SHOALHAVEN CITYWIDE DREDGING FEASIBILITY STUDY

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EXECUTIVE SUMMARY

Council requires a strategy to deal with increased demand for improving navigation and boating safety at a number of estuarine sites. This report investigates the practical aspects of dredging, and estimates costs and options for use of dredged sand.

Major dredging projects are costed and ranked in accordance with marine safety benefits, providing a broad community benefit or added benefits such as supply of sand for beach nourishment and overall cost effectiveness as follows:

Site in Priority Order	Priority Points	Sand volume cu.m	Cost Estimate	Comments
Currambene Creek Navigation Dredging	79	8,000	$ 439,000	Cost includes scraper hire to place sand along Callala Beach (northern end)
Sussex Inlet Channel Navigation	76	10,700	$ 460,200	Local placement of sand in flood tide delta
Conjola Configuration Dredging	63	12,000	$ 597,700	Cost includes haul of sand to Mollymook Beach
Conjola Entrance Sand Mining	61	Say 30,000	$1,303,300	Cost includes haul of sand to Mollymook Beach
Sussex Inlet Bar	59	Not known	$ 600,000	Approx. cost only, limited life
Shoalhaven Heads Flood Notch	47	2,000	$ 10,000	Cost is per event, with more than one likely per year
Currambene Creek Additional Moorings	38	Not known	Not known	Not feasible under Marine Park zoning
Shoalhaven Heads Environmental Opening	36	15,000	$ 75,000	Opening for tidal flushing would have short life. Cost excludes gaining approvals.
Currarong Creek Navigation	34	5,000	$ 25,000	Value of project is as beach nourishment material

Minor dredging projects at local boatramps have a priority system reflecting boating safety, cost effectiveness and community support:

Site in Priority Order	Priority Points	Sand volume cu.m	Cost Estimate	Comments
Callala Bay Boat Ramp	75	300	$ 6,000	Timing every 5 years, note seagrasses limit extent of excavation
Sanctuary Point Boat Ramp	66	Minimal	$ 2,000 to $ 3,000	Timing infrequent as required
Aney St Conjola Boat Ramp	33	Major	-	Impractical; no demand from local community
Narrawallee Boat Ramp	29	Major	-	Majority of local community would oppose
Cunjurong Point Boat Ramp	26	Major	-	Impractical; no expectation from local community

In order to better manage project costs, a number of strategies are available. Projects that are consistent with Council's Coastal Zone Hazard Management Plan or with navigation and safety benefits may be eligible for 50% State Government subsidy under its various programs.

Flexible project planning should look to combine projects in proximity. Hence future dredging works may be carried out consecutively across a number of sites. This will allow Council to take advantage of economies of scale for dredge establishment and disestablishment.

Finally, a partnership arrangement with the private sand and concrete industry would offer considerable cost savings. Our discussions have confirmed an interest amongst private operators, with preference for Council to use its expertise to gain statutory approvals. A potential model for a partnership is discussed in this report.

SHOALHAVEN CITYWIDE DREDGING FEASIBILITY STUDY

INTRODUCTION

Background

Council requires a strategy to deal with increased demand from the community for improving navigation and boating safety at a number of estuarine locations across the city area. This report investigates the practical aspects of dredging, estimates costs and options for use / disposal of dredged sand. A system of prioritising the various projects is proposed and a list of priorities is recommended.

Dredging is a term that implies removal of material at least partially underwater, traditionally by either dragline, airlift or by a cutter suction dredge on a water-borne barge. However the term is used more broadly in this study to include the occasional opening of the mouths of intermittent estuaries. Commonly excavators and articulated trucks are used for this purpose. Lake openings would occur in response to heavy rainfall triggering a flood relief response. Conversely a more traditional 'dredging' exercise is a planned project within a given timescale and budget. The two project types therefore have different methodologies and considerations for the setting of priorities.

Dragline

A dragline excavator can be used for port construction, pond and canal dredging, and as pile driving rigs. A dragline is designed to be dismantled and transported on flatbed trailers. Draglines with perforated buckets allow water to drain from underwater excavations.

Draglines have a work area limited by the reach of the boom and cables. They typically unload their bucket close to the machine. This requires a wide work / stockpile area on the bank of the work site. Their use on Shoalhaven projects would be limited by this factor. Their use has largely been replaced by long reach excavators.

Long Reach Excavator

Long Reach Excavators have been designed specifically for jobs requiring longer reach than standard excavators, combined with digging capabilities. Long Reach Excavation machines are ideally suited for applications such as deep or long distance digging in sand or gravel pits (replacing draglines), cleaning of settling banks and ponds, and for drainage schemes. Their maximum horizontal reach is 18 - 20 metres.

Council uses these machines on the beach berm with articulated dump trucks to quickly open estuary entrances. A 20 tonne excavator with 2 articulated dump trucks would achieve daily excavation rates of about 1000 cu.m and cost about $5,000 per day.

Cutter Suction Dredging

Traditional water-based dredging of a scale seen around NSW estuaries would use a cutter-suction dredge, which uses a cutting mechanism at a suction pump inlet. Bed material is sucked up by a centrifugal pump and discharged either to a barge, side cast close to the excavation or pumped

through a discharge pipeline. With this technique, it is uncommon for turbidity at the cutter head to be a concern.

Figure 1 Small 150mm Cutter Suction Dredge

A small cutter suction dredge such as that shown in Figure 1 above is ideal for estuary work, deepening boating channels, de-silting of boat ramps and jetties and for beach nourishment. Discharge rates can be up to 30 cu.m of sand per hour over a pumping distance of 400m. Larger distances require a booster pump or pumps which can cover an additional 1km per booster over flat terrain. Larger 200mm dredges can discharge up to 80 to 100 cu.m per hour.

Sand is discharged as a slurry mix comprising about 30% sand and 70% seawater by weight. An hour's dredging can discharge around 150,000L of excess water. Hence drying beds or dewatering bunds shown in Figure 2 are necessary. These allow the sand to settle and the water to either runoff or seep away. The land-based component of dredging can require up to 500 to 1,000 sq.m for dewatering, dependent on local conditions and the receiving waters' sensitivity.

The areas under investigation, which comprise recently laid down deposits, would be assumed to comprise clean coastal sand. In dredging clean sand, there is little or no potential for disturbance to aquatic ecosystems from the sediment. A silt curtain at the outlet of a dewatering bed can control fines if the dredged material is suspected to contain silts or clays. This can prevent sedimentation of the receiving waterway.

Costs of dredging vary enormously with the scale of the job. For a 150mm dredge, a base cost of around $10 to $30 per cubic metre of sand is applicable, subject to location, material type and pumping distance. The higher rates apply to projects in exposed waters, as these sites can result in significant unpaid down-time during adverse weather.

An additional and quite significant cost is establishment and disestablishment, to transport and assemble the dredge, install the pipeline and booster pumps and erect signage and safety items. Costs vary but can be of the order $50,000 to $70,000 for combined establishment and

disestablishment activities. Hence these components can be a significant cost for a small project, but become more economical for a larger exercise when spread over larger volumes of material to be removed. To these base rates is added the costs of subsequent handling, excavating drying beds or bunds and restoration or dune shaping.

If a booster pump was required, an additional cost of $5 /cu.m should be allowed. Larger dredges would have higher mobilisation / demobilisation costs but lower cubic metre rates.

Figure 2 Dewatering bunds at Corrigans Beach, Batemans Bay with recent dredged sand in the foreground

It would be advantageous to Council to combine a number of smaller dredging projects in order to reduce the impact of establishment overheads. This of course requires advanced planning and has annual budgeting implications for Council. This may also affect the timing of works programs in order to be cost effective. Larger projects of a scale 8,000 to 10,000 cu.m can stand alone and still be reasonably cost effective.

Airlift and Dredge Pumps

Southern Commercial Divers offer an airlift technique to remove submerged sand. Airlift pumps typically comprise a 100mm or 150mm suction pipe and a compressor that supplies air to the lower end of the pipe. Rising air moves up the pipe, sucking sand upwards. This technique is useful in submerged situations that require sand removal in very small quantities over very short distances.

A better option for some of the boat ramp jobs would be a dredge pump. This pumps sand / water slurry (30% sand) over distances up to 100 to 150 metres. Typical output rates are 700 to 800 cu.m per day. Longer distances could be achieved (up to 500 metres on level terrain) with an on-shore booster pump, however output rates would decrease.

Sand Shifter Technology

Sand shifter recycling technology was developed by an Australian company Slurry Systems Marine Pty Ltd. The technology has been used successfully at Lakes Entrance, Victoria and on the Gold Coast. The Sand Shifter is based on a fluidising principle, which allows a permanent installation of pipework typically in a river or estuary entrance. Sand is pumped in a slurry, with the equipment operated when the channel is blocked to create or maintain an opening. The units would be installed deep enough to not be lost during a flood scour event.

This procedure would be suitable if the opening of the entrance was primarily for environmental flows or for minimising upstream flooding. It would not be suitable for a reliable navigation channel unless training walls were constructed.

This technique is investigated in this report for Shoalhaven Heads in more detail.

NAVIGATION DESIGN PARAMETERS

Dredging related to navigation aims to create a safe depth and width for maritime vessels. Aspects such as wave climate, wind and currents all can reduce boat manoeuvrability.

For navigation within an estuary, recommended dimensions of navigation channels are adapted from AS 3962 - 2001 which list requirements for entrances to a marina. From AS 3962 the guidelines relevant to this study are:

- **Channel width** should be the greatest of:

  - 20 metres ; or
  - L + 2 metres where L is the length of the longest boat; or
  - 5 x B where B is the beam of broadest (mono-hull) boat.

Note the preferred width is the smaller of 30 metres or 6 x B.

Where an increase of wave climate could impact moorings inside an otherwise protected entrance, the wave climate can be minimised by providing a narrower (15 metres wide or 3 x B) entrance channel over a short length.

- **Channel depth** at ISLW [1] should ideally be the minimum of:

  - Draught of the largest boat; PLUS
  - Minimum of half the significant wave height from swell, wind waves or boat wash as appropriate to the site; PLUS
  - Allowance for siltation if required to extend the project life; PLUS
  - Minimum under keel clearance of 0.3 metres.

With regard to the above guidelines, the cost and scope of dredging may dictate the size of the largest boats that can practically use a waterway at all tides.

[1] **Note:**
This report will quote two methods of water level measurement. Expressing heights in metres above (or below) Australian Height Datum (AHD) is a common surveying practice, which allows a standard comparison of levels across Australia. A level of 0.0 m AHD is very close to mean sea level. The average high tides on our part of the coast are 0.5m above AHD and the lowest low tides (zero on the tide chart) are just over 0.9m below AHD.
This report uses depths above Indian Spring Low Water (ISLW) when discussing navigation issues. ISLW is zero datum on the tide chart and is approximately - 0.9m AHD. It is the mean of the lower low tide levels experienced a few times a year.

PROCEDURES & TIME FRAMES

The following procedures are common to the planning and implementation of most dredging projects. Both the dredging area and the spoil processing /disposal areas are to be included in the following considerations.

Planning / Environmental Assessments

- Define scope of works and volumes from hydrosurvey
- Stage Agency consultation
- Geotechnical analysis of sediment
- Land and topographic surveys if necessary (dredging and disposal areas)
- Fauna and flora, ecological surveys
- Hydrodynamic assessments
- Review of Environmental Factors
- Public consultation 28 days
- Most of these aspects would involve consultants and may have a lead time of 2 months to prepare, advertise and assess tenders and 4 months to complete

Approvals

- Application for Crown Lands licence
- Application for Marine Parks permit where required
- Application for Fisheries permit if required
- Any other approvals as required by REF document
- Time frame typically 3 or 4 months once applications are prepared and lodged. Note that final licencing can be delayed until a dredging tender is let and environmental controls specific to the dredging equipment and work methods are approved (see below).

Implementation

- Project management and documentation - prepare contract and specifications to tender
- Pre-works surveys if necessary to define volumes
- Design and implement environmental controls and safety measures and lodge for approval with agencies
- Carry out dredging works
- Site remediation if required
- Typical contract documentation, tender letting and assessment would require 3 to 4 months.

