 years) using a discount factor of 7 per cent. The total cost of each option permutation for the given time periods is presented in **Table 3.4**. Note that all values are rounded to the nearest 1000.

Table 3.2 - Design Dredge Volumes and Costs – Capital

Option 1 Summary	**130% of Design dredge volume (m³)** (consistent with Table 3.1)	**A1** Cutter suction dredge at 'normal' productivity for volumes over 90k m³ = $**12.16 per m³** Cutter suction dredge at 'normal' productivity for volumes <60k m³ = $**28.88 per m³**	**A2** Multi-purpose amphibious dredge/ excavator - normal productivity for volumes over 90k m³ = **11.11 per m³** <60k m³ = $**25.14 per m³**	**A3** **20.11 per m³** Average historical contractor's rates (2006-2008) uplifted with CPI values (2006 to 2012) for volumes over 90k m³.	**Average Capital** volumes over 90k m³ = **14.46 per m³** for volumes <60k m³ = $**24.71 per m³**	**Average Capital + 15%** (15% Design/investigation/ supervision fee.	***Compare 1*** *60k m³ rate* *$12.23 per m³* *30k m³ rate* *15.72 per m³* *20k m³ rate* *18.34 per m³* ***Assumed rates Moses & Ling (2010)*** *These dredge estimates are taken from Moses and Ling (2010) based on previous LPMA dredging projects, 2010 estimates are uplifted to 2012 prices using NSW CPI rates. This is assumed to be an 'all-in' cost.*	***Compare 2*** ***WBM (2003)*** *NB. Volumes of material to remove are not presented in WBM (2003) and are therefore unknown. This cost is taken directly from the 2003 report and increased to 2012 prices using CPI rates. Includes 35% contingency/design fees allowance.*
Option 1 (60m wide, -3.0m AHD)	28730	$830,000	$722,000	$578,000	$710,000	$816,000	$405,000	$726,000
Option 1 (60m wide, -3.5m AHD)	62530	$1,806,000	$1,572,000	$1,257,000	$1,545,000	$1,777,000	$756,000	$1,229,000
Option 1 (60m wide, -4.0m AHD)	117945	$1,434,000	$1,310,000	$2,372,000	$1,705,000	$1,961,000	$1,110,000	$1,733,000
Option 1 (120m wide, -3.0m AHD)	179400	$2,181,000	$1,993,000	$3,608,000	$2,594,000	$2,983,000	$1,688,000	$1,780,000
Option 1 (120m wide, -3.5m AHD)	287430	$3,495,000	$3,192,000	$5,780,000	$4,156,000	$4,779,000	$2,704,000	$2,915,000
Option 1 (120m wide, -4.0m AHD)	421638	$5,127,000	$4,683,000	$8,479,000	$6,096,000	$7,011,000	$3,966,000	$4,048,000

Table 3.3 - Maintenance Costs

Option 1 Summary	**Annual maintenance cost** (130% of design dredge volume as per Table 3.1)	**Annual maintenance cost - 2012** (uplifted using CPI rates ~1.2767 for 2003 to 2012)	**PV Maintenance Cost 10 years** (130% of design dredge volume as per Table 3.1)	**PV Cost Maintenance 25 Years** (130% of design dredge volume as per Table 3.1)
Baseline*	$506,000	$646,000	$4,855,000	$8,055,000
Option 1 (60m wide, -3.0m AHD)	$289,000	$368,000	$2,130,000	$3,750,000
Option 1 (60m wide, -3.5m AHD)	$282,000	$360,000	$1,200,000	$2,113,000
Option 1 (60m wide, -4.0m AHD)	$256,000	$327,000	$2,347,000	$4,131,000
Option 1 (120m wide, -3.0m AHD)	$598,000	$763,000	$3,471,000	$6,111,000
Option 1 (120m wide, -3.5m AHD)	$417,000	$533,000	$2,401,000	$4,226,000
Option 1 (120m wide, -4.0m AHD)	$144,000	$184,000	$4,974,000	$8,757,000

Table 3.4 - Option 1: Costs Results Summary

Option 1 Summary	Initial Cost	On-going Annual Maintenance	Total PV Cost Capital, maintenance, fees, contingency (10 years)	Total PV Cost Capital, maintenance, fees, contingency (25 years)
Baseline		$646,000	$4,855,000	$8,055,000
Option 1 (60m wide, --3.0m AHD)	$710,000	$368,000	$3,303,000	$5,129,000
Option 1 (60m wide, --3.5m AHD)	$1,545,000	$360,000	$4,311,000	$6,095,000
Option 1 (60m wide, --4.0m AHD)	$1,705,000	$327,000	$4,299,000	$5,918,000
Option 1 (120m wide, -3.0m AHD)	$2,594,000	$763,000	$8,272,000	$12,055,000
Option 1 (120m wide, -3.5m AHD)	$4,156,000	$533,000	$8,755,000	$11,395,000
Option 1 (120m wide, -4.0m AHD)	$6,096,000	$184,000	$8,952,000	$9,864,000

3.1.3 Option 2

Option 2 involves dredging of the main channel as in Option 1 - to a width of 120 metres and depth of -4 metres AHD, but the sand is used to infill the western shoal areas rather than being extracted from the channel and removed.

The costs associated with this option are similar to Option 1 as the extraction method will be the same, with the deposition of the sand in a different location (i.e. pumped west rather and deposited within the channel, rather than east to an onshore storage site) and there will be no volume of sand available to sell to offset the costs. Cost estimates in Moses and Ling (2010) from between 2006 and 2008 estimate the average all-in cost used per cubic metre of extracted sand to be around $13. It can be assumed that removing a cost for loading, transporting and handling could reduce the cost by approximately $7 per cubic metre (Moses and Ling 2010).

It is assumed that full dredge volume will be placed in the shoal area to form the newly infilled amenity area.

The following costs in **Table 3.5** are for the reduced cost method of *in situ* recycling of the sand within the channel.

Table 3.5 - Design Dredge Volumes and Costs - Capital

Option 2 Summary	130% of Design volume (m^3) Consistent with Table 3.1	In situ placement Vol 90k + = $7.46/$m^3$
Option 2 (120m wide, -4.0m AHD) + deposition of sand within channel	421,638	$3,145,000

The maintenance costs for this option are uncertain. Modelling to determine the yearly volumes to be extracted is beyond the scope of this assessment, thus, it is assumed Option 1 maintenance volumes still apply (refer **Table 3.3**). **Table 3.6** presents the total costs for this Option.

