NSW ENTRANCE BAR MANAGEMENT – BAR CROSSING SAFETY AND BAR TO BEACH: LINKING DREDGING OPERATIONS WITH COASTAL HAZARD MITIGATION AND BEACH AMENITY IMPROVEMENTS

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Introduction

The NSW Department of Industry – Crown Lands and Water (CLaW) is responsible for the sustainable management of nearly half of the land in NSW. The Crown land estate encompasses the dry land and the submerged land of the State's waterways 5.5 km out to sea including the ocean floor, most coastal estuaries, many large riverbeds and some coastal wetlands. This management responsibility also encompasses the built assets and natural resources on and within Crown land. Along the NSW coastline, CLaW manages a range of built maritime assets (excluding the commercial Ports of Newcastle, Sydney, Port Botany and Port Kembla) worth over $2 billion, maintaining access to these assets where appropriate. The major maritime assets comprise 34 trained harbour and river entrances, accommodating 25 coastal harbours.

The NSW coastal harbours cater for the commercial fishing industry, a growing tourism industry and increasing recreational boating activity across the State. In addition to being operational bases for commercial fishing fleets, the coastal harbours are experiencing increasing demand due to tourism and as departure points for charter and recreational boating activity. The coastal harbours also provide an important role in the ongoing success of many coastal communities, providing opportunities for economic growth, jobs, tourism and recreation, supporting over $1 billion of commercial activity in NSW. The infrastructure (breakwaters and training walls) that characterises the coastal and river entrances plays a vital role in the safe navigation and shelter of marine craft, including commercial and recreational vessels. These structures also can contribute greatly to catchment flood mitigation by improved hydraulic efficiency of the river entrances. It is noteworthy that the breakwaters and river training walls are also a popular destination for fishing, walking and site seeing.

The NSW Coastal Infrastructure Capital Works Program, now administered by CLaW (originating in 2011) has utilised around $10M to $15M per annum towards successfully upgrading and maintaining critical infrastructure to optimise safety and serviceability, reduce future repair and maintenance costs and support local employment and industry for the benefit of a wide range of users and stakeholders. Notwithstanding this, however, navigating the coastal and river entrances of NSW can be very dangerous due to sedimentation that occurs primarily from natural coastal processes. The sediments found within these flood tide shoals originate from up-drift ocean beaches and not only affect safe navigability, but may also lead to long-term beach recession within adjacent coastal sediment compartments between long-term cycles of major catchment runoff necessary to naturally return sediments to the littoral system. The adverse consequences of overly shoaled coastal and river entrances in NSW include:

- disruptions to commercial activities, including delays and restricted harbour operations around low tide with some entrances being serviceable for the safe passage of larger vessels only at or near high tide;

- forgone commercial and tourist development opportunities due to unsafe or restricted ocean access;
- restricted recreational opportunities (boating, fishing) due to unsafe or restricted ocean access;
- damage to maritime vessels (including running aground, collisions and capsizing);
- added administrative costs associated with increased maritime incidents; and
- personal injuries, including fatalities.

The dynamic and naturally shoaling characteristics of many NSW coastal harbours and river entrances requires that maintenance dredging works be periodically carried out to help achieve the NSW Government's objects of providing improved access and safety in our waterways and river entrances. NSW Governments' Manly Hydraulics Laboratory (MHL) has carried out a preliminary review of recorded boating incidents and minimum under keel clearance analysis for 11 of the 34 trained river entrances in NSW with the aim of assessing the feasibility of establishing a rational process or set of triggers to help prioritise future dredging activities.

Furthermore, MHL was commissioned by CLaW to prepare a Discussion Paper on the opportunities for linking dredging operations with coastal hazards mitigation and beach amenity improvements along the NSW coastline. Preliminary indications are that a well-structured Program has significant potential to maximise the value of dredging operations to best utilise limited sand resources while enabling regional growth through improved safety and more sustainable access to our coastal waterways and harbours for the benefit of NSW communities.

This paper outlines the findings of both the NSW Entrance Bar Safety study and the NSW Bar to Beach discussion paper.