Finalisation

- Post-works survey
- Final report as required

FUNDING SOURCES

Government Subsidy

The NSW Government is committed to delivering a sustainable dredging strategy for NSW to improve the accessibility and environmental health of our waterways. The strategy is outlined in *NSW Government Sustainable Dredging Strategy 2012/13 - 2014/15*. A call for project applications under this strategy - titled the Rescuing our Waterways Program - was announced early in March, closing 14th April 2014. Funding is generally on a 50/50 basis.

Applications for funding will be assessed based on the following considerations in priority order:

1. Demonstrated navigation improvements in waterways for a range of boating enthusiasts and for the continued viability of commercial boating operations and tourism where compatible with the estuary management planning process.
2. Reinstates waterway access to public aquatic infrastructure such as boat ramps and wharves.
3. Restoration of tidal flushing and water quality, especially in high priority oyster growing areas that delivers local economic benefits.
4. Pre-dredge activities for projects which would be eligible for funding and are likely to proceed to dredging including investigations (such as sediment analysis, sediment hydrodynamics, aquatic flora and fauna surveys) and environmental impact assessments.
5. Preparation of dredging strategies.

Private sector dredging of sand for extractive industries is possible under the policy with no contribution by State government. Project management, approvals and funding are to be by the beneficiary, which we understand can include Councils in a joint venture (see discussion below).

Funding assistance for local government for dredging to address coastal flooding, coastal hazard management (beach replenishment) and environmental issues is provided under either of the Coastal, Estuary and Floodplain Management Programs under the administration of the Office of Environment and Heritage (OEH). In order to gain potential funding from these programs, a project would need to meet the program objectives. Coast-related projects must be consistent with Council's Coastal Zone Hazard Management Plan. The level of funding is subject to state wide priorities and available state budgets.

Private Industry Interest

Beach sand is favoured as it provides the best level of workability for concrete, although blending with manufactured sand from crushed rock is being used by the Sydney industry for a cheaper resource. The cost of beach sand ex-gate in Sydney varies from $40 to $60 per tonne, or $60 to $90 / cu.m. The resource on the south coast is more available and therefore cheaper.

We have contacted limited private industry contacts to gauge the level of interest in sand reserves in the Shoalhaven City area. Cleary Bros has confirmed in discussions that there would be broad interest in a joint venture with Council to dredge sand reserves. Reserves in their current working

areas around the Shoalhaven would last about 10 years. Their sand pit life would be extended by roughly a year for every 50,000 cu.m of sand sourced from elsewhere. Their preference would be for Council to use its expertise to gain statutory approvals.

Cleary Bros would have a use for sand mainly for concrete mixes. Several features affect the suitability of fine aggregate (sand) for concrete. These include particle size distribution, particle shape and surface texture, clay, silt and dust content, chemical impurities, presence of mechanically weak particles, water absorption and mica content. Grading is singled out as the most important property, followed by particle shape and presence of impurities.

Australian Standard 2758.1 Table 3 provides the required grading for fine aggregate (sand) for concrete production. We understand the beach sands at Sussex Inlet channel and most likely also at Lake Conjola would meet these standards, although this would need to be confirmed by sampling if a joint venture was to proceed.

A sand volume such as 30,000 cu.m (Lake Conjola) is a relatively small quantity for the concrete industry. However sand is costly to haul and store. Cleary Bros may well need to time a dredging program in response to their budgets and demand for sand or concrete.

Shoalhaven Sand specialise in river sand for the asphalt market. They would need to purchase a second dredge to undertake joint venture work with Council, and are not interested in expanding to beach sand sources for this reason.

Royalties

Note that payment to the state of a royalty may be applicable for any extraction activity, particularly for sale or profit. If material is being removed under a maintenance dredging contract to improve navigation and is being sold as part of the contract agreement to recover part of the cost, then the project may be approved by Crown Lands for exemption from royalty payment.

If the project is not considered by Crown Lands to be a maintenance dredging project to improve navigation, then it would generally be dealt with as a commercial project and progressed via an Expression of Interest process. In this case royalties would be payable for any materials removed and sold.

If material is removed under any project and placed back on Crown land for beach nourishment, there may be a case for exemption from payment of royalties.

Royalty rates vary from site to site based on location relative to the market, extraction process and the quality and type of material being removed. Crown Lands advise that the current royalty rates for sand varies from $0.75 to $3.00. However, it should be noted that all royalty rates are programmed for review later this year and it is expected that they may increase. The imposition of an additional royalty payable to Council to cover project approval costs is an option for council to consider.

Possible Operating Model

A possible operating model with the private industry could operate as follows:

- Council undertakes SID, REF process and gains approvals (an extended time limit for commencement of works could be specified in licence approvals)
- Project approvals identify site limits, surveyed volumes and practical issues such as dewatering areas and haul routes
- Tender or Expressions of Interest for sand removal
- Project could incorporate a component to place sand for beach replenishment
- Successful tenderer to be responsible for site safety, maintenance of access and dewatering / loading area, environmental controls at stockpile site
- Include royalty amount for Crown if applicable
- Potential for Council to recoup its upfront costs through separate small royalty payment or sharing of Crown royalty
- Contractor to give adequate notice of commencement to enable prior volume survey and supervision by Council

There is a strong likelihood that fully commercial projects would be cost-neutral to council. However there is the possibility of state agency objection to large volumes of sand being removed from the system.

Purchase of Dredge

A group of individuals at Taree have gained grants and raised funds locally to enable the purchase of a dredge. The Farquhar Inlet Management group purchased an old dredge from Brisbane for $80,000 and refurbished it for a further $30,000 in cash and an additional $60,000 estimated for donated work. Most labour was voluntary from the group and its local contacts. The asset would now be worth something like $250,000 on the open market.

Their operating costs are met project by project by the local Council, who pay per cubic metre of sand. This funds a dredge operator and offsider. Costs to dredge river sand are about $4 per cu.m. However this rate does not allow for maintenance, wear and tear and replacement of cutter heads. Careful consideration would have to be given to the life cycle costs and usefulness of owning a dredge over a long period.

Commercial river sand dredging rates by comparison in the Manning Valley are $8 to $10 per cubic metre. Establishment and disestablishment is of the order $15,000 each way.

In the case of Shoalhaven City Council, the advantage of Council owning and operating a dredge compared to commercial rates would essentially be the saving of the major establishment and disestablishment costs. Additional equipment that Council would require includes discharge pipe (150mm flanged poly) and for larger jobs a diesel booster pump. A dredge operator would need to be hired.

A private / public joint venture would avoid capital cost of equipment and ongoing running costs.

STATUTORY REQUIREMENTS

There are a number of statutory provisions which relate to maintenance dredging activities. The following summary gives an overview of the controls and their possible impacts on maintenance dredging and the placement of spoil.

The approvals process raises complexities that will have to be addressed on a case by case basis.

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (the EPBC Act) establishes an environmental assessment and approval system that is separate from and additional to State systems.

Under the assessment/approval provisions of the EPBC Act, actions likely to have a significant impact on a matter of national environmental significance are subject to a rigorous assessment and approval process. The Act identifies seven matters of significance:

- World Heritage properties;
- National Heritage places
- Ramsar wetlands of international significance;
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Environmental Planning & Assessment Act 1979

Public authorities proposing to undertake maintenance dredging have an obligation (under Part V of the EP&A Act 1979) to examine the likely environmental impacts of the activity and to consider the appropriate level of environmental assessment that is required prior to approving the activity. Such an examination would usually take the form of a Review of Environmental Factors (REF). There is no sunset clause under Part V approvals.

Clause 228 (EP&A Regulations 2000) sets out the factors which a public authority must consider when assessing the significance of the environmental impact of an activity. If the environmental impacts were assessed as *"likely to significantly affect the environment"* then an environmental impact statement (EIS) would be prepared and exhibited before any approval is given. A dredging project over 30,000 cu.m triggers Designated Development provisions, which require an EIS. We would suggest any dredging campaign be limited to below 30,000 cu.m to avoid excessive costs and time delays.

Development proposed and undertaken by others falls under Part IV of the EP&A Act and is subject to development approval by the appropriate development consent authority. A Development

Application would require an accompanying Statement of Environmental Effects (SEE). Planning advice confirms that if council was the project proponent and manager, then regardless of the works being carried out by a contractor, the Part V process applies. The parallel would be council doing roadworks using contractors.

Note for a Council project of maintenance dredging for navigation or beach nourishment, SEPP (Infrastructure) 2007 removes the need for development consent (see overleaf for details).

Crown Lands Act 1989

A license would be required from the Department of Trade & Investment / Crown Lands for maintenance dredging activities on submerged crown land. Applications are referred to other agencies such as Fisheries and Marine Parks if relevant.

Part of the consideration of Crown Lands is whether Native Title considerations apply. Evidence of past disturbance by prior dredging would extinguish Native Title. If Native Title applies, the assessment process would be simplified if works were for public safety or beach nourishment. If dredged sand was to be sold, the Native Title process may be more complex. Also if sand was to be sold, royalties may be payable to the Crown.

Protection of the Environment and Operations Act 1997

This legislation controls environmental pollution and regulates scheduled activities carried out in NSW. In relation to dredging activities, the provisions of the Act would primarily relate to preventing water pollution, contaminated waste (spoil) and transport of dredge spoil as well as ancillary matters such as noise and air pollution. Dredging activities that involve the dredging of more than 30,000 m^3 of material annually are scheduled and may require an Environmental Protection License.

Threatened Species Conservation Act 1995

The Threatened Species Conservation Act requires assessment of listed threatened species that occur on any proposed development site. A Seven Part Test will be required under this legislation as part of the environmental assessment for individual dredging proposals. Listed migratory species (shorebirds) in particular are likely to require special consideration for each dredging proposal and for some disposal options.

Fisheries Management Act 1994

The Fisheries Management Act requires Council to obtain permits for dredging or reclamation works. However, a permit is not required where the works are authorized under the Crown Lands Act or by any other relevant authority (excluding Council). Given that a Crown Lands licence will be required for all river dredging sites identified in this strategy, a dredging permit from NSW DPI will not be required.

The Act also requires a permit to be issued where marine vegetation is to be harmed. For instance, disturbance to seagrasses or saltmarsh would require a permit. These would be considerations for Callala Bay boatramp and for disposal of dredge spoil in the tidal zone of an estuary.

Water Management Act 2000

This legislation requires a controlled activity approval to be obtained for works within 40m of rivers or foreshores. However, public authorities including Councils are exempt from the requirements of the Act.

Coastal Protection Act 1979

The Coastal Protection Act includes requirements for whether Ministerial concurrence would be required for the proposed dredging activities (e.g. when dredging is carried out under Part V assessment or under the Infrastructure SEPP). Issues for the Minister's consideration are related to potential impacts on the coast or waterways. Actions that are in accordance with a Coastal Zone Management Plan are exempt.

State Environmental Planning Policy (Infrastructure) 2007

SEPP (Infrastructure) 2007 aims to facilitate the effective delivery of infrastructure across the state by permitting certain types of development without consent, provided appropriate consultation with all relevant government authorities and environmental impact assessment under Part V of the Environmental Planning & Assessment (EP&A) Act, 1979, are undertaken.

The following activities are applicable without consent:

- provision of port, wharf or boating facilities;
- routine maintenance works (including dredging, or bed profile levelling, of existing navigation channels) for safety reasons or in connection with existing port, wharf or boating facilities;
- development for the purpose of waterway or foreshore management activities (including coastal management and beach nourishment); and
- environmental management and/or protection works.

SEPP (Infrastructure) 2007 does not remove the requirement for compliance with other legislation, or the need to obtain any necessary licences, approvals or permits. Preparation of a REF or SEE would still be required.

State Environmental Planning Policy 14 – Coastal Wetlands

SEPP 14 applies to developments that have potential to damage/destroy identified coastal wetlands. Assessment within the REF would determine whether the dredging or the placement of spoil would impact identified wetlands.