Table 3.6 - Option 2: Costs Results Summary

	Capital Cost	**Annual Maintenance**	**Total PV Cost** Capital, maintenance, fees, contingency (10 years)	**Total PV Cost** Capital, maintenance, fees, contingency (25 years)
Option 2	$3,145,000	$184,000	$5,904,000	$8,667,000

3.1.4 Option 3

Option 3 again includes dredging of the main channel (as in Option 1) to a width of 120 metres and depth of -4 metres AHD, supplemented with the construction of a submerged training wall from lower cost materials, i.e. geotextile sand containers. This is a variation on the WBM (2003) option of building a rock armour training wall across the western shoals.

The original capital cost of the WBM (2003) training wall option was $5.72 million, with a total PV cost of $7.44 million after 10 years, and $11.79 million after 25 years, including maintenance costs. This option represented a significant cost, and would alter the current amenity of the channel and shoal area.

The intention of the new framework option is not to provide a robust barrier across the western shoal, but to provide a partial barrier to limit some of the sediment re-entering the channel from the west, and to encourage deposition at the shoals beyond background rates. This will have a similar outcome to Option 2, however at a slower more natural rate. This may reduce the negative impacts on the local habitats (*cf.* instantaneous inundation), whilst the barrier may reduce maintenance dredging requirements. This option will also serve as an adaptable, low cost, low impact alternative to permanent full rock armouring.

It is proposed that large geotextile containers tethered to piling or other anchoring structures (e.g. mooring blocks), may be sufficient block some sand movement and encourage the deposition of sand within the shoaling areas west of the main channel. The weight of the containers would also need to be sufficient to stay *in situ* in peak tidal flows; therefore the dimension of each would need to be quite large. Current peak spring tidal flows are presented in **Table 3.7** (Worley Parsons 2010).

Table 3.7 - Current Peak Tidal Flows (Worley Parsons 2010)

	Current speed range ($m.s^{-1}$)
Flood	0.6 - 1
Ebb	0.4 - 0.8

Note, detailed design and assessment of any structure is not part of the brief of the project, therefore, the costs presented are estimates based on already available information and the assumptions stated. If the cost-benefit assessment determines that a low cost structure option is viable, it will require further modelling, design and more accurate costing.

The assumptions related to this option are noted as follows:

- The average bed elevation across the shoals is approximately -1.23 metres AHD.

- Depth at MSL is between 0.5 and 2 metres, assume average ~1.2 metres (see **Figure 3.2**).
- Water depth at MLW is approximately 0.93 metres.
- Structure is to be submerged at low tide, so estimate average diameter of geotextile containers to range between 0.6 - 1.2 metres by approximately 10 metres in length.
- Container volumes would be between 2.83 m^3 and 11.31 m^3.
- The cost of custom made geotextile containers would be between $2000 to 3000 each.
- Assume weight of full containers to be approximately 5.87 tonnes and 23.52 tonnes respectively (vol x 2.08 for compact, wet sand).
- Assume 3000 m^3 removed from total dredging volume to fill bags. This is greater than the container filling requirements, but assumes a number of cubic metres of sand is lost/dispersed during filling.
- The weight of the containers, supplemented with anchoring by mooring blocks will be sufficient to keep the containers in place.
- The sand used for filling the containers will be costed at the lower *in situ* placement dredging cost (**Table 3.8**).
- The sand not used for container filling may be stockpiled and sold as an additional benefit, but at an increased extraction cost (**Table 3.8**).
- **Table 3.9** shows the costs for the geotextile containers, assumes an additional establishment cost for appropriate water based filling plant, costs for minor excavation if necessary, filling and laying of the containers (by divers), an allowance for signage etc and a disestablishment cost.

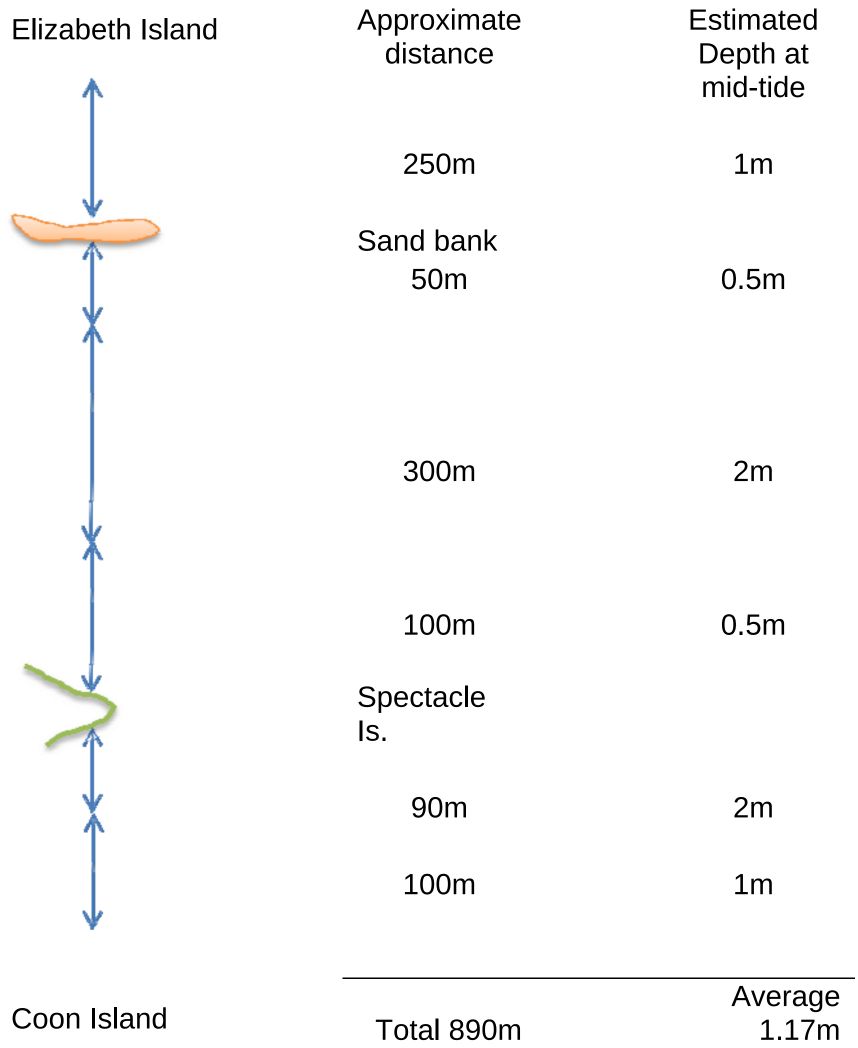

Figure 3.2 - Approximate Length of Training Wall and Approximate Depths

The maintenance costs for this option are uncertain. Modelling to determine the yearly volumes to be extracted is beyond the scope of this assessment, thus, it is assumed Option 1 maintenance volumes still apply (refer **Table 3.2**). It would be assumed that the barrier would reduce the maintenance volume requirements; however this would require modelling to confirm. It is therefore noted that any potential reduction in maintenance spend would be reused in the monitoring and maintenance of the geotextile container wall anyway. With appropriate signage, and the addition of the vandal proofing, the potential damage to bags is considered minimal.