NSW Entrance Bar Safety

Unlike historical dredging activities which utilised most dredge spoil for land reclamations, dredging under the Government's current strategy must return dredged sand to the littoral system within the relevant coastal sediment compartment, consistent also with the NSW coastal management reforms presently underway. Setting the priorities of a dredging strategy with access to limited funding, involving the management of conflicting interests and overlapping administrative and technical concerns is a challenging task. The outcome of maximising the sustainability and value of dredging operations which are deemed necessary to maintain the serviceability of our coastal harbours should drive the best practice dredging decision making process. Pursuant to this outcome, the primary factors influencing the prioritisation of dredging include regional significance of the port, hazard rating along the bar and the associated dredging costs at the entrance. Additionally, environmental factors relating to amenity for coastal communities, placement of dredge spoil and consideration of ecological systems should be integrated into the process at various stages.

The decision making process is resultantly complex and time consuming and the need for a rational decision making process involving the amalgamation of evidence-based qualitative and quantitative data is clear. In service of this goal, MHL completed a preliminary investigation comparing recorded boating incidents to nearshore ocean conditions and minimum under keel clearance for 11 of the 34 trained river entrances in NSW. The entrances considered in this study were:

1. Tweed River
2. Brunswick River
3. Richmond River
4. Evans River
5. Clarence River
6. Macleay River
7. Hastings River
8. Manning River
9. Wallis Lake
10. Wagonga Inlet
11. Bermagui River

These river entrances were selected to be a representative sample of all NSW entrances and assessed in terms of recorded incidents and the associated physical conditions at that time. Additionally, assessment was performed for each entrance's typical navigability under a range of conditions using a generalised under keel clearance calculation.

Boating Incident Analysis

The data for this analysis was collected, aggregated and digitised by MHL from sources within NSW Roads and Maritime Services (RMS) and Marine Rescue NSW. The total number of incidents gathered from these sources for the period 1995-2015 totalled 351 reports. Of these, 64 were excluded due to their location being outside of the study domain and for a further 56 there was no offshore wave data available at the time of incident. Therefore 231 events comprised the total incident dataset. These data are summarised in Table 1.

Table 1 – Boating incident data grouped by location

Location	Nil Injury	Minor Injury	Serious Injury	Fatal Injury	Total Incidents
Tweed River	18	9	6	0	33
Brunswick River	13	7	1	1	22
Richmond River	15	6	6	1	28
Evans River	18	5	1	0	24
Clarence River	11	7	0	0	18
Macleay River	26	12	3	0	41
Hastings River	10	5	4	0	19
Manning River	2	3	0	0	5
Wallis Lake	3	1	1	0	5
Wagonga Inlet	17	9	6	4	36
Bermagui River*	0	0	0	0	0
Total	133	64	28	6	231

*Bermagui reported no incidents at the river entrance between 1995 and 2015

The offshore wave parameters gathered for each incident were the significant wave height (H_s), the peak spectral wave period (T_p) and primary wave direction (bearing). These offshore wave parameters for the period 1 January 2012 to 29 March 2015 were then translated onto the 10-metre isobath offshore of each entrance to be representative of the nearshore conditions. The nearshore conditions for this period were generated using a parametrised version of the NSW Nearshore Wave Transfer Toolbox (NWTT; http://www.nswaves.com.au) and the simulation period was chosen to represent the largest period for which good data was available. In many cases the wave direction was not recorded at the offshore buoy (preceding the installation of directional Waverider buoys) and in such cases an assumed direction corresponding to a frequency distribution analysis of direction verses peak wave period was chosen. These data were marked for sensitivity testing at a later stage.

Incident data was grouped according to severity with categories of 'Nil Incident', 'Minor Incident', 'Serious Incident' and 'Fatal Incident' being selected. The difference between a minor and serious incident was whether emergency crew had to remove injured persons from the incident location for more than routine monitoring. This data was recorded in many incident reports and where data was missing, an educated guess was made based on the description of the incident. In addition to wave data, tide levels were gathered from Sydney Harbour hourly observations for each incident.

Further analysis was performed by filtering out just the incidents which involved boats capsizing or crossing the bar. Summary statistics for this filtered analysis are presented in Table 2.

Table 2 – Summary of nearshore conditions for bar crossing or capsizing incidents

Incident Severity	Mean H_s (m)	Std. Dev. of H_s	Mean Tide Level (AHD)	Number of Incidents
Nil Injury Incident	1.00	0.4659	-0.01	92
Minor Injury Incident	1.22	0.6912	-0.06	46
Serious Injury Incident	1.30	0.8994	0.36	13
Fatal Injury Incident	1.43	0.1429	-0.19	4
Total	1.10	0.5847	0.01	155

Figure 1 shows the frequency distribution of significant wave height for each incident severity class. The three most common wave bins accounted for over half of all incidents recorded and occurred between H_s heights of 0.75m and 1.5m.