State Environmental Planning Policy No.62 – Sustainable Aquaculture

SEPP 62 applies to all developments that have the potential to adversely affect existing or future oyster aquaculture.

Draft Shoalhaven Local Environmental Plan 2013

Dredging must be a permissible use within the zone as applicable.

NSW Coastal Policy

The NSW Coastal Policy (1997) provides a framework for the balanced and coordinated management of the coast's unique attributes. It states in Strategic Action 5.2.9 that 'sand mining or extraction will be controlled on environmentally sensitive lands through the environmental impact assessment process'.

This may have considerable cost and time implications to these projects if it were applicable. We would suggest that the environmental assessment process is set by other more recent legislation, so that this policy would not over-rule other environmental guidelines.

JERVIS BAY MARINE PARK

A number of study areas are located within the Jervis Bay Marine Park:

- Callala Bay and Callala Beach are both within the Habitat Protection Zone
- the mouth of Currambene Creek and the tidal areas of the creeks have a range of zonings (see Figure 3)
- the wharf area at Huskisson is subject to a Special Purpose Zone
- the mouth of Currarong Creek and its tidal waters are Habitat Protection Zone.

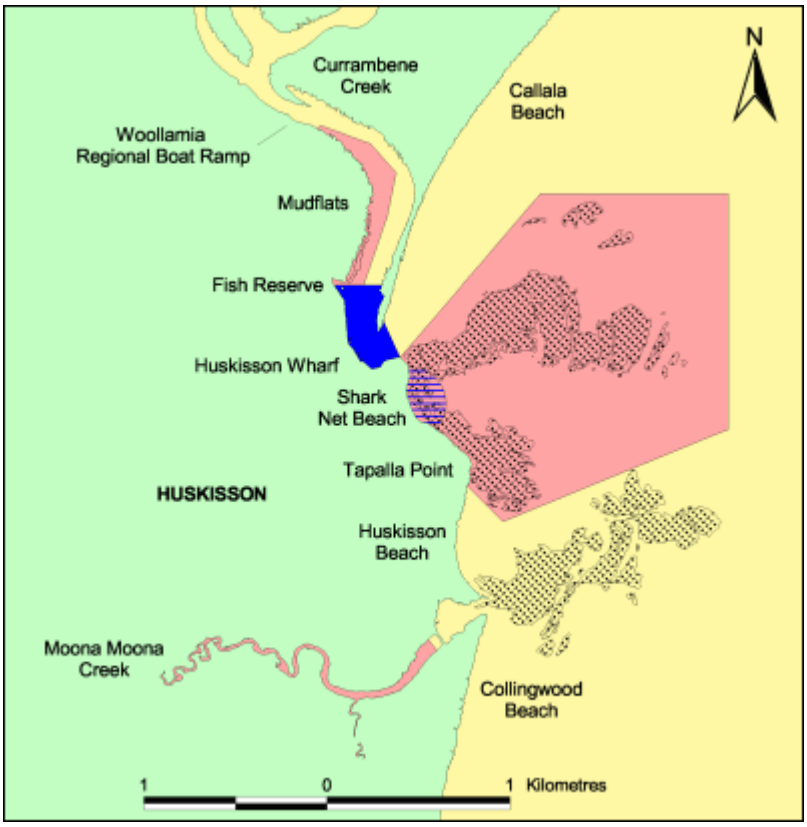

Figure 3 Jervis Bay Marine Park extract - map of Currambene Creek

Map legend : Pink = Sanctuary Zone; Yellow = Habitat Protection Zone; Dark Blue = Special Purpose Zone

Uses in these areas are regulated by the Marine Parks (Zoning Plans) Regulation 1999 through a zoning plan. Extracts from the Regulations relating to dredging (or sand removal) activities are as follows.

Sanctuary Zone

The Sanctuary Zones provide the highest level of protection to habitat, animals and plants. Specific regulations for a Sanctuary Zone are:

(1) A person must not carry out any dredging activity or beach replenishment activity in the sanctuary zone of a marine park.

(2) A person does not commit an offence against this clause if the dredging activity or beach replenishment activity is carried out with the consent of the relevant Ministers.

(3) Consent is not to be given to the carrying out of a dredging activity or beach replenishment activity in the sanctuary zone of a marine park unless the relevant Ministers are satisfied that the activity is necessary to prevent a serious risk of injury to a person, damage to property or harm to the environment.

Habitat Protection Zone

This zone also conserves marine biodiversity by protecting habitats and limiting high impact activities. For a Habitat Protection Zone the zoning requirements are:

(1) A person must not, while in the habitat protection zone of a marine park:

(a) harm, or attempt to harm, any animal (other than fish), or
(b) harm, or attempt to harm, any plant, or
(c) damage, take or interfere with, or attempt to damage, take or interfere with, any part of the habitat (including soil, sand, shells or other material occurring naturally within the zone), except with the consent of the relevant Ministers.

Consent is only to be given under subclause (1):

(a) for research, environmental protection, public health, traditional use or public safety purposes, or

(b) for the purposes of an ecologically sustainable use that does not have a significant impact on fish populations within the zone or on any other animals, plants or habitats.

PRIORITIES

Assessment Criteria

Given the scope of this strategy and the overall cost of dredging works, prioritising of dredging sites is required. Accordingly, dredging sites have been assessed according to a range of key criteria and prioritised using a matrix scoring process. **Appendix 2** provides detailed information on the prioritisation assessment.

A range of key criteria were adopted for this assessment with assistance from a community forum working group. These criteria include economic, social and environmental factors. Weighting factors have been applied to reflect the relative importance of the various components. For instance, broad community benefit, safety improvements and potential for added benefits would outweigh other components.

- Community benefit - commercial, economic, tourism, jobs
- Total cost
- Navigation improvements under expected coastal processes
- Extent of safety benefits
- Environmental outcomes
- Beneficial effects of or disruption to natural coastal processes
- Level of boating activity
- Opportunities for external funding (Government or private sector)
- Effectiveness - longevity of dredging
- Potential for other benefits - e.g. sites for sand nourishment, protections of assets, ease of approval process.

A separate assessment has been made for two categories of project - major dredging projects and for minor dredging projects around boat ramps. Each category has a different component weighting.

Priority Results

The ranking of projects results in the following priorities and scores.

Major projects:

1. Currambene Creek Navigation 79
2. Sussex Inlet Channel Navigation 76
3. Conjola Configuration Dredging 63
4. Conjola Entrance Sand Mining 61
5. Sussex Inlet Entrance Bar 59
6. Shoalhaven Heads Flood Notch 47
7. Currambene Creek Additional Moorings 38
8. Shoalhaven Heads Environmental Opening 36
9. Currarong Creek Navigation 34

Minor projects:

1. Callala Bay Boat Ramp 75
2. Sanctuary Point Boat Ramp 66
3. Aney St Conjola Boat Ramp 33
4. Narrawallee Boat Ramp 29
5. Cunjurong Point Boat Ramp 26

Repeat Dredging

The likely longevity is one factor that affects prioritising of these major projects. Dredging of any site that had accumulated sand would inevitably require future maintenance in response to further infilling. The longevity of a dredging campaign would depend on volumes of sand removed and sources of replacement sand. Major factors would include sand longshore drift rates, and natural influences such as beach erosion from storms, scouring by flood events and the like.

Given the unpredictability of these natural events, it is not possible to determine the life of dredging projects. However an indication is given below of the comparative longevity, based on current knowledge and engineering judgement. A rating of 'Poor' would suggest a life of months rather than years, while 'Good' would suggest a life of a decade rather than years.

Major Project Site	Sand drift	Dune erosion	Scour from floods	Overall Longevity
Shoalhaven Heads	Regular, major infill	Dune sand freely available	Irregular benefit	Poor
Currambene Creek	Minimal infill	Dune sand available but reef offers protection	Minor beneficial impact	Fair to good
Currarong Creek	Regular, medium infill rate	Dune sand available, low wave climate	Minimal	Fair
Sussex Inlet Channel	Low infill rate	Minor impact of sandhill erosion	Irregular benefit	Good
Sussex Inlet Bar	Sporadic medium infill rate	N/A	Irregular benefit	Poor to fair
Lake Conjola	Medium regular infill rate, sporadic major infill	Minor impact	Irregular benefit	Fair to good

Note that in the case of Lake Conjola, the sand infill rate is a positive aspect as it becomes a resource if sourced for beach nourishment.

The life expectancy of sand removal at boatramp sites under investigation would also vary with the sand volume removed and sand infill rates. The latter vary with prevailing winds as this is the main

driving force in sand drift for the estuarine sites that are mostly unaffected by ocean influences. Priority of works at these sites is more relevant to the need for the works on a safety or navigation basis, rather than longevity.

Boatramp Site	Sand drift	Dune erosion	Scour from floods	Overall Longevity
Callala Bay	Regular, low rate	Nil	Nil	Reasonable
Sanctuary Point	Irregular, low rate	Nil	Nil	Good
Cunjurong Point	Major factor	Nil	Irregular benefit	Poor
Narrawallee Inlet	Minor	Nil	Not known	N/A
Aney St Conjola	Minor	Nil	Unlikely	N/A

Comments

It should be noted that despite the priorities determined by this systematic process, flexible project planning should look to combine projects in proximity. Hence future dredging works may be carried out consecutively across a number of sites. This will allow Council to take advantage of economies of plant mobilisation and demobilisation.

Also note that priorities have not been allocated to the (non-optional) periodic opening of intermittent lake entrances. This activity includes pilot channel excavation, and is required from time to time to relieve flooding, regardless of the above priorities.

BOAT RAMPS

This report deals with navigational dredging around boat ramps separately as the scale of the issues at ramps is much smaller than the other estuarine sites in this study.

Callala Bay

The Callala Bay Coastal Management Scheme (SMEC 2008) has examined the design of a beach nourishment scheme for the area of Callala Bay north of the boat launching ramp and south of Sheaffe Street. This area has been undergoing erosion since the late 1970s.

SMEC (2008) undertook an examination of the coastal processes in this area. It was found that the area is subject to a high potential for longshore drift, with sand moving from south to north, due to the oblique angle of the ambient wave climate.

A potential management scheme which would be appropriate for this situation involves the construction of a groyne, coupled with significant beach nourishment and beach scraping. Large volumes of sand available for beach nourishment were recommended to be sourced from the beach near the entrance to Wowly Creek, approximately 600 metres northeast of the site. This report does not further analyse or prioritise this project. It is confined to investigating the boat ramp.

The Callala Bay boatramp is a high demand ramp that accesses Jervis Bay for all trailer vessels. The ramp is understood to have been shallow since a suspended slab ramp was constructed about 15 years ago.

A shallow shoal at the end of the ramp appears to have been created by boaters powering their boats onto the trailer. This shoal was evident in the 2007 survey and is quite problematic at low tide on our December 2013 inspection. Launching at low tide is difficult, particularly for larger boats which bottom out on the outboard when leaving their trailers at a sharp downward angle.

NSW Fisheries report that extensive beds of Posidonia seagrass occur locally, from our aerial photography observation near the end of the jetty. Any works around the ramp needs to recognise the environmental significance of these seagrass beds. The eastern extent of the area available to deepen the ramp approaches is therefore limited.

A simple ‘cut and fill’ project utilising a barge-mounted dredge pump is recommended. The dredge pump would return sand to the beach opposite the nearby toilet block. Volumes of sand are relatively small - say 300 cu.m - and a project cost of the order $6,000 over 2 days is envisaged. It is possible that the boat ramp sand contains silts and may not be suited to surface placement. It should be placed in an excavated bund at the back of the beach for dewatering, using sediment controls such as a silt fence or hay bales on the outlet. Excavated beach sand would then be placed over the dredged material.

Sand nourishment here is consistent with the Landscape Concept Plan for the Callala Bay frontage. Volumes derived from boat ramp maintenance would be minor and of short term benefit to the beach nourishment process.

Note this area is within a Habitat Protection Zone of Jervis Bay Marine Park. Licencing by Marine Parks would be required. The works are considered to be consistent with the zone objectives.