The total costs for Option 3 are presented in **Table 3.10**.

Table 3.8 - Dredging Cost For Option 3

Option 1 Summary	Design volume (m^3)	In situ placement rate (vol required for containers) Vol 30-60k = \$17.71/m^3 Vol 90k + = \$7.46/m^3 To fill containers ~3000m^3 * 17.71m^3	Average cost for sand extracted from the channel volumes over 90k m^3 = 14.46 per m^3 for volumes <60k m^3 = \$24.71 per m^3 = 324,337- 3000 = 321337m^3
Option 1 (120m wide, -4.0m AHD)	421,638	\$53,000	\$6,054,000

Table 3.9 - Option 3 Container Wall + Dredging Cost (Based On Uplifted Costs From WBM 2004; and Advice From Geofabrics Australasia, Pers. Comm.)

Container wall anchored with mooring blocks		Required length/vol	Unit	Quantity	2003 cost	2012 cost	Total
1	**Site establishment**						
	Water based plant			1	20000	\$26,000	\$26,000
	Establish silt curtain around site	assume 1000m	m	1000	20	\$25.53	\$26,000
2	**Construction materials**						
	Geotextile containers (2 fills ports & 6 tie down tags, covered in vandal resistant material)	1000m	m	150		\$3,000.00	\$450,000
3	**Dredge cost (see above)**	1000m	m^3	3000			\$53,000
4	**Construction**						
	Excavation of sand prior to laying containers	1000	m^3	3000	20	\$25.53	\$76,000
	Filling of containers	1000	m^3	786	20	\$25.53	\$20,000
	Supervision 3 x divers 1 x engineer and 3 x operators	Assume 40 days @150 per hr	per day	\$8,400			\$336,000
5	**Mooring blocks, signage & buoys**		allowance				\$50,000
6	**Disestablishment**				15000	\$19,000	\$19,000
						Subtotal	\$1,056,000
					fees	15%	\$158,000
					contingency	20%	\$211,000
						Total (containers)	\$1,425,000
						Total (channel dredging)	\$6,054,000
						Grand total Op 3 (Capital)	\$7,479,000

Table 3.10 - Option 3: Costs Results Summary

	Capital Cost	Annual maintenance	Total PV Cost Capital, maintenance, fees, contingency (10 years)	Total PV Cost Capital, maintenance, fees, contingency (25 years)
Option 3	$7,479,000	$184,000	$10,710,000	$11,622,000

3.2 Benefits

Generally, the economic benefits of an option can be seen as:

- the reduction in spend occurring over the appraisal period, as a result of putting an option in place;
- an increase in revenue generated over the appraisal period, as a result of putting an option in place;
- an increase in the social and recreational values (sometimes not easily enumerated);
- the reduction in the total potential damages (where appropriate) occurring over the appraisal period, as a result of putting an option in place.

The benefits of any of the three options will therefore be the difference in additional revenue (negative costs or damages) between the option and base case. The benefits of the option will then be divided by the cost of putting it in place. The result is termed as the average benefit cost ratio (BCR). Generally, for an option to be economically viable, the BCR must be greater than one.

Damage calculations have not been undertaken in the past, however some potential future scenarios that may arise, based on the options, have been considered (but not enumerated). These considerations of the long term effects are particularly related to the removal of sand from the wider system, and the consequences of not recycling it.

The option that has the highest BCR is identified as the leading option, however, may not be the most appropriate. It is merely to support and economically justify an option. This and other factors must be considered to determine the preferred option.

3.2.1 Methodology

The previous WBM (2003) assessment used a weighted value to evaluate relative benefits. A score between -10 and +10 (**Table 3.11**) was assigned which was then multiplied by a weighting factor. The options were then ranked (**Table 3.12**). This method has been repeated, however the criteria scores have been revised based up to date knowledge and the changes to the options. Some importance values have also been revised as they appeared too low in the previous assessment e.g. Posidonia seagrass is a protected species under the *Fisheries Management Act 1991*, therefore the importance is raised to a 10. An additional two columns have been added, to account for the impacts on seagrass in the short and long term, as although in the short term inundation will be detrimental, in the long term the increased sedimentation will provide increased areas for seagrass habitat.

The criteria in **Table 3.11** and **3.12** relate to the following:

a) Need for Maintenance Dredging.

b) Accretion near entrance to Swan Bay.

c) Navigation.

d) Scour at Nauru Pt.

e) Scour adjacent to Spoil Is.

f) Scour Elizabeth Is.

g) Scour Coon Is.

h) Scour Pelican Is.

i) (1) Seagrass Health - short term (2) seagrass health - long term.

j) Waves in Swan Bay.

k) Lake Hydraulics and Tidal Exchange.

l) Flushing of Swan Bay.

Table 3.11 - Benefit Scores From WBM (2003) Updated Where Necessary

	Benefits score criteria (-10 to +10, see 12 criteria below)												
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i1**	**i2**	**j**	**k**	**l**
Option 1 (60m wide, -3.0m AHD)	1	1	4	0	0	0	1	1	0	0	0	0	2
Option 1 (60m wide, -3.5m AHD)	2	1	5	0	0	0	2	2	0	0	0	0	2
Option 1 (60m wide, -4.0m AHD)	3	1	6	0	0	0	3	3	0	0	0	0	2
Option 1 (120m wide, -3.0m AHD)	1	0	5	7	7	-1	3	3	0	0	0	0	2
Option 1 (120m wide, -3.5m AHD)	4	0	7	8	8	-2	4	4	0	0	0	0	2
Option 1 (120m wide, -4.0m AHD)	8	7	8	9	9	0	5	5	0	0	0	0	4
Option 2 (WBM Option 5)	3	6	7	9	9	0	6	7	-8	3	0	-3	4
Option 3 (WBM Option 5)	6	8	9	9	9	0	7	8	-5	3	0	-3	4
Importance Value	**6**	**7**	**10**	**4**	**3**	**2**	**3**	**4**	**10**	**10**	**2**	**5**	**6**
Importance (%)	**8.33**	**9.72**	**13.89**	**5.56**	**4.17**	**2.78**	**4.17**	**5.56**	**13.89**	**13.89**	**2.78**	**6.94**	**8.33**