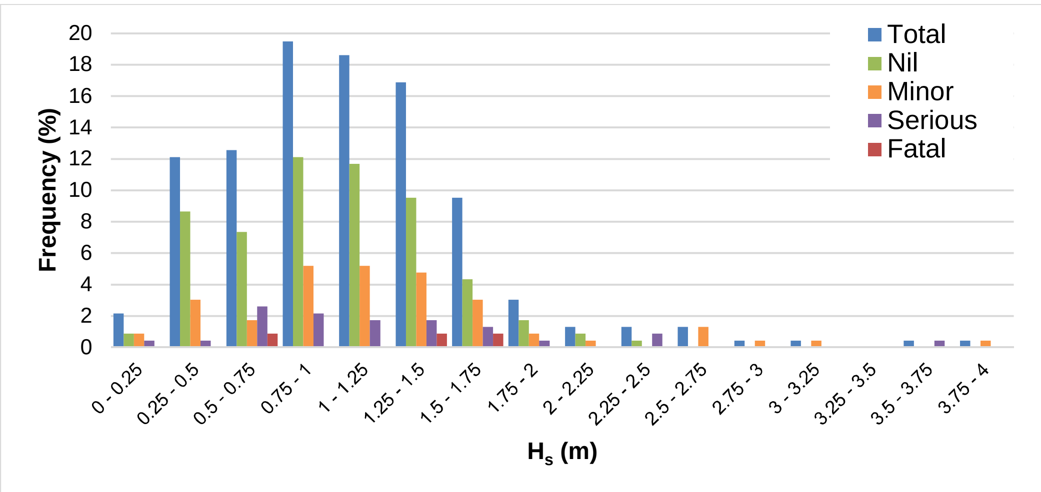

Figure 1 – H_s frequency distribution for each incident severity class

From the data, the incident severity class does not seem to correlate to a rise in significant wave height. Average H_s values for Nil, Minor, Serious and Fatal Injuries were calculated to be 1.00, 1.23, 1.23 and 1.17m respectively. There is no consistent rise in wave height class as injuries become more severe observable in the data. These results point to the sensible conclusion that there are more factors involved in incident occurrence and severity than the nearshore wave conditions alone can explain. It may also indicate also that bar crossings are not attempted when larger wave conditions are present as might be anticipated from ongoing information dissemination campaigns undertaken by RMS to improve bar crossing safety.

When looking at only those incidents in which a vessel capsized or had an incident crossing the bar, the severity of the incident is positively linked to a rise in nearshore significant wave height. This result appears to indicate that for certain types of boating incidents there may be a correlation between local environmental conditions and the incident's severity. More work will need to be done to determine how to identify and classify these types of incident in order to properly manage them. Standard deviations are high for all incident classes, further reinforcing the conclusion that incidents can occur in any conditions. The impact of the inshore wave direction will vary between entrances due to geographic orientation, sheltering and prevailing conditions. The data shows high levels of directional variability even within single river entrances and there is no observable trend between incident severity and inshore wave direction.

Other important physical factors which could impact upon likelihood and severity of boating incidents include the variability of the entrance bar conditions, the inshore wave direction and the influence of the tidal cycle on estuarine flow. Quantifying bar condition variability over time is very difficult and currently there is not enough data to determine correlation between bar conditions and boating incidents. Instead, generalised under-keel clearance has been used to estimate bar conditions at each entrance.

Under-keel Clearance Analysis

Calculation of the net under-keel clearance (UKC) for each channel entrance followed the procedure and guidelines in the PIANC Report 121 – Harbour Approach Channels Design Guidelines (2014).

The formula developed from these guidelines to calculate the net UKC is given as:

$$UKC = d - T - s - Z_{max} - Z_{wr}$$

$$\begin{aligned} where\ d &= water\ depth\ above\ channel\ bottom \\ T &= static\ vessel\ draught \\ s &= vessel\ squat \\ Z_{max} &= wave\ response\ allowance \\ Z_{wr} &= dynamic\ heel\ due\ to\ wind \end{aligned}$$

This formula assumes that the bottom related factors and draught uncertainty are negligible. For the former, the channel depth was chosen to represent the shallowest cross-section within the entrance. For the latter, it was assumed that any draught uncertainty would be negligible when compared to the other terms in the above equation.

After an initial analysis it was determined that the size of the Z_{wr} term was more than an order of magnitude smaller than either T or Z_{max} for the small class of vessels crossing the river bars and provided negligible change to the results. Consideration of wind effects, therefore, was omitted from further calculations.