Sanctuary Point

The John Williams Reserve boat ramp at Sanctuary Point is a high demand ramp accessing St Georges Basin. This ramp is scheduled for a major upgrade within the next five years. Medium grainsize sand would periodically cause some difficulties with boat launching. Sand could be excavated and trucked to the nearby sailing beach at Ray Brooks Reserve. Again there would be seagrass considerations that limit the extent of works at this site.

Expenditure would be minimal, possibly $2,000 to $3,000.

Aney Street Conjola:

Grant funding has been received by Council from the RMS 'Better Boating' Program to upgrade car parking in order to reduce sediment run off. The expectation is that this would lead to increased usage and demands for bigger boat access.

Aney Street is the 'local' ramp and used only for launching tinnies. It is shallow and remote from the main estuary channel. Community representatives have agreed that no dredging is warranted.

Cunjurong Point

There is reportedly a low community expectation for launching at this ramp, which is only used for lake access when the Lake Conjola navigation channel has migrated north. Volumes of sand to be removed to achieve navigation would be enormous at times of an accreted estuary. No dredging is warranted on the basis of navigation.

Narrawallee Inlet

This ramp is located in a shallow sandy backwater of the inlet. The depth at the boat ramp is shallow such that use of the ramp is restricted to higher tides. Access is only for small vessels using the inlet and creek; access across the bar is not expected.

A community representative has conducted face to face surveys with users of the Inlet. A small minority wanted dredging for boating; most didn't want any dredging as the limited use suits a family oriented place. Passive uses such as kayaking and paddle boarding are growing in popularity. Issues for the locals included a channel would need to go through the shallows where children play.

No improvements at this site are possible without excessive amounts of sand being removed. No works are recommended.

LAKE ENTRANCE MANAGEMENT

Background

At Lake Conjola, Swan Lake, Burrill Lake and Tabourie Lake occasional entrance opening is necessary. Council's opening policy for each estuary specifies particular conditions for the breaching of the entrance. This requires excavation of sand and placement usually by articulated tip trucks at locations specified under the opening policy or REF.

Dredging of a pilot channel at the entrance has also been necessary on occasions at Burrill Lake and Lake Conjola, prior to breaching the beach berm. This would typically be required when the lower estuary behind the beach became choked with sand after periods of high storm wave activity.

This section deals with the former activity only i.e. entrance berm breaching.

Sand Placement

The locations to place excavated sand are specified under the lake's opening policy and/or REF. This is generally to build up dunes near the entrance location. Occasional local opportunistic uses can be expected.

For instance, the widening of the beach in front of the Dolphin Pt Tourist Park at Burrill entrance would utilise sand excavated from the Burrill Lake mouth. Otherwise sand is placed on the northern dunes. At Lake Conjola, the lake-side walking track frequently requires topping up with small volumes of sand. Otherwise sand is placed on the northern shore or added to dunes south of the spit.

At Tabourie Lake, placement of spoil is recommended in the Estuary Management Plan (PSA 2006) against the northern bank immediately adjacent to the Shoalhaven Holiday Park. Swan Lake has a higher trigger elevation and generally opens naturally. It does not normally require issues of sand placement to be resolved.

Cost Estimates

Council staff advise that the cost of entrance openings is about $5,000 per day. This allows for a 20 tonne excavator and two articulated dump trucks, which in combination would excavate some 1,000 cu.m of sand daily. This assumes placement of sand reasonably locally.

Excavation of sand across the beach berm for a lake opening would typically require between 1-2 days of excavation. This will vary according to the berm height, width of beach and ocean conditions.

SHOALHAVEN HEADS

Sand Transport Rates

The exposed nature of the beach at Shoalhaven Heads and its high wave energy are significant factors in considering sand excavation issues. There is a high average rate of longshore drift supplying sand to and past this site. PWD report that longshore drift rates average about 350,000 cu.m per year with a northward component of about 60% or 200,000 cu.m. Not all of this sand would necessarily enter an open entrance.

The closure of the flood channel after the June 2013 flood was recorded in a series of surveys by Council. This provides a reasonable estimate of the actual sand infill rate over 6 months. It does not allow for sand that passed beyond the channel and onto the flood tide delta, and so provides a lower bound estimate of volume. Volume calculations performed on these surveys show the flood event scoured out 145,000 cu.m from the beach compartment. This included 66,500 cu.m scoured from the area below mean tide level.

The sand infill rate from these surveys show that the peak infill (from 9 October to 12 December 2013) was of the order 61,500 cu.m at an average rate of about 1,000 cu.m per day. This is of the same order as the PWD estimate of longshore drift of 350,000 cu.m per year, suggesting that when the entrance is open large volumes of sand can be available for infill.

Dry Notch for Flood Management

Flood relief is the main issue for the Shoalhaven River entrance at Shoalhaven Heads. Council policy attempts to maintain a 'dry notch' across the beach berm to ease the breakout of floodwaters. This aims to limit the peak level of severe flooding. The goal is to maintain the notch at a level of 2.0m AHD [2] over a width of about 50 metres. Note that a level of 2m AHD is about 2 metres higher than the average tidal ocean level.

Given the high availability of sand, the volume excavated from the notch can be refilled in a short timeframe, particularly on higher tides combined with even a moderate swell. The reality is that maintaining the notch excavation often proves difficult.

There are two options to maintain a lower beach berm - repeated sand excavation by mechanical means or by using sand shifter technology. An additional strategy that has been raised is to open the entrance once every three or four years to introduce tidal flushing. The pros and cons of these options are discussed below.

Traditional Sand Excavation

Traditional sand excavation utilises an excavator and trucks, with excavated sand trucked north to build up and strengthen dunes. Costs for 'dry notch' maintenance would typically be $5,000 per day to remove 1000 cu.m of sand daily. Notch maintenance would likely cost approximately $10,000 per event, with a number of events potentially required each year dependent on sand infill.

[2] See footnote in previous section for discussion of AHD.

To open the entrance completely for tidal flushing across say 200m of beach berm (from west to east) and link up with the relief channel would require removal of some 15,000 cu.m of sand. We would estimate a cost of up to $75,000 per opening using traditional excavation and sand removal techniques or $30,000 if sand was placed along the channel but not removed.

Figure 4 **Shoalhaven Heads entrance features 2010**

Figure 5 **Shoalhaven Heads flood tide delta November 2013**

Sand Shifter Technology

The Submarine Sandshifter is based on a fluidising principle which allows sand to be recovered from below the sea floor over a horizontal distance of 20 to 40 metres. In a typical fixed installation, the Sandshifter unit is buried in sand on the up drift side of an entrance or training wall. The Sandshifter creates a sand trap that captures littoral drift sand before it can infill an entrance or navigation channel. The captured sand is discharged to an onshore pumping station where the sand/water mixture is pumped through a transfer pipeline to the down drift side of the entrance.

The components comprise above water and underwater pumping equipment. An approximate cost to supply and install the underwater pumping equipment plus train operators would be $250,000. The underwater components would have a life of at least 5 years or significantly longer if the unit was used irregularly.

The above water pumping system components would have a capital cost of about $2.3 million. This allows for a pump station building, high-voltage power conduit and cabling, pipework and mechanical equipment and controls. This plant would have a life of at least 20 years if regular maintenance is performed.

Sand shifter recycling technology would be suitable at Shoalhaven Heads if the opening of the entrance was primarily for environmental flows or for minimising upstream flooding. It would not be suitable for a reliable navigation channel at this site without training walls.

Operating costs specific to the heads are summarised below. These costs assume a contractor is appointed to operate and maintain the system.

- Monthly Cost: $10,800
- Volume Rate: $3.50 / cu.m
- Power Costs: $0.45 / cu.m (using off peak power)
- Maintenance: $10,000 / year (based on 50,000 cu.m / year)

An indicative annual cost of sand pumping by this means is estimated at $11.40 per cu.m assuming 50,000 cu.m per year. This includes repayment of $2.4 million capital costs borrowed at 8% p.a. over 20 years. A cheaper interest rate may be available to Council, resulting in reduced annual costs.

Note that this volume would not maintain a permanent opening at Shoalhaven Heads, calculated above to require potentially up to 350,000 cu.m of sand removed per year. It would however maintain a reliable flood notch.

Regular River Entrance Opening

Examination is required of the idea to open the entrance once every three or four years. The concept is for an environmental opening to introduce tidal flushing.

There are common issues with periodic opening of any intermittently closed and open lake or lagoon (ICOLL) to introduce tidal flushing. Wallaga Lake and Lake Wollumboola have demonstrated that opening an ICOLL at low water levels without rapid follow-up rainfall can be damaging to estuary health. Depleted oxygen levels resulting in fish and crustacean kills have been directly attributable

to lake entrance breaching at both these estuaries. Rotting sea grasses exposed around estuary fringes can result, a major source of odour complaints, and these can add to the anoxic (low oxygen) conditions in the remaining lake waters. These factors are due to resultant low water levels in the estuary.

This experience with odour and degraded water quality is not necessarily applicable to the Shoalhaven River at Shoalhaven Heads, however. Shoalhaven Heads is different to these ICOLLs in that it is hydraulically connected to a permanent ocean entrance at Crookhaven Heads. Therefore issues with low water levels after an opening would not occur. However closure would be expected within a short time unless a flood discharge was to scour a deep channel and discharge sand well offshore.

There would be a slight shift towards a more saline estuarine environment in the main basin at Shoalhaven Heads if it opened regularly. Changing nutrient and algal levels would impact on light penetration and seagrass growth in unpredictable ways.

State Government policy is to minimise intervention in estuary entrances and to emulate a natural opening regime. The construction of Berrys Canal in the early 1800's to create a permanent opening at Crookhaven Heads has changed the natural regime at Shoalhaven Heads. To attempt a regular opening at Shoalhaven Heads would oppose what has become the new natural regime and hence be contrary to State Government policy.

It would appear from the above considerations that a Review of Environmental Factors for this activity would conclude that impacts could be significant. Any benefit of 'tidal flushing' to be gained for the significant cost of sand excavation would be minimal and short term. We would recommend to Council that this option not be advanced further without detailed studies to support the project.

Flood Tide Delta

More frequent opening of the river at Shoalhaven Heads would introduce the possibility of increased sand movement into the entrance. This is because inflow on incoming tides would exceed the scour of sand out of the channel. This effect was in evidence after the June 2013 flood opening, where sand from beach erosion subsequent to the opening was washed in large volumes into the entrance. This sand has also spread northwards into the flood relief channel (see Figure 4 and Figure 5). This sand deposit is known as a flood tide delta and is a common feature of estuaries with open entrances. Carvalho (2013) confirms that the flood tide delta is a significant component of the Shoalhaven's sediment budget.

Additional shoaling from flood tide delta extension could result in a more difficult entrance to open in future. This could have implications for flood management in minor but not major floods. It would be reasonable to utilise the flood tide delta as a source of sand for local projects such as dune or river bank management if required.

Configuration Dredging at Berrys Canal

We understand this concept to involve shaping ebb tide channels at Berrys Canal confluence with the Shoalhaven River, in order to direct ebb tidal flow north into the lower Shoalhaven. The goal is to improve tidal flushing without maintaining an open entrance at Shoalhaven Heads.

The probability of improving tidal flushing at the Shoalhaven Heads entrance by this means is very low. Circulation of tidal flow at the junction would extend northwards roughly as far as the sand delta extent. At this point the circulation velocity would form a very slow eddy that would extend only a few hundred meters further north. There would be no additional tidal circulation achieved at the Shoalhaven Heads entrance area.

The only way to 'force' more circulation at the entrance is to create a tidal opening at the heads. This provides a difference in water level elevation which drives tidal flow. As discussed above this is an expensive exercise to create and maintain without a flood event.

CURRARONG CREEK

Currarong Creek at the coastal village of Currarong enters the ocean through a narrow tidal channel. Sand drift along the beach towards the creek mouth periodically blocks the creek entrance. Ocean swell diffracted by Beecroft Head and local reefs produces mostly east to west longshore drift along the rest of Currarong Beach. However, along the section of the beach located between the central reef and Currarong Creek, lower sediment transport rates entrance occur dominantly from west to east. This drift is generated by local diffraction effects and wind waves (SMEC 2011). The tidal flow in the creek is at times unable to flush sand deposits after a significant input, and the mouth has been dredged in previous years.