Table 3.12 - Weighted Benefit Scores, Total and Rank

	Weighted scores														
	a	b	c	d	e	f	g	h	i1	i2	j	k	l	Tot	Rnk
Option 1 (60m wide, -3.0m AHD)	0.83	0.97	5.56	0.00	0.00	0.00	0.42	0.56	0.00	0.00	0.00	0.00	1.67	10.00	8
Option 1 (60m wide, -3.5m AHD)	1.67	0.97	6.94	0.00	0.00	0.00	0.83	1.11	0.00	0.00	0.00	0.00	1.67	13.19	7
Option 1 (60m wide, -4.0m AHD)	2.50	0.97	8.33	0.00	0.00	0.00	1.25	1.67	0.00	0.00	0.00	0.00	1.67	16.39	6
Option 1 (120m wide, -3.0m AHD)	0.83	0.00	6.94	3.89	2.92	-0.28	1.25	1.67	0.00	0.00	0.00	0.00	1.67	18.89	5
Option 1 (120m wide, -3.5m AHD)	3.33	0.00	9.72	4.44	3.33	-0.56	1.67	2.22	0.00	0.00	0.00	0.00	1.67	25.83	4
Option 1 (120m wide, -4.0m AHD)	6.67	6.81	11.11	5.00	3.75	0.00	2.08	2.78	0.00	0.00	0.00	0.00	3.33	41.53	1
Option 2	2.50	5.83	9.72	5.00	3.75	0.00	2.50	3.89	-11.11	4.17	0.00	-2.08	3.33	27.50	3
Option 3	5.00	7.78	12.50	5.00	3.75	0.00	2.92	4.44	-6.94	4.17	0.00	-2.08	3.33	39.86	2

A scenario where the additional benefits from the sale of sand (applied as negative costs) will be applied before applying the ranking method to Options 1 and 3 and presented for comparison against not selling the sand (see **Section 4.3** for sand sale values and **Section 5.0** for complied results). Option 2 involves recycling the dredged sand within the channel, thus no adjustment for sand sales is necessary.

4.0 Socio-Economic Assessment

4.1 Introduction

Part of the scope of this project is to update the socio-economic assessment to better reflect today's community requirements and economic climate. The previous study was undertaken as a separate study to the technical costs-benefit assessment presented in WBM (2003). This study was carried out by Gillespie Economics and Hassall & Associates Pty Ltd in 2003.

The assessment enumerated three socio-economic components in relation to the channel dredging options:

1) the costs and benefits assessed to consider whether the benefits to the community options outweigh the costs of dredging;

2) the financial feasibility of dredging operations which examined the revenues and costs associated with dredging and processing, and sale of sand;

3) the regional economic impact assessment, which examined the additional stimulus to the Lake Macquarie economy from expenditure of visiting vessels and dredging operations.

The following sections describe how the new assessment has considered the previous assessment and how the updates have been carried out. As with any economic assessment, certain assumptions have been made to allow the assessment to progress, these are noted where necessary.

4.2 Costs and Benefits of Dredging and Costs To The Community

4.2.1 Background

The Gillespie and Hassall (2003) cost assessment focused on 3 permutations of the preferred option determined by WBM (2003), i.e. large scale dredging of the main channel to 120 metres wide by -3 metres, -3.5 metres or -4 metres AHD. The same options are updated in this assessment for consistency. Note, the maintenance costs presented in Gillespie and Hassall (2003) and WBM (2003) are different as shown in **Table 4.1**. The WBM value represents current maintenance practices, and the potential maintenance cost to maintain a passable channel, whereas the socio-economic baseline (Gillespie and Hassall, 2003) was defined as 'allowing the channel to reach its own equilibrium, with occasional minimal maintenance dredging (say $30,000 pa) to remedy specific shoaling issues'.

Gillespie and Hassall (2003) examined vessel movements through the channel based on bridge openings, types of vessels and size, and therefore the required draught. This gave a number of assumed return trips per annum which would (normally) be multiplied by an assumed willingness to pay (WTP) value. Since no appropriate values for WTP were available, the previous values in Gillespie and Hassall (2003) are indicative. Thus, they opted for a second method that enumerated the critical threshold value which represented the required WTP value for the navigational benefits to outweigh the costs.

Table 4.1 - Baseline Maintenance Dredging Annual Cost

WBM (2003)	$506,000
Gillespie and Hassall (2003)	$30,000

4.2.2 Methodology and Results

The most significant direct benefit the dredging facilitates is improved navigation through the channel. Therefore recent use of the channel was considered, and the potential number of users that will benefit from the increased width and depths.

For the economics update, data was provided from RMS, which related to vessel movements through the channel based on Swansea Bridge openings (**Table 4.2**). The average number of vessels movements per year between 2005 and 2011 was 3816. This was used to account for variability over the years from 2005 to 2011. The number of separate vessels can be derived from the number of vessel movements. It is assumed that 3816 vessel movements relates to 2150 separate vessels, 56 per cent of the total, based on the previous methodology. It is estimated that 79 per cent the total vessel movements are considered local return trips that are likely to be inhibited by a shallow channel, equalling 1500 return trips based on the previous method (Gillespie & Hassall 2003).

It is necessary to determine which of this total number are actually inhibited by siltation in the channel. The RMS registration data gives the type and size of vessels registered, however no information on draught. Each of the type and size categories was assigned an assumed draught using sailing knowledge. These were also separated into categories based on whether the vessels were moored, berthed or other (i.e. trailered) to get an estimate of the fees paid to the RMS for registration and licensing for incorporation into the main framework document. **Table 4.3** shows the overall summary of the processing of the RMS data. Note, the RMS data does not categorise vessels above 12.1 metres. Therefore percentage of vessels that would require a draft above 3 metres is uncertain. It is acknowledged that there may be some very large vessels within the lake that would require a channel dredged to more than 4 metres, but it is assumed to be less than 1 per cent of vessels. It is also assumed that the entrance coal seam would limit their ability to enter and exit the channel anyway.

The number of return trips (**Table 4.4**) are then related to the vessel draught requirements in **Table 4.3**.

To account for the expected increase in boat traffic that may occur once the channel is more consistently passable; the previous assessment increased the number of assumed visitors to a total of 250 per cent of previous levels (i.e. a 150 per cent increase). This increase was arbitrarily assigned based on conversations with local boat users by Gillespie & Hassall in 2003. Due to the uncertainty of this, a sensitivity value of 175 per cent total was included. No new information is available to inform of potential increases in channel users, other than comments from stakeholder groups saying ‘a lot more’, therefore the same increase has been applied to the updated economics for consistency (**Table 4.4**). A full thorough social engagement assessment would be required to more accurately determine this number, which is out of the scope of this project.