In accordance with the guidelines (PIANC, 2014) the maximum vertical displacement of the ship was estimated as two times the significant wave height. This height was taken as the average H_s for each entrance to obtain generalised conditions. The ship squat was calculated using the Barras3 formula (PIANC, 2014) and assumed an unrestricted channel for all entrances (S=0.1) since, under all conditions, the design vessel's beam was less than eight times the channel width.

$$S_{Max,B3} = \frac{C_B {V_k}^2}{100/K}$$

$where\ K = 5.74S^{0.76}$

$C_B = vessel\ block\ coefficient$

$V_k = Ship\ speed$

The net UKC was calculated for two vessel types across the study domain: a 'worst-case' vessel, the dimensions of which are provided in Table B1 (LOA=length overall, BOA=beam overall), and a 'typical vessel' which, for this study, was assumed to be a 6m long outboard runabout with beam of 2.3m and a draught of 1m. These dimensions were informed by typical ship parameters in the guidelines (PIANC, 2014) as well as analysis of the incidents at each entrance. For each of these vessel types the net UKC was calculated for three tide levels: the mean high tide, mean sea level (MSL), and lowest astronomical tide (LAT). Table 3 presents the results of the UKC analysis.

Table 3 – Under-keel clearance results

	Net UKC (m)					
Entrance	*Typical Vessel*			*Worst-Case Vessel*		
	Mean High	MSL	LAT	Mean High	MSL	LAT
Tweed	2.34	1.66	0.98	1.04	0.30	-0.38
Brunswick	0.27	-0.23	-1.14	-1.49	-1.99	-2.90
Richmond	0.8	0.33	-0.5	-2.33	-2.80	-3.63
Evans	0.67	0.36	-0.57	-1.36	-1.67	-2.60
Clarence	3.16	2.74	2	1.1	0.68	-0.06
Macleay	2.29	1.83	1.04	0.79	0.33	-0.46
Hastings	2.92	2.52	1.73	0.42	0.02	-0.77
Manning	-	-	-	-	-	-
Wallis	3.09	2.67	1.97	1.29	0.87	0.17
Wagonga	1.78	1.45	0.8	1.58	1.25	0.6

The UKC values presented in Table 3 represent conservative estimates in most cases. The representative channel depths were chosen based on the shallowest bathymetry cross-section. Vessels which are rarely in service were considered and many of those would still find the channel navigable under normal conditions.

The Manning River entrance at Harrington is described as 'dangerous' by locals and upon bathymetric analysis was determined to be highly variable in terms of channel depths but also in the entrance location. For this reason, presenting representative values for this entrance was deemed unfeasible and no under-keel analysis was performed.

Operators at Brunswick, Evans and Wagonga have all stated that larger vessels often either have a difficult time entering the channel or are forced to remain docked most or all of the time due to the shallowness of the channel. The under keel analysis supports this for both Brunswick and Evans, however Wagonga seems to have an adequate UKC and Richmond does not report difficulties despite appearing to have them. The above observations bring into question what types of vessels should be entering these rivers. It is fairly clear that for Brunswick and Evans at least some of the larger vessels (for example those upon which the ‘worst-case’ vessels were based) should not be attempting to traverse the entrance at all due to the danger. One cost effective alternative to increasing dredging at these bars could be to dis-incentivise some of these larger vessels from making crossings or provide training on available guidelines through which vessels could more safely navigate the river entrance.

NSW Bar to Beach

The Rescuing our Waterways funding assistance program was launched under the NSW government’s Sustainable Dredging Strategy in 2011 to improve the accessibility and environmental health of the state’s waterways. The program has provided more than $3.5M to form partnerships with local government that are required to contribute 50 percent of project costs and manage project delivery. In 2014, the NSW government allocated $10M over 4 years (2014 – 2018) for dredging of priority waterways on the north coast with an emphasis on areas between Forster and Tweed Heads.

The NSW Government is committed to taking a strategic and pro-active approach to dredging that delivers recreational boating benefits for local waterways in regional NSW. The latest NSW Coastal Dredging Strategy identifies the funding arrangements to support delivery of navigational dredging projects to improve the accessibility and safety of our coastal waterways in regional NSW. Locations where dredging to maintain navigational access to the State owned maritime infrastructure are considered under the Coastal Dredging Strategy as ‘priority regional locations’ and dredging at these locations will be fully funded by the State Government under the NSW Government’s Coastal Infrastructure Program. Other locations in regional coastal NSW where dredging is required to meet community needs and that deliver navigational benefits in local waterways will be delivered in partnership between State and local government under the Rescuing our Waterways Program. The NSW Government is delivering through Transport for NSW (TfNSW) and Boating Now $70 million towards new and improved boat ramps, pontoons, wharves and boat storage which is the boating licence and registration fee at work. It is important that boating accessibility to these facilities is maintained.