A new boatramp provides access to the ocean for vessels. Previous to this new ramp, the only boat ramp access was into the creek, requiring vessels to access the ocean via the creek entrance.

The new ramp negates the previous need for dredging the creek entrance for navigation. However the entrance does provide a partial source of sand for beach nourishment.

The Currarong Beach Erosion Remediation Study (SMEC 2011) recommends sand nourishment in combination with a groyne to stabilise the beach. The upper nourishment volume estimated from SMEC 2011 is 25,000 cu.m of sand in an ideal case. Some 7,000 cu.m of sand was estimated to be available in the creek.

Marine Park

Both Currarong Creek and the creek entrance are zoned Habitat Protection Zone under the Jervis Bay Marine Park.

For a Habitat Protection Zone the requirements for dredging are outlined elsewhere in this report. In brief, consent is only to be given to removal of sand for research, environmental protection, public health, traditional use or public safety purposes.

We would conclude that sand removal around Currarong Creek mouth would need to primarily address public safety and / or environmental protection. Consent would be considered more likely for maintenance excavation for local beach nourishment.

Cost Estimates

We understand Council carried out beach nourishment in 2002 and again in 2009, sourcing sand from the creek. This was a small volume compared to the volume required to fully restore the beach. Costs of around $25,000 were incurred in 2009.

At current rates this expenditure would remove about 5,000 cu.m using an excavator and articulated dump trucks. This is an appropriate stop gap measure that could be carried out opportunistically as sand was to accrete in this area. Without a groyne to contain sand drift towards the creek mouth however, an ongoing maintenance process would be necessary.

CURRAMBENE CREEK

General

Currambene Creek provides the sole all-weather public boat moorings for Jervis Bay. NSW Roads and Maritime list a total of 96 moorings in the creek. The creek extends upstream to Myola and includes a regional boat ramp at Woollamia, which services users from outside the local area. Council expects this ramp to experience an increasing demand from recreational boaters.

Council's public wharves at Huskisson are located just inside the creek mouth. These provide loading and unloading access in all but storm swell conditions, and are currently being examined by Council for options to provide disabled access. Increasingly, a large commercial presence uses the public wharf at Huskisson. These commercial vessels are increasing in size to meet tourism demands for boat tours of Jervis Bay. Drafts of up to 1.3m are reported on the larger vessels which can't access the bay below a 0.5m tide. This limits some international tourism visits which need to work to a strict timeframe.

The possibility has been recently raised for tenders servicing Carnival Australia tour boats to use the wharf at Huskisson. The tenders have a 1.0 metre draught and a capacity of 90 to 100 persons. Guaranteed access would be required on the days of tour boat visitation, regardless of tide heights.

Access from the creek to Jervis Bay is across a narrow opening between the rocky shore and a sand shoal, over a shallow sand bar. The bar has reportedly been dredged 30 or so years ago. This shoal and bar are permanent features which expand and contract with the balance of swell action, tides and rainfall. Larger commercial vessels in particular can only cross the bar at higher tides. Vessel navigation is more difficult in times of swell penetration into Jervis Bay, as waves are more oblique to the vessel's approach line at the entrance.

Inside the creek mouth, the entrance to the navigation channel containing a number of moorings on the northern side involves a second shallow crossing. A rock ledge outside the creek entrance near the swimming pool is a navigation hazard, for keeled yachts and wider commercial vessels in particular. This ledge is about 0.7m below ISLW and is critically situated just off the entrance leads.

Boat Usage

Boat usage statistics from Marine Rescue at Huskisson incorporate boat log-ins from the whole of Jervis Bay. It is not possible to separate boat users at Huskisson by this data source. However the numbers of tourist passengers on commercial vessels is the highest of any location in the city area. Tour boat tenders would add considerably to user numbers.

Coastal Processes

Patterson Britton and Partners (PBP December 1996) have investigated coastal processes in the creek mouth. PBP concluded that sand from Callala Beach is not supplying a significant nett volume of sand to the spit. Sand circulates between the 'flood tide delta' (the sandbar inside the creek entrance) and the 'tombolo shoal' (sandbar in the lee of the exposed reef) depending on the prevailing balance between swell waves, tidal flow in the creek and rainfall.

There is expected to be a general inflow of sand to the creek under wave and tidal action. This is typical of open estuaries which supply sand into the entrance more efficiently than ebb tides can remove it. The occasional flood-producing rainfall event would assist to remove some of the accumulated shoal, such that the nett supply of sand is unaffected. Sand supply to the entrance shoals from bank erosion on the creek itself is negligible (PBP 1996).

Potential Dredging Projects

The possibilities identified for dredging at this site identified by Council staff (see Figure 6) are:

- Dredging of the sand shoal and bar would widen and deepen the entrance channel to improve navigation and safety
- Dredging of shoals to widen mooring capacity inside the entrance
- Dredging along the channel inside the creek up to Woollamia boat ramp.

These options are discussed in detail below. In addition, Council has recently resolved to undertake excavation at the public wharves as part of the coming upgrade. This would provide minimum depths of 1.6m to 2.2m at ISLW. The intention is to achieve access to the downstream wharf at all tides for vessels with a 2.0m draft.

Entrance Channel Widening / Bar Dredging

The sand budget at the entrance of Currambene Creek is in balance. Over-dredging the sand shoal at the creek mouth would result in temporary loss of sand from the creek's delta system. It would also open up the wharf and moorings to more ocean storm swell. The likely nett impact would be the eventual loss of a roughly equivalent volume of sand from the southern end of Callala Beach from erosion in a severe storm event. Hence the scale of a dredging campaign at this location is somewhat limited.

Sand sourced from widening the channel and deepening the bar would be expected to be clean beach sand suited to beach nourishment. There is no local site for dewatering and loading, so sand would be pumped over the creek to the southern end of Callala Beach. This could not feasibly be pumped 3km to 4km north-east to Callala Beach for nourishment. This beach has been identified as requiring an ongoing supply of 8,000 to 19,000 cu.m p.a. to balance beach recession from sea level rise (*Royal Haskoning 2013 - Draft*). These volumes would <u>not</u> be available on an ongoing basis solely from the Currambene Creek shoal.

Dredging should aim for a depth to achieve safe navigation at all tides and to a width of 20 - 25 metres. Allowing for a boat draught of 2.0m, a reasonable goal at the entrance would be to achieve a depth of at least 2.5m below ISLW to allow for some wave action. Further upstream, removed from wave action, the target depth would be 2.0 to 2.2m below ISLW. This depth allows for infill over time. We would estimate this scale of dredging to require removal of 7,000 to 8,000 cu.m. Survey should be undertaken to confirm this volume estimate.

Dredged Sand Transport

Options to transport sand to Callala Beach would be by scraper or articulated dump trucks filled by loader or excavator. The cheapest options may depend on plant availability at the time. As a guide

to productivity and haulage cost, scrapers would cart 17 cu.m per load and (working in pairs for efficiency of loading) would each do 4 loads per hour over this distance. Scraper hire cost is $390 per hour for each machine. Additional float cost of $2200 per machine would apply.

The overall transport cost per cubic metre would be about $6.50 for a quantity of 8,000 cu.m, with an overall budget for haulage of **$51,000**.

The dredging operation could alternatively discharge onto barges, transport to Callala Beach and tip sand just offshore. However sand losses would be greater using the barge technique.

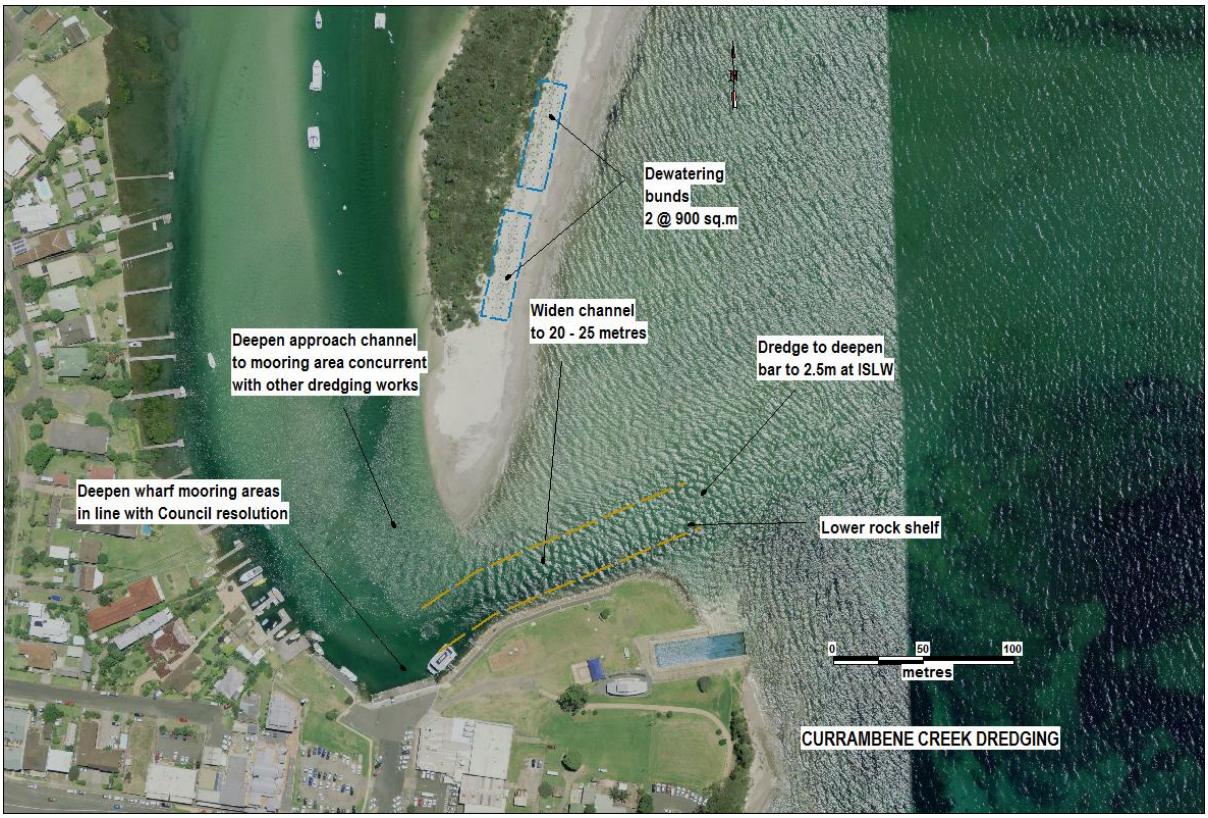

Figure 6 Currambene Creek - feasible dredging projects

Storm Response

If council commits to a deeper channel across the bar, dredging in response to an ocean storm event should also be considered. Should the southern end of the beach wash into the channel by major ocean storm action, channel width and depth could be impaired. The natural flow regime would eventually clear the channel. However this would cause difficulties in navigation for possibly weeks or months.

An appropriate response would be by long-reach excavator, and dozer, pushing sand back onto the local beach dune for remediation. This technique would be a cheaper and more rapid response than establishing a dredge for a one-off exercise. This would have the advantage of offering protection to

the eroded beach while re-establishing a safe navigation channel. Such an exercise may cost of the order $8,000 to $10,000 and would be tide dependent.

Additional Moorings and Mooring Access

Council staff have requested an analysis of the possibility of increased mooring numbers inside the entrance. This would be achieved by widening the sand shoal on the western side of the existing mooring area.

Our initial discussions with Marine Parks officers strongly suggests that dredging solely to achieve additional mooring spaces in the lower creek would not meet the objectives of the Jervis Bay Marine Park plan. Hence we explore this option no further.

However there is a possibility that the access to the existing mooring area could be deepened to improve safety (see Figure 6). The entrance to this mooring area has a depth estimated at 0.7m at ISLW. This could conveniently be deepened cost effectively if done concurrently with the entrance bar works. Survey data is not available, but the design depth should match the depth at the moorings.