Table 4.2 - Bridge Openings and Vessel Movements

	2005		2006		2007		2008		2009		2010		2011	
Date	Openings	Vessels	Openings	Vessels	Openings	Vessels	Openings	Vessels	Openings	Vessels	Openings	Vessels	Openings	Vessels
January	282	772	242	662	275	742	238	560	253	736	275	711	246	579
February	188	501	167	419	190	514	137	356	158	333	163	365	167	411
March	191	353	137	239	164	323	221	467	166	306	164	277	157	263
April	207	507	178	373	191	407	135	300	152	278	209	390	199	443
May	141	222	127	225	163	307	151	263	116	168	124	190	126	214
June	157	252	102	176	70	137	112	184	119	210	117	214	97	172
July	149	242	118	226	89	129	113	206	129	236	134	248	127	235
August	38	71	133	252	121	211	117	195	127	204	103	191	130	260
September	51	111	129	231	134	253	118	183	123	201	128	187	124	208
October	127	274	142	299	154	324	173	344	159	271	162	277	168	294
November	129	204	155	269	139	269	137	194	158	245	161	235	144	205
December	226	532	215	520	214	518	198	462	207	399	205	424	191	352
Total	**1886**	**4041**	**1845**	**3891**	**1904**	**4134**	**1850**	**3714**	**1867**	**3587**	**1945**	**3709**	**1876**	**3636**
Ave/month	**157.2**	**336.8**	**153.8**	**324.3**	**158.7**	**344.5**	**154.2**	**309.5**	**155.6**	**298.9**	**162.1**	**309.1**	**156.3**	**303.0**

Average vessels movements: 3816
Number of vessels: 2150
No. of return trips: 1500

Table 4.3 - Total Vessels in Lake Macquarie by Draught Depth (2011 to 2012)

	Size	Draught < 2m	2.0m < Draught < 2.5m	Draught > 2.5m	Total Vessels
Moored	Number	903	939	480	2,322
	Percent	39%	40%	21%	100%
Berthed	Number	-	388	112	500
	Percent	0%	78%	22%	100%
Other	Number	19,242	0	0	19,242
	Percent	100%	0%	0%	100%
Total	**Number**	**20,145**	**1327**	**592**	**22,064**
	Percent	**91%**	**6%**	**3%**	**100%**

Table 4.4 - Potential Number of Return Visitors by Vessel Draught Requirements

Draught	Return trips per year	Return trips per year + 75%	Return trips per year + 150%
2m (3m AHD)	1369	2396	3423
2.5m (3.5m AHD)	1460	2554	3649
3m (and 3+) (4m AHD)	1500	2625	3749

To assess the value of the improved navigation to the community, a consumers' surplus assessment relating to the willingness to pay (WTP) was undertaken similar to the previous assessment. As mentioned in **Section 4.2.1**, the previous study found few appropriate values to use in the WTP assessment that directly related to increases in the value of recreational navigation due to dredging. Additional research has shown that a US study undertaken in 2007 may provide some appropriate values. The study estimated the change in value of recreational boating with a dredging program along the Atlantic Intracoastal Waterway in North Carolina. The annual benefits of the dredging program were valued at US$20.5 million, with recreational boat users willing to pay US$97 annually, potentially as a surcharge on their boat registration fee (Whitehead 2007).

Another recent study undertaken to enumerate the value of Sydney's beaches (Anning 2012) determined an average WTP of AUD$116.27± 69.63 as a one-time donation for the prevention of climate change induced erosion. Although the circumstances are very different to this dredging project, it does give an indicative 'ball park' value that people are willing to part with for a benefit that they consider significant to them.

A value of AU$95 has been used for the WTP calculations assuming an exchange rate of $1.02 US to the dollar. This value is multiplied by the assumed number of vessels, 2150, equalling a total contribution of $204,250 per year. Note, this does not account for the required draught of the various channel users, thus assumes all users are willing to pay a general channel maintenance levy regardless of whether their vessel requires the channel to be dredged or not. This value is far below the required contribution over the next 25 years for the capital works and ongoing maintenance of the channel.

Table 4.5 presents the critical threshold values, i.e. required WTP estimates for the navigational benefits to outweigh the costs, calculated similarly to Gillespie and Hassall (2003). With the low number of assumed channel users that would benefit from the dredging of the channel, the required WTP estimates per return trip (to break even) are high, thus highlighting the fact that additional contribution, other than users, would definitely be required.

Table 4.5 - Threshold Values per Trip (i.e. Required WTP Estimates)

		Return trips per year		Return trips per year + 75%		Return trips per year + 150%	
	Draught o	Trips	Threshold value per trip (7%)	Trips	Threshold value per trip (7%)	Trips	Threshold value per trip (7%)
Option 1	2m (3m AHD)	1369	$706.17	2396	$403.48	3423	$282.43
	2.5m (3.5m AHD)	1460	$625.91	2554	$357.80	3649	$250.43
	3m (and 3+) (4m AHD)	1500	$527.40	2625	$301.37	3749	$211.02
Option 2		1500	$326.77	2625	$186.72	3749	$130.74
Option 3		1500	$649.60	2625	$371.20	3749	$259.91

4.3 Additional Benefits - Sale of Sand

To aid in financing the ongoing dredging, the revenue generated from sale of the dredged sand needs to be considered as an additional benefit.

Sand is a valuable commodity used regularly within the construction industry. Previous studies have determined that sand dredged from the channel is suitable to be sold as fill material for the construction industry. The dredged sand from Swan Bay has been sold in the past as part of a commercial operation (Belmont Sands). The sand dredged from the channel in 2010 was also sold as a limited one-off supply.

4.3.1 Sand values

The market value and the annual demand for local sand (in the Hunter Region) was estimated in Gillespie and Hassall (2003). These have been updated based on local knowledge of the sand mining industry. The estimates in **Table 4.6** show the previous demand estimates compared with the new estimates, which are considered to be conservative. The operations at Redhead have ceased, thus the value is now zero. The volumes for the Hunter River are unknown, therefore assumed to be similar to the previous.

Table 4.6 - Conservative Estimate of Local Sand Demand

Local Source	Previous Estimates of Tonnage Recovered and Sold (2003)	Updated Estimates (2008)
Stockton	1,000,000	1,500,000
Redhead	250,000	0
Hunter River	250,000	250,000
Total	**1,500,000**	**1,750,000**

According to a supply demand study done in 2008 relating to sand extraction in the Hunter, if no new approvals for sand quarries are granted, the demand for sand will increase greatly. Also, some significant sand quarry sites supplying the Sydney construction industry are expected to cease operations in the next 3 years, thus increasing demand from nearby sources, potentially, the Hunter (Don Reed and Assoc. 2008). This would indicate that there is always likely to be a market for a local source of sand, regardless of the limited volumes and possible irregular nature of the supply. The assessment therefore assumes there will always be a buyer for all volumes available. We are also aware of a local business that would be willing to pay $4 a tonne for the dredged sand. Moses & Ling (2010) estimate the revenue from sand sales (for beneficial use, rather than construction) to be $3 per cubic meter ($5.40 per tonne, using 1.8 multiplier).