The focus of past dredging programs has been on improving navigation within the waterways and not with respect to the entrances where many of the boating incidents occur. It is recognised also that despite the recent efforts, the demand for dredging still exceeds the level of funding available, which led to the development of the NSW Bar to Beach Discussion Paper to assess other possible options to improve safety and access to the State’s waterways and to revisit the triggers and priorities for dredging of NSW coastal harbour and river entrances. The sought improvements in waterway safety and access for commercial and recreational pursuits is recognised to drive economic growth through the increased capacity of associated primary industries and communities consistent with the purpose and desired outcomes of the DoI Strategic Plan and the DoI Corporate Plan (2015 – 2019).

The purpose of the NSW Bar to Beach discussion paper was to further explore the significant potential that a well-structured program has to maximise the value of dredging operations and best utilise limited sand resources while enabling regional growth through improved safe and sustainable access to our coastal waterways and harbours for the benefit of NSW communities. Furthermore, this program would be consistent with the established importance of placing any dredged sand of marine origins, back within the active coastal zone and not removing this material from the relevant Coastal Sediment Compartment (NSW Coastal Management Act, 2016).

Coastal Erosion Hotspots and Coastal Hazard Areas

The NSW Government has identified 15 coastal erosion Hotspots in 11 council areas. These locations have been defined as areas where five or more houses and/or a public road are located in a current (or immediate) coastal hazard area as identified in a Coastal Hazard Study. There are at least 45 other locations along the coastline where either a smaller number of houses or only residential land (that is, no houses) are within an immediate coastal hazard area affected by coastal erosion and/or coastal inundation. Without effective mitigation measures, the number of locations with assets at risk is expected to increase with sea level rise that is taking place along the NSW coastline. The demands for beach nourishment along the NSW coast are further expected to increase with rising sea levels in the next 20 years and beyond.

Given the widespread and large number of coastal erosion Hotspots and coastal hazard areas in NSW, there is good proximity with many potential sources of sand for beach nourishment from coastal harbours and river entrances, particularly in areas north of the NSW Central Coast, as demonstrated in Figure 2. The discussion paper and analysis of opportunities for beach nourishment from entrance dredging activities (Bar to Beach) has been undertaken in recognition that sand and other sediment moves on a large scale within coastal sediment compartments. Coastal management activities (including dredging and beach nourishment) should take into account coastal processes and other strategic issues on a regional scale. The viability of using dredged material for sand nourishment will depend on the relative transport distances within each coastal sediment compartment and the willingness and ability to pay for the added transport and placement costs associated with providing the added beach amenity and coastal protection benefits arising.