Creek Channel Widening

Assessment of widening of the navigation channel along the creek would need survey data, detailed analysis of sediment type and disposal options. It is likely that sediments would be sand dominated. However floods could trap pockets of catchment-derived silts at depth within the shoals.

Dredging Cost Estimates

Cost estimates for dredging 8,000 cu.m of sand from the bar and the entrance channel would be of the order $388,000 as detailed in **Appendix 1**. Haulage and spreading by scraper to the northern end of Callala Beach would be an additional $51,000 as detailed above.

Lowering of part of the rock ledge near the pool to widen the channel approach has been estimated by others at $8,000 to $10,000.

We have no survey information to determine the volume of sand that could be removed to deepen access to creek moorings inside the entrance.

Marine Park Issues

The Jervis Bay Marine Park covers the whole of Currambene Creek to the tidal limit and includes the entrance area. The extent of the zoning plan in this area is as follows:

- Outer reef area beyond the entrance is designated Huskisson Sanctuary Zone
- The Huskisson wharf area is a Special Purpose Zone
- The waters off Callala Beach including the tombolo shoal are Habitat Protection Zone
- Inside the mouth, the northern mooring area is Habitat Protection Zone
- Currambene Creek mudflats on the inside of the bend almost to the Woollamia boat ramp are a Sanctuary Zone to mean high water mark.

Dredging is not necessarily prohibited in either the Sanctuary Zone or the Habitat Protection Zone. However restrictions apply in each zone as discussed elsewhere in this report.

Clearly to address Marine Park zonings, any dredging around Currambene Creek mouth will need to primarily address public safety or environmental protection, or both.

Public safety issues would apply to unsafe crossings of the bar by commercial vessels and by cruise ship tenders, which work to a set timetable rather than to the tides. This reliability has not been possible to date at Huskisson. However as tourist demand for the service increases, inevitably more risks would be expected to be taken.

An appropriate project might involve sand sourced from either zone for public safety reasons and discharged along Callala Beach to protect public property. Environmental protection issues in both zones would then be relevant, with the sand utilised for beach nourishment. This could either aim to restore the southern end of the beach at the spit following a major storm event or to haul to the northern end.

We would conclude that dredging is not necessarily prohibited in these zones; however some thought needs to be put into how the project details match the zoning requirements.

SUSSEX INLET

Background

The tidal inlet to St Georges Basin known as Sussex Inlet has a history of shoaling. Most sand movement is within a kilometre or so from the entrance, comprising coarse shelly marine sand. Channel scour events from large catchment flows which assist in maintaining an open entrance for Sussex Inlet are rare (*Boardman 2009*). St Georges Basin has a large volume which absorbs smaller runoff flows without scouring the tidal channel.

The incoming (flood) tide, wave climate and ocean-storms combine to influence the sand distribution near the entrance in low rainfall periods. Sand infilling on the incoming tide occurs during periods of low rainfall, producing the large flood tide shoal inside the entrance.

Navigation of the lower kilometre or so of Sussex Inlet has been impacted by these shoals for some time. A similar shifting behaviour pattern for these lower estuary sand shoals has been demonstrated over the last 70 or so years (*Boardman 2009*).

The ocean entrance beyond the channel comprises marine sand, reportedly interspersed with patches of ballast rock. Navigation by even small craft can be difficult around lower tides. Locals especially know to plan trips outside around the tides. Local experience indicates the entrance depth has improved over the latter part of 2013.

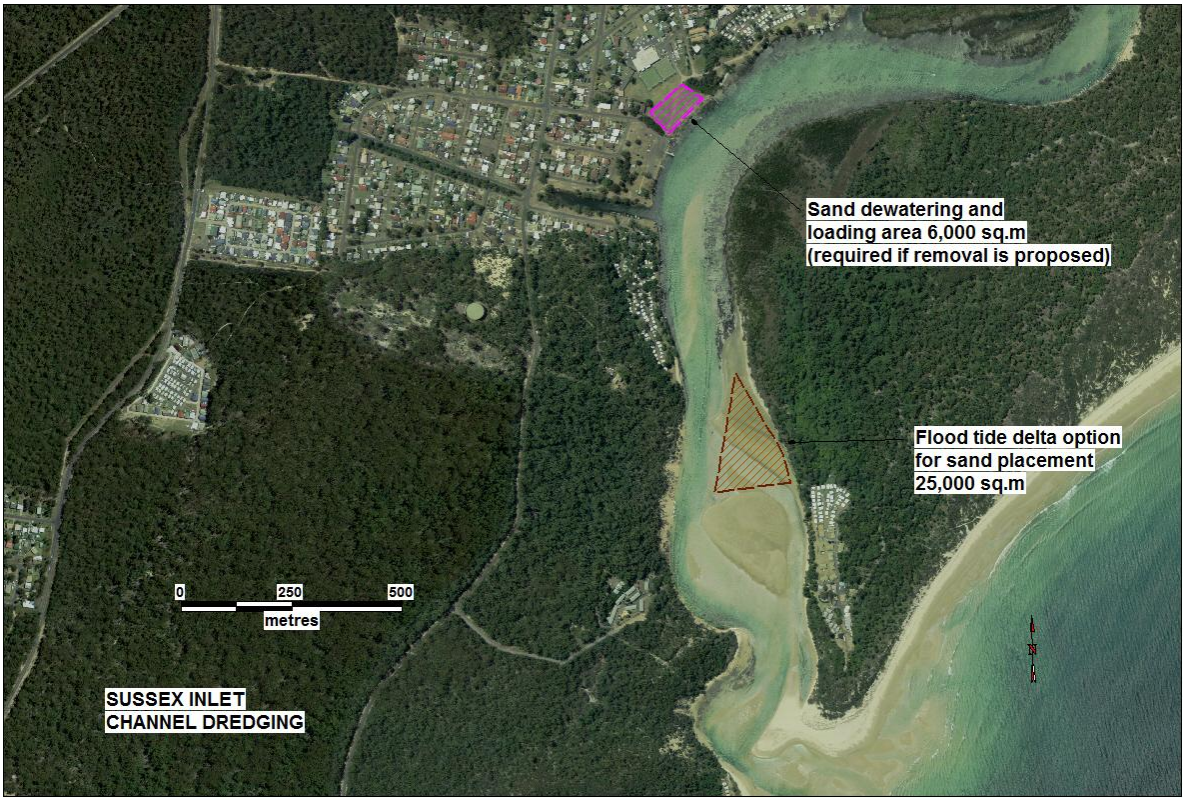

Figure 7 **Channel dredging sand disposal options - Sussex Inlet**

Boat Usage

Boat use statistics over the years 2011 to 2013 have been provided by Sussex Inlet Marine Rescue. These list local boat log-ons and people on board (POB) from the Sussex Inlet operations area which includes the Sussex Inlet entrance and also the Bendalong boat ramp. Without any adjustment for small boat number from Bendalong, the following statistics are recorded. Note that an estimated 40% of all boats log-on, the majority of which are crossing the bar. The exception is July's annual fishing competition which attracts inside and outside fishers. At other times, a handful of locals log-on when heading up to St Georges Basin but most are outside fishers.

Exact numbers of boats or people using the entrance channel and bar at Sussex Inlet are not possible to derive, however the data below has value as a guide to the scale of boat usage.

SUSSEX INLET MARINE RESCUE DATA 2011 to 2013

	2011		2012		2013		Average
	Year total	Peak Month	Year total	Peak Month	Year total	Peak Month	Year total
Boat Log-ons	620	118	691	105	558	99	**623**
People on Board	1,715	335	1,735	255	1,355	190	**1,602**

Note peak month was January, ignoring large boat numbers in July which would include more inside users

Marine Rescue advises the month of January 2014 to have been extremely busy with 132 log-ons and 337 POB. They recorded 15 assists for that month.

Marine Safety Issues

Marine rescue operations based in Sussex Inlet rely on reasonable water depth to access the ocean. These emergency call-outs cannot be timed to coincide with high tides. The marine rescue craft has a draught of 0.4 metres yet has been delayed on a rescue operation waiting for the tide to rise over shoals in the channel. The alternative rescue facility for these waters is from Ulladulla, which can have a response including at least 1 hour travel time. The Sussex crew can be waterborne and in ocean waters within 15 minutes.

Members confirm that channel shoals have progressively shallowed while the entrance periodically clears itself as it has done in November 2013. Local advice is that the bar has not restricted marine rescue craft. This would suggest that with a limited budget, to best address safety / navigation priorities would require dredging of the channel shoals in preference to the ocean entrance.

Dredging Options

Sand removal in the tidal channel is assumed to be done by traditional water-based dredging. Land access is restricted to make shore-based excavation unlikely.

Options for sand placement (see Figure 7) would be:

1. Placement on the flood tide delta within the estuary; or
2. Removal to stockpile for use by a commercial sand supplier.

Sand placed on the flood tide delta would inevitably be transported back to the navigation channel in extreme events. The timeframe would be reliant on the frequency of ocean storms and higher than normal tides. The alternative of placement on the beach would provide a ready sand source for the bar which is not favoured. No local placement options would be long lasting at this site and are less effective compared to Option 2.

Dredging to remove sand would need a land base site (bunded area) for dewatering of pumped sand slurry. Community representatives suggest the reserve on Alamein Rd in front of Bowling Club and we would confirm the size of the area to be suitable. There would be additional costs to pump sand to the Alamein Rd site of about $5.00 per cubic metre as a booster pump would be required when dredging the southern half of the channel.

We have not costed the removal of sand as destinations and haul distances are not known. Truck movements would occur through the village for a couple of months during the operation if sand was removed from the estuary.

Dredging of the entrance bar would require a second booster pump to the Alamein Rd site. We assume the flood tide delta area would be filled by dredging the channel and would not be available as a placement site. The longevity of a dredged channel in this area would be limited by the unlimited southward feed of sand from Bherwerre Beach.

Cost Estimates

Estimates prepared in March 2013 (PSA 2013) for restoring the estuary channel required the dredging of at least 7,700 cu.m based on sand volumes from a 2012 survey and sand removal to 1.2m below ISLW (tide chart datum). Accurate dredging to a design profile over the length of channel could not be guaranteed, so estimates allow for an additional 3,000 cu.m to ensure an effective campaign. A current overall cost estimate of $460,200 for a dredging campaign placing sand on the flood tide delta is presented in **Appendix 1**.

Additional costs for booster pumping sand of $5 per cu.m and for loading and haulage would be incurred if option 2 was adopted for the channel. The haulage vehicles would typically comprise a truck and dog combination with an overall load of up to 33 tonnes or 20 cu.m. These run at an hourly cost of $140. Overall haul costs would be dependent on haul distance.

Costs to dredge the bar would involve an additional $10 per cubic metre over the channel dredging campaign. We do not have survey data of the bar and have not prepared detailed estimates. We would estimate dredging a navigable channel across the bar to involve at least 10,000 cu.m of sand. Allowing for booster pumping to Alamein Road the dredging activity cost alone would be at least an additional $100,000 compared to the channel dredging project. Down time in periods of heavy swell would involve additional contractual costs. Conservatively an all-up cost of $600,000 to dredge the bar would be realistic.

Canal Estate

Council is preparing a draft management plan that outlines Council and resident/ratepayer responsibilities in relation to maintenance of canals, including issues such as dredging of canal beds and replenishment of sand on beaches. This includes the Riviera Keys Canal Estate at Sussex Inlet.

Siltation within the Riviera Keys Canal Estate is a potential issue. This navigable waterway is a drainage reserve under the control and management of Council. If siltation of the channels linking the canals to the inlet was to occur, this could eventually reduce tidal flushing and lead to water quality issues.

Hydrosurveys would allow a comparison of existing water depths to the original profiles. An initial survey by council in February 2014 suggests water depths in the canals are close to design levels. The original PWD design is shown in Figure 8. Over time a picture will be built up of whether siltation is occurring in the canals or the lead-in channels. It is noted that bed material in the canals may not be clean sand at all locations, and bed sampling would be required prior to developing a dredging strategy. Placement options for dredged material would be an important consideration.