The market value of sand has increased since the 2003 socio-economic report. Previous prices ranged from $6 per tonne for fill, to $12 per tonne for quality bricky's sand. Prices from Don Reed & Associates (2008) indicate that 'ex-bin' prices of local sand from Stockton (i.e. dry screened sand loaded on a truck, but not transported) ranged from $6 per tonne in 2001 to $9 per tonne in 2005. Screened and washed sand ranged in price from approximately $10 to $22 per tonne at Salt Ash. In 2008 the 'ex-bin' weighted average price was around $12.40. Delivery and trucking costs were calculated to be approximately $0.12 to $0.15 per tonne per kilometre.

It is noted that the volumes of sand available from dredging of the channel will not be constant and not likely be sufficient to support an ongoing sales operation. It is also unlikely that any staging/stockpiling area near the channel will be equipped with sieving or washing facilities, thus the supply would be raw dredged sand, thus the price would not be in the order of those mentioned previously. It is considered reasonable that the previous cost of $6 per tonne used ($3.34 per m^3) in the previous assessment would still be viable considering the available information. This does not incorporate any adjustment for price increase or inflation; however, there seems little justification to increase the price. It is also assumed this price will remain constant for the duration of the project.

The volumes in **Table 4.7** shows the likely average amounts extracted per year based on the capital and maintenance dredging requirements presented by WBM (2003). The assessment assumes that the maintenance volume will stay constant from year 2 to year 25. In reality, these volumes will change due to natural variation and conditions within the channel. It was assumed in the previous socio-economic assessment that a volume of 250,000 tonnes ($138,889^3$) will be the maximum able to be taken in one year, so to not exceed the market threshold and to ensure the price of $6 remains viable (Gillespie and Hassall 2003). We have used 250,000 m^3 (450,000 tonne) as the previous amount is too low for the technical aspects of the capital operation to be viable, also demand is considered higher now than previously. Dredging plans and plant requirements noted in the framework document will also consider/incorporate this limitation.

The baseline maintenance dredging volume was not presented in the previous socio-economic report, thus, the volume is based on back calculations from the capital cost and the cubic metre rate similar to the other options. The estimated yearly revenue from sand sales from the capital and maintenance dredging is presented in **Table 4.7**. Note, Option 2 assumes sand is recycled within the channel, thus no sales revenue. The results are then incorporated directly into the benefit cost analysis as a negative cost (see **Section 5.1**).

Table 4.7 - Estimated Supply over the Project Period

Option	Year one - capital (m³)	Year 2 - capital (m³)	Year 2 - 25 maintenance (m³)	Total (25 yrs) (m³)
Baseline			*75,000**	*1,800,000**
Option 1 (120m wide, -3.0m AHD)	138,000		68,100	1,772,400
Option 1 (120m wide, -3.5m AHD)	221,100		47,600	1,363,500
Option 1 (120m wide, -4.0m AHD)	250,000	75,000	16,500	720,000
Option 2	0	0	0	0
Option 3	250,000	70,000	16,500	720,000

* back calculated from capital cost as volume was not available.

Table 4.8 - Estimated Revenue from Sand Sales over the Project Period

Option	Year one	Year 2	Yearly Maintenance Yr 2 - 25
Baseline			$250,000
Option 1 (120m wide, -3.0m AHD)	$461,000	0	$227,000
Option 1 (120m wide, -3.5m AHD)	$738,000	0	$159,000
Option 1 (120m wide, -4.0m AHD)	$835,000	$248,000	$55,000
Option 2	0	0	0
Option 3	$835,000	$238,000	$55,000

The critical threshold values in **Table 4.5** can then be recalculated to incorporate the revenue from sand (**Table 4.9**).

Table 4.9 - Threshold Values per Vessel per Trip (i.e. Required WTP Estimates) Including Sand Sales

		Return trips per year		Return trips per year + 75%		Return trips per year + 150%	
	Draught	Trips	Threshold value per trip (7%)	Trips	Threshold value per trip (7%)	Trips	Threshold value per trip (7%)
Option 1	2m (3m AHD)	1369	$455.07	2396	$260.01	3423	$260.00
	2.5m (3.5m AHD)	1460	$432.00	2554	$246.71	3649	$246.71
	3m (and 3+) (4m AHD)	1500	$409.29	2625	$233.88	3749	$233.88
Option 2		-	-	-	-	-	-
Option 3		1500	$532.14	2625	$304.08	3749	$304.08

4.4 Regional Economic Impact Assessment

Gillespie and Hassall (2003) used an input-output[2] model to examine the potential regional impacts of the dredging activity and the visitation by vessels moored outside Lake Macquarie. The premise behind this assessment is that a direct impact (e.g. investment in the ongoing dredging) will have flow-on impacts; for example increase local demand for other services and greater employment.

A regional impact assessment is useful in identifying the implications of a particular investment. However care is required in using it to justify public funding to encourage/stimulate the local economy as there will be alternative uses of such funds; that is, there is an opportunity cost of using such funds. The flow-on impacts are potentially relevant to a cost-benefit analysis to the extent that they stimulate use of otherwise under-utilised resources.

Specific social indicators such as employment, income and gross regional product were used. Gillespie and Hassall (2003) estimated the gross regional output and the gross value added of the Lake Macquarie economy for 2001 to be $10,620M and $5,530M respectively.

The assessment also identified the direct impacts on the regional economy by examining the initial impact of stimulus of the expenditure associated with the dredging campaigns and the expenditure associated with the increased vessel access, and potential increase in visits.

[2] An input-output model is a model that represents interdependencies (e.g. in demand for services) between sectors of an economy. The input-output tables show the flow-on of demand between services and can be used to estimate the extent to which local resources are used (and conversely the amount of imports and exports to the region) to generate multipliers.

4.4.1 Impact of Dredging Campaigns

The assessment found that there was a small impact on the regional economy resulting from the dredging campaigns. Although there would be some minor flow on effects with increases in income and employment, the values when distributed amongst the number of households in the Lake Macquarie area were low. The number of new jobs generated by dredging was assumed to be between 4 and 8. Ultimately, the dredging was calculated to represent less than 0.009 per cent of the local economy. Furthermore, the G&H assessment was conducted relative to a baseline of minimal dredging ($30k a year).

In light of this, there is little need to update the value of the dredging campaigns within the regional setting, as the overall value of the new campaigns are similar to the previous assessment. The Hunter mining boom will have increased the local economy greatly since 2001, therefore the value of the dredging would be less than the 0.009 per cent figure previous calculated. It should be noted that although the economic value of the dredging in the wider community is relatively low, the social value is high. Any increases are going to have a positive effect, especially in terms of local morale as this is a significant community project. There is also the potential for the project to be used as a catalyst to attract future investment.

4.4.2 Value of Additional Visitor Vessels into Lake Macquarie

Gillespie and Hassall (2003) used the estimate of return visitors (from **Section 3.1.1**) and communications from boat owners who own vessels outside of Lake Macquarie to estimate the number of trips that may potentially be taken if the channel was more readily passable, the amount of time people would stay and general expenditure whilst visiting.

This economics update follows a similar methodology to this and uses the revised number of assumed visitors from outside of the Lake, for a seven day visit. The estimates of expenditure are uplifted to 2012 prices and allocated against the sectors of the input-output model similar to the previous assessment, for consistency. This will provide the direct and indirect values for the local Lake Macquarie economy potential increase in job numbers. The previous study enumerated the impacts of the increased visitor numbers to present the value as 0.06% of the economic activity in the local economy; this value will be updated to account for the increases since 2003.

Updates to the previous assessment of the average number of visitors based on the most recent RMS data (2006 to 2011) were undertaken. An estimated 974 vessel movements indicated there were approximately 487 return trips into the Lake from vessels moored outside of the lake. Similarly to the previous assessment an arbitrary increase of 150 per cent in numbers of visitors was assigned to be consistent.

The average number of vessels movements assumed to be from vessels moored outside of the lake (i.e. visitors) is 974, which is 487 return trips (**Table 4.9**). Again the ratio of required draught by vessels is applied (refer **Table 4.3**) to determine the additional number of trips related to each dredge depth option.

Gillespie and Hassall (2003) estimated the expenditure per vessel per trip to Lake Macquarie at $3,942 in 2003. This value was uplifted to 2012 prices using CPI rates, the total spend per trip in 2012 can be estimated at $5033. This value was multiplied to return visit numbers for each option. Gillespie and Hassall (2003) allocated this expenditure across different sectors (e.g. restaurants) and applied the input-output analysis to determine multipliers that could be used to estimate the flow-on impacts for a given direct impact. These ratio multipliers determined in Gillespie and Hassall (2003) are also still assumed to be applicable (**Table 4.10**). The updated values have followed the same methodology. The same tax and margin adjustment values were also used to determine the direct impacts for the income and value-added. No adjustment has been made for employment as it is assumed the works are similar to the previous and thus, the employment opportunities the same. The results are presented in **Table 4.11**.

Table 4.10 - Estimated Number of Return Visits From Vessels Outside The Lake

Option	Return Visits per Year
Baseline	0
Average (2006-2011)	487
Option 1 (120m wide, -3.0m AHD)	1111
Option 1 (120m wide, -3.5m AHD)	1185
Option 1 (120m wide, -4.0m AHD)	1217

Table 4.11 - Ratio Multipliers for Visitor Regional Expenditure (Gillespie & Hassall 2003)

	Direct	Production induced	Consumption induced	Flow-on	Total
Output	1	0.51	0.21	0.72	1.72
Income	1	0.46	0.23	0.69	1.69
Employment	1	0.28	0.17	0.45	1.45
Value-added	1	0.53	0.23	0.76	1.76

Table 4.12 - Regional Economics Impacts for Annual Visits from Outside The Lake

	Direct	Production induced	Consumption induced	Flow-on	Total
Output ($)					
2m	4,328,535	2,207,553	908,992	3,116,545	7,445,080
2.5m	4,613,770	2,353,023	968,892	3,321,914	7,935,684
3m	4,740,944	2,417,882	995,598	3,413,480	8,154,425
Value added ($)					
2m	1,928,243	1,021,969	443,496	1,465,465	3,393,708
2.5m	2,055,307	1,089,313	472,721	1,562,034	3,617,341
3m	2,111,960	1,119,339	485,751	1,605,089	3,717,049
Income ($)					
2m	543,451	249,987	124,994	374,981	918,432
2.5m	579,263	266,461	133,230	399,691	978,954
3m	595,230	273,806	136,903	410,708	1,005,938
Employment					
2m	13	4	2	6	19
2.5m	15	4	3	7	22
3m	15	4	3	7	22

5.0 Discussion

The following section pulls together results where necessary and summarises the overall results of the technical and socio-economic assessments. It describes the significance of the results, and what implications these will have for the framework project.

5.1 Results - Compilation of Costs and Benefits

The previous sections have detailed the methods and results of each discrete aspect of the appraisal. This section pulls together all of these results. **Figure 5.1** shows the various aspects and how they fit together and overlap in the overall picture.

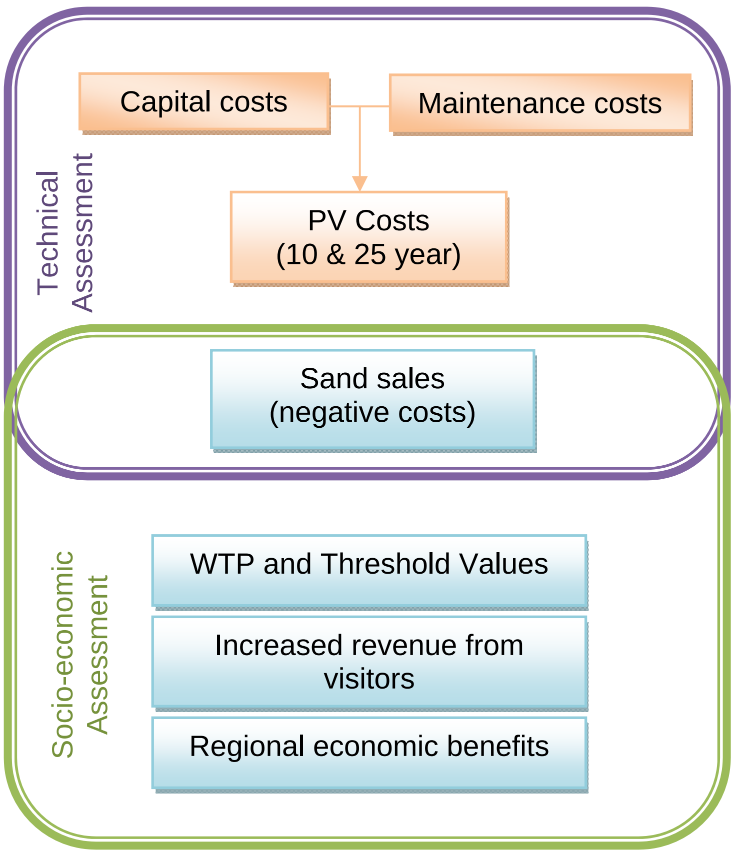

Figure 5.1 - The Various Aspects of the Technical and Socio-Economic Assessments

The total direct PV costs are presented with and without the addition of the potential revenue generated through sale of the sand. This is to account for uncertainty as to whether sale of the sand is viable and sensible. **Table 5.1** shows the difference in costs with and without the negative costs for sand sales incorporated.