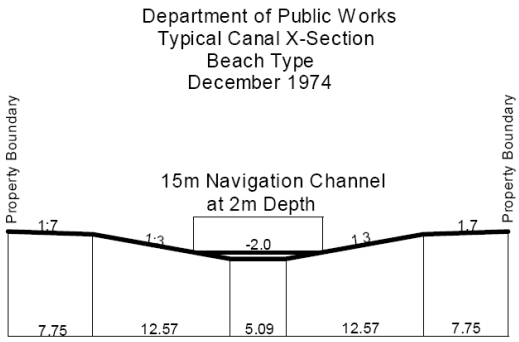

Figure 8 Original Riviera Keys Canal Design

LAKE CONJOLA ENTRANCE

Background

The Lake Conjola entrance is naturally infilling, driven by coastal and wind forces. Sand deposition in the lee of Green Island provides a source of sand to enter the estuary by tidal action when the mouth is open. Wave overtopping of the entrance spit during periods of high storm wave activity has been responsible for the injection of additional volumes of marine sediment to the entrance area. This restricts the tidal flow in the channel and chokes the tide entering the estuary.

The 1999 *Conjola Entrance Study* (PBP 1999) calculates an approximate average annual accumulation of sand into the entrance area of 30,000 cu.m. This makes the estuary a potential source of clean beach sand for beach nourishment.

Council's opening policy for Lake Conjola specifies particular conditions for the breaching of the entrance. This requires excavation of sand and placement by tip truck at various locations specified under the opening policy and REF. Lake openings such as this are discussed in a separate section of this report.

At Conjola however, a lake opening can also require excavation of a pilot channel prior to entrance breaching, in order to link a deeper channel to the beach. This would typically be required when the entrance area was choked with sand, as experienced over the past few years. Without this prior pilot channel excavation, an opening could require extensive excavation in an emergency flooding situation to achieve an opening.

Local resident representatives report that the community wants to work with the ICOLL cycle and preserve or maintain tidal flow – they are not looking for a permanent opening. The concept put forward is to better manage 'feeder channels' to create an equilibrium regime. This would require configuration dredging (see Figure 9 for two possible channel alignments that depend on shoal configurations) to emulate a natural ebb channel orientation or a 'flood relief channel' as reported in the lake opening REF. This option probably requires dredging within the tidal flats by traditional dredge rather than excavator and trucks, as sand would be water-charged or underwater.

Cost Estimates

Pilot channel excavation can be costly depending on the distance and sand elevation to be excavated. Pilot channel excavation using excavator and trucks could cost around $25,000 to remove up to 5,000 cu.m of sand in the lake behind the beach and spit. This estimate assumes sand would be utilised locally for dune management at Conjola. Alternatively it could be utilised at Mollymook Beach which requires nourishment. Additional cartage costs to Mollymook are examined below.

Configuration dredging as discussed above, or a larger scale dredging operation to mine sand for beach nourishment (also shown in Figure 9) are both feasible and sustainable options. Both would require establishment of dredge plant and pipeline, and a shore-based dewatering area for the sand slurry. Suitable areas for dewatering are at the eastern end of the Entrance Tourist Park (involving grassed sites), and incorporating the adjoining western end of the reserve.

Volumes involved would depend on sand shoaling patterns. We provide costing details in **Appendix 1** for two scales of operation:

- configuration dredging of 10,000 to 12,000 cu.m with an overall cost of $492,700 or about $45 per cu.m of sand; and
- a more extensive project maximising sand volumes for beach nourishment by removing almost 30,000 cu.m of sand. The cost estimate is $1,040,800 or about $35 per cu.m.

Note that the cost of truck haulage to remove sand is not included in these estimates. This is estimated below assuming haulage to Mollymook Beach for replenishment.

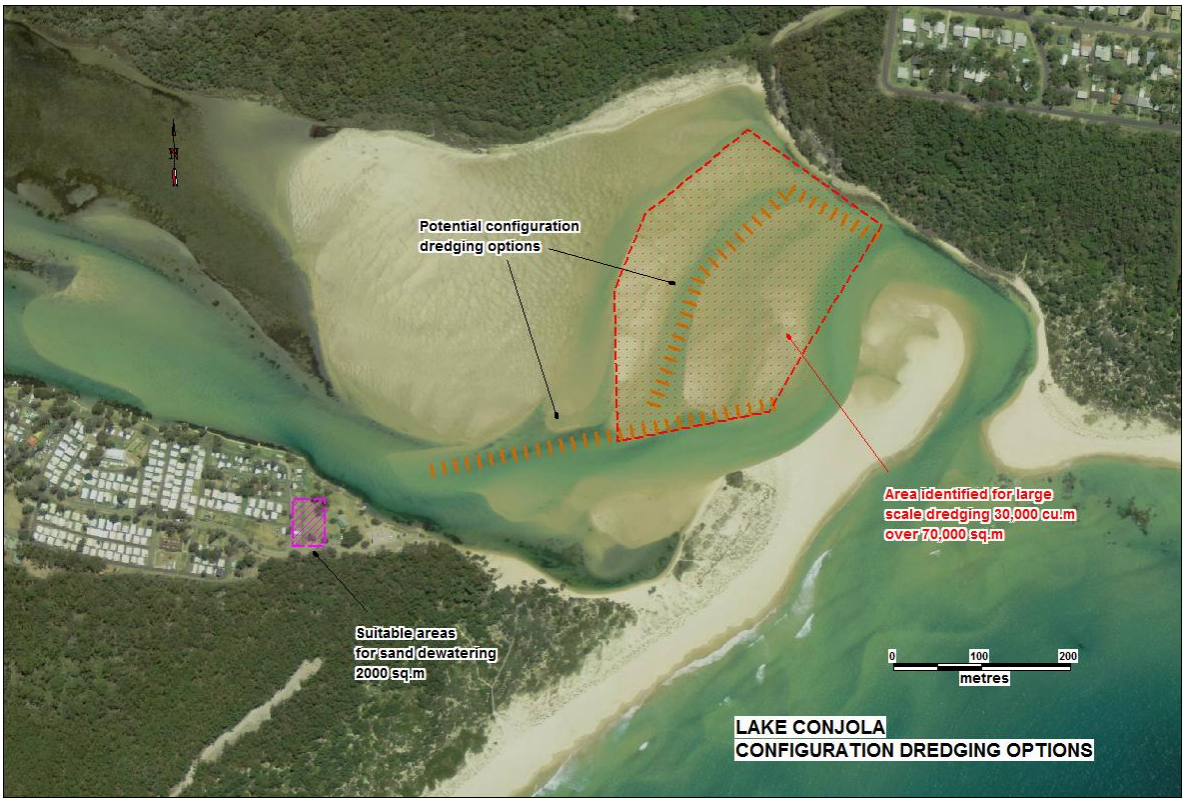

Figure 9 **Dredging Options Lake Conjola entrance**

Mollymook Beach Nourishment

The report Shoalhaven Authorised Locations Coastal Erosion Remediation Options - Mollymook Beach (*Royal Haskoning Draft 2012*) estimates that large volumes of sand are required to provide protection against immediate threat to foreshore development. Depending on other options for structural protection, volumes required are 750,000 m^3 ('Scenario 1') or 130,000 m^3 ('Scenario 2'). Ongoing addition of 22,000 cu.m of sand would then be required as nourishment annually at Mollymook Beach to balance sea level rise recession.

Clearly the available volumes from Lake Conjola entrance would not meet this overall demand. However it may prove opportunistic to progressively utilise sand within the Conjola entrance at

Mollymook Beach to address local erosion or amenity issues. This would assist with opening the lake to relieve flooding by removing the current need for regular pilot channel excavation.

Costs to source clean beach sand, assuming a traditional dredge working within the tidal part of Lake Conjola entrance, are estimated in **Appendix 1**. The overall indicative costs are of the order $33 to $39 per cu.m, dependant on the scale of the operation.

The additional cost to transport sand from Conjola to Mollymook is estimated at **$8.75 per cu.m**. The haulage vehicles are assumed to comprise a truck and dog combination with an overall load of up to 33 tonnes or 20 cu.m. These are run commercially at an hourly cost of $140.

Based on various volumes, haulage costs would be **$105,000** for 12,000 cu.m and for 30,000 cu.m hauled the cost would be **$262,500**.

Environmental Opportunities

The Lake Conjola entrance spit is a significant breeding area for shorebirds, including Little Terns and Pied Oystercatchers. Some of these birds are threatened species, protected under NSW and Commonwealth legislation, and others are protected under international agreements.

Conceptually, there are opportunities with configuration dredging to create additional breeding habitat for shorebirds by local sand placement within the lake entrance. This would involve no additional cost over and above dredging costs. The risk is that a future high rainfall event may wash out the habitat area so created.

Safety Issues

The narrow channel along the tourist park to the entrance boat ramp places boats, fishers and swimmers in potential conflict. The navigation channel here is close to the estuary's southern shore. The inevitable congestion in this area could be periodically relieved by widening the channel at its choke points. This could be opportunistically done by long reach excavator. Alternatively a traditional dredge would be efficient, should it be in the area. Small volumes of sand involved could conveniently be placed in the lake entrance's south-eastern corner or along the lakeside walking track, in line with locations in the lake opening REF.

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Shoalhaven City Council **Currambene Creek Boating Infrastructure Strategy Discussion Paper** September 2013

Shoalhaven City Council **Shoalhaven River Entrance Management Plan for Flood Mitigation** November 2006

Slurry Systems Marine Pty Ltd **Dredge Specifications MSV 12085 150mm Cutter Suction Dredge**

Slurry Systems Marine Pty Ltd **Design Manual for Shoalhaven River Sand Bypassing System** November 2013

APPENDIX 1 DETAILED COST ESTIMATES

This appendix presents a detailed breakdown of cost estimates for the major dredging projects investigated in this report. The costs of minor excavation projects are detailed sufficiently in the individual site descriptions in the main body of the report.

Note that estimates include preliminaries such as preparation of a Review of Environmental Factors (REF) to a basic level, preparation of contract documentation and specifications and gaining licence approvals. REF costs assume no complications with ecology, hydrodynamics or sediment quality.

Cost savings would apply if the preliminaries were combined for a number of projects, rather than undertake these studies individually. This could also simplify the approvals and licencing processes with State Agencies.

Once contract documents were available for one project, an economy of scale would apply in that they would be applicable to similar projects with minor cost implications.

Estimates do not include preparing and reviewing an Expression of Interest for a private or industry partnership with Council, should Council wish to go this way. We would estimate consultancy fees to undertake this process to be of the order $15,000 to $20,000. The outcome would feed into contract documentation activities which are included in estimates.

Detailed estimates on the following pages cover dredging projects at:

- Currambene Creek for navigation
- Sussex Inlet Channel for navigation
- Lake Conjola configuration dredging
- Lake Conjola Entrance sand mining

Costings for other projects are contained in individual sections of this report. Note all costs include GST.

Currambene Creek Entrance

The estimate covers traditional dredging of the channel at Currambene Creek, Huskisson. The proposal pumps sand to the southern end of Callala Beach for dewatering and possible beach nourishment.

Hauling to the northern end of the beach for beach replenishment by scrapers would be at additional cost of $51,000.