Table 5.2 pulls together the costs and benefits, based on the benefits assessment in **Section 3.2**. The lead options are highlighted in **blue**.

Table 5.1 - PV Costs, Negative Costs (Sand Sales) and Totals For 10 And 25 Year Project Periods ($K)

		Baseline	Option 1						Option 2	Option 3
			60m x -4m AHD	120m x -4m AHD	60m x -3.5m AHD	120m x -3.5m AHD	60m x -3m AHD	120m x -3m AHD	Infilling western shoals	Submerged western training wall
10 years	**PV Costs**	4,855	4,299	8,952	4,311	8,755	3,303	8,272	5,904	10,710
	Negative PV costs (sand sales)	1,883		1,426		1,933		2,170		1,417
	Total PV Costs including sand sales	2,972		7,526		6,822		6,102		9,293
25 years	**PV Costs**	8,055	5,918	9,864	6,095	11,395	5,129	12,055	8,667	11,622
	Negative PV costs (sand sales)	3,124		1,699		2,721		3,297		1,690
	Total PV costs including sand sales	4,932		8,165		8,674		8,758		9,932

Table 5.2 - Total PV Costs (With and Without Sand Sales) for 10 and 25 Year Project Periods Against Relative Benefits ($K)

		Baseline	Option 1						Option 2	Option 3
			60m x -4m AHD	120m x -4m AHD	60m x -3.5m AHD	120m x -3.5m AHD	60m x -3m AHD	120m x -3m AHD	Infilling western shoals	Submerged western training wall
10 years	**a) PV Costs**	4,855	4,299	8,952	4,311	8,755	3,303	8,272	5,904	10,710
	b) Total PV Costs incl sand sales	2,972		7,526		6,822		6,102		9,293
	Benefits adjustment		16.39	41.53	13.19	25.83	10	18.89	28	40
	Ratio for a		3.81	4.64	3.06	2.95	3.03	2.28	**4.74**	3.73
	Ratio for b			**5.52**		3.79		3.10		4.30
25 years	**a) PV Costs**	8,055	5,918	9,864	6,095	11,395	5,129	12,055	8,667	11,622
	b) Total PV Costs incl sand sales	4,932		8,165		8,674		8,758		9,932
	Benefits adjustment		16.39	41.53	13.19	25.83	10	18.89	28	40
	Ratio for a		2.77	4.21	2.16	2.27	1.95	1.57	3.23	3.44
	Ratio for b			**5.09**		2.98		2.16		4.03

The results show that, on the basis of the ratio of the benefit measure to cost, the without the incorporation of the sand sale revenue, the lead option over 10 years is Option 2 - infilling of the western shoals with the sand dredged from the channel. The costs are relatively low for this option due to the sand being recycled within the channel rather than being pumped to a storage site. This greatly reduces handling costs. The benefits score for this option is quite high, third overall. The drawbacks of this option are the short term impacts on the seagrass habitats, the potential effects on the e-folding time (water quality) and the uncertainty surrounding the effects of the change in morphology (especially depth and resultant current flows) of the western shoals and the potential for sediment flow back into the channel.

With incorporation of the sand sales revenue, the lead option is Option 1 - dredging to 120 metres by -4 metres AHD. This option has the highest benefits score, and the lowest uncertainty, as this option has been modelled in the past. It has the least ongoing maintenance costs, and will likely be the most efficient at ensuring the channel stays open. The challenges related to this option will be ensuring the most appropriate plant is used so sufficient volumes of sand are removed over the space of a year or two, that an appropriate staging and storage site is located nearby, and that there is a buyer(s) able to take that volume of sand over the project.

5.1.1 Disadvantages of Long Term Sale of Sand

Usually it would be preferable for sand within a system to be recycled within the same system for beneficial use elsewhere; however, in this case the sand will attract a significant beneficial source of revenue if sold, so should be considered. Beneficial use of sand is more thoroughly considered in the Framework main report.

It could be argued that since the modelling studies show that there is minimal sand entering the system, and minimal exiting via the channel entrance, that the permanent extraction of the sand would have few implications. That may, in effect, may be true; however the long term loss must also be considered in terms of minimising damages elsewhere. The channel will likely continue to scour and redistribute sediment from the outer and middle channel to the inner. In time this may exacerbate channel foreshore erosion, which is already being experienced in certain locations. Sand is a valuable resource to minimise the effects of this erosion by renourishing eroded areas. Although this sand would be somewhat sacrificial, it would still serve to lessen foreshore risk.

The sand would also be an important resource for renourishing open coast areas at risk from coastal erosion and inundation. The management of the channel in terms of hazards and risk will be assessed in future by Council. It would be in Councils interests to investigate the cost-benefit implications of using the sand to build up at risk areas of the channel and coastline to offset long term erosion damages.

5.2 Consideration of the Socio-Economic Impacts

The socio-economic update has furthered our understanding of the social aspects of the dredging campaigns in the past, and potentially in future. The total revenue generated from the regular users of the channel (the willing to pay (WTP) calculations) show that the dredging costs to regular users to keep it open are far beyond the means of the channel users. Estimates range between $100 and $700 dollars per return trip. This cost lessens when incorporating the revenue from sand sales, however still not to any values that realistically the community would be willing to pay per trip.

The real significant impacts are seen in the assessment of the potential tourism revenue generated is factored in. The results show that there would potentially be increases in the order of $7 - 8 million a year, increased value of $3.3 - 3.7 million a year, increased income of $0.9 - 1.005 million a year and the generation of additional employment, potentially around 19 to 22 jobs. This would be a significant boost to the local economy.

However, it is necessary to consider the potential costs that that boost may incur. The money to kick start this must come from somewhere i.e. State or Local Government. Any public funding must be supported by higher revenue collection (e.g. increased taxes, levies or rates) or reduced investment in other services (e.g. reduction in infrastructure projects or community grants). Thus it is important to consider the net effects of the investment. The net benefits maybe positive if the investment stimulates use of surplus capacity, i.e. under-used resources, underutilised infrastructure and unemployed people. This was not investigated as part of the previous assessment, however would be worth considering after the outcomes of the Framework funding are decided and an ongoing commitment to funding established.

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