CURRAMBENE CREEK ENTRANCE CHANNEL - DREDGING PROPOSAL
PRELIMINARY COST ESTIMATE

Item	Description	Comments	Unit	Quantity	Rate	Amount	Item Total
1	**Preliminaries**						**$ 54,000**
1.1	Environmental studies and REF					$ 25,000	
1.2	Geotechnical analysis of sediments					$ 2,000	
1.3	Hydrodynamics					$ 3,000	
1.4	Technical specifications					$ 6,000	
1.5	Meetings, licences and approvals					$ 12,000	
1.6	Tender documents					$ 6,000	
2	**Site Establishment**						**$ 45,000**
2.1	Establishment including installation of signage, safety fencing at disposal area, liaison with authorities		Lump Sum			$ 30,000	
2.2	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program					$ 15,000	
3	**Dredging Activities**						**$ 190,000**
3.1	Pre- and post- dredging surveys		Item			$ 14,000	
3.2	Dredging to 2.25m depth on chart datum (RL -3.2m AHD)		m^3	7,000	$ 22	$ 154,000	
3.3	Permitted over-dredging to 2.5m depth		m^3	1,000	$ 22	$ 22,000	
3.4	Payable down-time		Days	0	$ -	$ -	
4	**Sand Fill Areas**						**$ 4,000**
4.1	Prepare dewatering bunds at Callala Beach		m^2	2,000	$ 1	$ 2,000	
4.2	Maintain access, signage & safety fencing		Item	-	-	$ 2,000	
5	**Site Disestablishment and Clean up**		Lump Sum				**$ 25,000**
	CONSTRUCTION COSTS (Items 2 - 5)				***SUB TOTAL***		**$ 264,000**
Add	Contingency on construction cost		15%				$ 39,600
					SUB TOTAL : CONSTRUCTION COST		**$ 303,600**
Add	Supervision and contract administration		10%				$ 30,400
Add	Preliminaries (Item 1)						$ 54,000
					COST ESTIMATE		**$ 388,000**

Sussex Inlet Channel

The estimate covers traditional dredging of the channel at Sussex Inlet. The proposal places sand on the flood tide delta within the channel.

Additional dredging costs of $5 per cu.m (Items 3.2 and 3.3) would apply if sand was to be pumped to a dewatering area for later removal. There is no current destination for haulage of sand away from the site as there are no local requirements by Council for beach nourishment. We are therefore unable to estimate transport costs.

SUSSEX INLET CHANNEL - DREDGING PROPOSAL
PRELIMINARY COST ESTIMATE

Item	Description	Comments	Unit	Quantity	Rate	Amount	Item Total
1	**Preliminaries**						**$ 51,000**
1.1	Environmental studies and REF					$ 20,000	
1.2	Geotechnical analysis of sediments					$ 3,000	
1.3	Hydrodynamics					$ 4,000	
1.4	Technical specifications					$ 6,000	
1.5	Meetings, licences and approvals					$ 12,000	
1.6	Tender documents					$ 6,000	
2	**Site Establishment**						**$ 45,000**
2.1	Establishment including installation of signage, safety fencing at disposal area, liaison with authorities		Lump Sum			$ 30,000	
2.2	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program					$ 15,000	
3	**Dredging Activities**						**$ 249,400**
3.1	Pre- and post- dredging surveys		Item			$ 14,000	
3.2	Dredging to 2.25m depth on chart datum (RL -3.2m AHD)		m^3	7,700	$ 22	$ 169,400	
3.3	Permitted over-dredging to 2.5m depth		m^3	3,000	$ 22	$ 66,000	
3.4	Payable down-time		Days	0	$ -	$ -	
4	**Sand Fill Areas**						**$ 4,000**
4.1	Prepare dewatering bunds at flood delta		m^2	2,000	$ 1	$ 2,000	
4.2	Maintain access, signage & safety fencing		Item	-	-	$ 2,000	
5	**Site Disestablishment and Clean up**		Lump Sum				**$ 25,000**
	CONSTRUCTION COSTS (Items 2 - 5)				***SUB TOTAL***		**$ 323,400**
Add	Contingency on construction cost		15%				$ 48,600
					SUB TOTAL : CONSTRUCTION COST		**$ 372,000**
Add	Supervision and contract administration		10%				$ 37,200
Add	Preliminaries (Item 1)						$ 51,000
					COST ESTIMATE		**$ 460,200**

Lake Conjola

These estimates detail the cost of configuration dredging within the lake entrance at Lake Conjola. Two scales of project are costed - configuration dredging of 12,000 cu.m of sand and a large scale project of (just less than) 30,000 cu.m.

Note that the cost of truck haulage to transport sand to Mollymook Beach is not included. This is estimated elsewhere in this report to add **$8.75 per cu.m** of sand. The transport costs would add $105,000 to the configuration project and $262,500 to the major campaign.

LAKE CONJOLA ENTRANCE CHANNEL - CONFIGURATION DREDGING PROPOSAL
PRELIMINARY COST ESTIMATE

Item	Description	Comments	Unit	Quantity	Rate	Amount	Item Total
1	**Preliminaries**						**$ 55,000**
1.1	Environmental studies and REF					$ 25,000	
1.2	Geotechnical analysis of sediments					$ 2,000	
1.3	Hydrodynamics					$ 4,000	
1.4	Technical specifications					$ 6,000	
1.5	Meetings, licences and approvals					$ 12,000	
1.6	Tender documents					$ 6,000	
2	**Site Establishment**						**$ 45,000**
2.1	Establishment including installation of signage, safety fencing at disposal area, liaison with authorities		Lump Sum			$ 30,000	
2.2	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program					$ 15,000	
3	**Dredging Activities**						**$ 256,000**
3.1	Pre- and post- dredging surveys	Contract payment based on survey	Item			$ 16,000	
3.2	Dredging to 2.25m depth on chart datum (RL -3.2m AHD)		m^3	10,000	$ 20	$ 200,000	
3.3	Permitted over-dredging to 2.5m depth		m^3	2,000	$ 20	$ 40,000	
3.4	Payable down-time		Days	0	$ -	$ -	
4	**Sand Fill Bunded Areas**						**$ 20,000**
4.1	Prepare dewatering bunds		m^2	3,000	$ 2	$ 6,000	
4.2	Maintain access, signage & safety fencing		Item	-	-	$ 4,000	
4.3	Restore bund areas in reserve and tourist park		Item	-	-	$ 10,000	
5	**Site Disestablishment**		Lump Sum				**$ 25,000**
	CONSTRUCTION COSTS (Items 2 - 5)				***SUB TOTAL***		**$ 346,000**
Add	Contingency on construction cost		15%				$ 51,900
					SUB TOTAL : CONSTRUCTION COST		**$ 397,900**
Add	Supervision and contract administration		10%				$ 39,800
Add	Preliminaries (Item 1)						$ 55,000
					COST ESTIMATE		**$ 492,700**

LAKE CONJOLA ENTRANCE - FULL DREDGING PROPOSAL
PRELIMINARY COST ESTIMATE

Item	Description	Comments	Unit	Quantity	Rate	Amount	Item Total
1	**Preliminaries**						**$ 74,500**
1.1	Environmental studies and REF					$ 40,000	
1.2	Geotechnical analysis of sediments					$ 2,500	
1.3	Hydrodynamics					$ 5,000	
1.4	Technical specifications					$ 6,000	
1.5	Meetings, licences and approvals					$ 15,000	
1.6	Tender documents					$ 6,000	
2	**Site Establishment**						**$ 45,000**
2.1	Establishment including installation of signage, safety fencing at disposal area, liaison with authorities		Lump Sum			$ 30,000	
2.2	Provision of preconstruction documentation - Environmental Management Plan; Emergency Management Plan; Construction Program					$ 15,000	
3	**Dredging Activities**						**$ 673,800**
3.1	Pre- and post- dredging surveys	Contract payment based on survey	Item			$ 16,000	
3.2	Dredging to 2.25m depth on chart datum (RL -3.2m AHD)		m^3	28,000	$ 22	$ 616,000	
3.3	Permitted over-dredging to 2.5m depth		m^3	1,900	$ 22	$ 41,800	
3.4	Payable down-time		Days	0	$ -	$ -	
4	**Sand Fill Bunded Areas**						**$ 20,000**
4.1	Prepare dewatering bunds		m^2	3,000	$ 2	$ 6,000	
4.2	Maintain access, signage & safety fencing		Item	-	-	$ 4,000	
4.3	Restore bund areas in reserve and tourist park		Item	-	-	$ 10,000	
5	**Site Disestablishment**		Lump Sum				**$ 25,000**
	CONSTRUCTION COSTS (Items 2 - 5)				***SUB TOTAL***		**$ 763,800**
Add	Contingency on construction cost		15%				$ 114,600
					SUB TOTAL : CONSTRUCTION COST		**$ 878,400**
Add	Supervision and contract administration		10%				$ 87,900
Add	Preliminaries (Item 1)						$ 74,500
					COST ESTIMATE		**$1,040,800**

APPENDIX 2 PRIORITIES

Minor Projects

Minor dredging projects around boat ramps have been ranked to reflect the importance of marine safety and navigation and the overall cost effectiveness of the project.

	FINAL WEIGHTED RANKING		MINOR DREDGING PROJECTS			
Weighting	**Component**	**Callala Bay Boat Ramp**	**Sanctuary Point Boat Ramp**	**Cunjurong Point Boat Ramp**	**Narrawallee Boat Ramp**	**Aney St Conjola Boat Ramp**
1	Broad community benefit	3	3	1	0	1
3	Cost effectiveness	12	15	3	3	9
3	Navigation conditions	15	9	9	9	9
3	Safety improvements	15	15	0	0	0
1	Environmental outcomes	1	1	0	0	0
1	Disruption to natural coastal processes	5	5	5	5	3
1	Level of boating activity	5	5	1	2	2
2	Opportunities for external funding (Government or private sector)	4	4	4	4	4
2	Effectiveness - longevity of dredging	8	8	4	6	6
2	Potential for added benefits	10	4	0	0	0
	TOTAL	**75**	**66**	**26**	**29**	**33**

Major Projects

Major dredging projects listed overleaf have been ranked to reflect the importance of navigation or marine safety, providing a broad community benefit or added benefits such as supply of sand for beach nourishment or protection of assets. Also important to Council considerations is the overall cost effectiveness of the project. Rankings and weightings are provided overleaf.

	FINAL WEIGHTED RANKING		MAJOR DREDGING PROJECTS							
Weighting	**Component**	**Shoalhaven Heads Flood Notch**	**Shoalhaven Heads Environmental Opening**	**Currambene Creek Navigation**	**Currambene Creek Additional Moorings**	**Currarong Creek Navigation**	**Sussex Inlet Channel Navigation**	**Sussex Inlet Bar**	**Conjola Entrance Sand Mining**	**Conjola Configuration Dredging**
3	Broad community benefit	15	9	15	6	3	12	12	12	12
2	Cost effectiveness	10	2	8	8	10	6	4	4	6
1	Navigation improvements	0	0	5	4	5	5	4	2	2
3	Safety benefits	0	0	15	0	0	15	12	0	0
1	Environmental outcomes	0	4	0	0	3	3	3	3	3
1	Effects of natural coastal processes	5	2	4	2	2	3	2	5	5
1	Level of boating activity	0	0	5	4	1	5	4	2	2
2	Opportunities for external funding (Government or private sector)	0	4	6	0	0	10	10	10	10
2	Effectiveness - longevity of dredging	2	0	6	5	4	8	2	8	8
3	Potential for added benefits	15	15	15	9	6	9	6	15	15
	TOTAL	**47**	**36**	**79**	**38**	**34**	**76**	**59**	**61**	**63**

APPENDIX 3 CONSULTATION

During this investigation we have been assisted by a number of people. We have benefitted from the valuable insight and local experience of a number of community representatives through their NRFMC membership.

NRFMC MEMBERS and observers present at community dredging forum 17 December 2013

John Tate, Peter Zealand and Jess Zealand - Shoalhaven Heads

Peter Cumes - Currarong

Bob Pullinger - Callala Bay

Michael Strachan (SCC) - Currambene Creek

David Tarbert - Sussex Inlet

Dirk Treloar and David Wilson - Lake Conjola

Wendy Fuller - Narrawallee Inlet

Annette Parsons - Tabourie Lake

James Coburn & John Tucker - Sussex Inlet Safe Navigation Action Group - observers

SHOALHAVEN CITY COUNCIL STAFF

Isabelle Ghetti, Ray Massie, Michael Strachan, Warwick Papworth, Penny Lumb, Barry Jeffery

STATE AGENCIES

Trade and Investment (Crown Lands) - Nowra and Newcastle offices

NSW DPI Fisheries

Marine Parks Authority

Roads & Maritime

Office of Environment & Heritage

PRIVATE INDUSTRY

Shoalhaven Sand

Cleary Bros

Holcim (Aust) Pty Ltd

OTHER

Farquhar Inlet Management Group - Greg Crisp

Greater Taree City Council - David Hopper