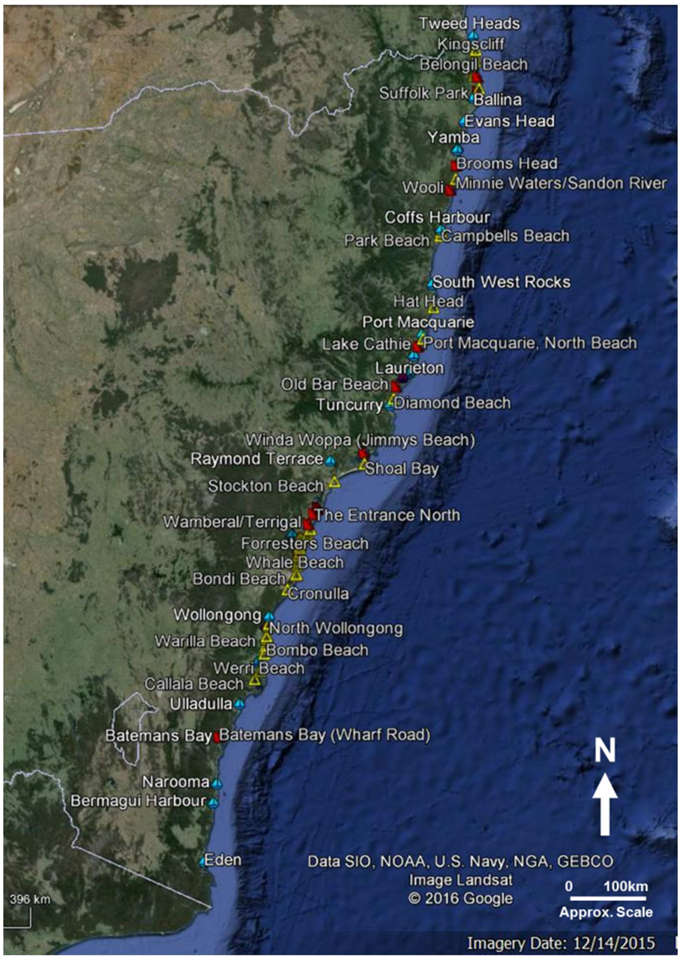

Figure 2 – New South Wales Coastal Harbours (blue), Erosion Hotspots (red) and Hazard Areas (yellow)

Scope of the Proposed Bar to Beach Program

To ensure the best value from dredging efforts, investment decisions would be assessed against a set of criteria further developed from an earlier analysis undertaken by CLaW which includes consideration of access to existing government maritime infrastructure, extent and value of boating activity, longevity and practicality of dredging, severity of shoaling, environmental sensitivity and benefits, contribution to regional economies, compatibility with estuary management planning and coastal management, and demonstrated support from local councils, community and other stakeholders.

Although the relative costs of dredging works can be determined with reasonable certainty, the main benefits of dredging and some of the social and environmental costs are not readily measurable in monetary terms. A Cost Effectiveness Analysis rather than Cost Benefit Analysis, therefore, is warranted in undertaking an economic appraisal of the proposed Bar to Beach Program as recommended by NSW Treasury (2007). Further, because the relative benefits and costs also vary between locations, a quantitative relative ranking of benefits and costs was undertaken with benefit and cost indicators including consideration of the following factors:

- Existing infrastructure
- Value of commercial/recreational activity
- Regional demographics
- Proximity to alternative facilities
- Longevity of dredging
- Practicality of dredging
- Severity of shoaling
- Environmental sensitivity

Based on the above criteria a preliminary evaluation of priorities was undertaken for 34 trained and 9 untrained entrances in NSW. The preliminary locational ranking was recognised to require ongoing refinement between regions and projects following stakeholder engagement based on a State wide consideration of issues, costs and benefits along the entire NSW coast rather than concentrating on a particular region. It is noted also that initial prioritie need to be adjusted following dredging works at each location and based on the longevity of the works that need to be assessed via ongoing monitoring as part of each investment decision. This is consistent with the present CLaW bi-annual hydrographic surveys being undertaken at NSW coastal harbour and river entrances.

Having established rationally based priorities for dredging of NSW coastal harbours and river entrances, and recognising also that investment decisions will depend on feedback from stakeholder engagement, it is necessary to determine clear triggers for when follow up dredging would be justified to maintain adequate safety and access to NSW coastal waterways. Triggers for action may include:

- maintaining satisfactory navigability
- maintaining water quality
- flood mitigation
- provision of a source of sand for beach nourishment

Cost and Budget Requirements

For the purposes of the discussion paper, use of a small seaworthy trailing suction hopper dredge (TSHD) of 450 cubic metres maximum hopper capacity was adopted to estimate comparative dredge loading/unloading costs, alongshore transport and nearshore placement costs to form typically 1.5 m high submerged sand bars in the nearshore of target beaches in water depths of 7 metres to 10 meters. Maximum laden and un-laden speeds for the dredge of 6 knots and 8 knots respectively have been adopted for estimating transport costs for beach nourishment. All dredge material is assumed to be clean marine sand with less than 10% fines as would be expected for most NSW coastal river entrances.

Two comparative dredging and transport costs have been prepared depending on the target minimum dredge depth. Where channels are dredged to at least 3.5 m below the Lowest Astronomical Tide level (LAT), the full capacity of the dredge hopper (450 cubic metres) may be utilised. However, where the target dredge depth is above this (say -2 m LAT typical of smaller and shallower entrances), only 250 cubic metres of the dredge hopper may be utilised in order to provide sufficient under keel clearance for the dredge to operate.

Figure 3 shows the influence of total dredge volume on the unit cost rate per dredging campaign, which includes loading and unloading, but excludes any transport costs beyond one kilometre. Dredging unit costs are relatively high for campaign volumes less than about 30,000 cubic metres due to high establishment costs, and the unit rate is fairly constant for volumes larger than about 100,000 cubic metres.

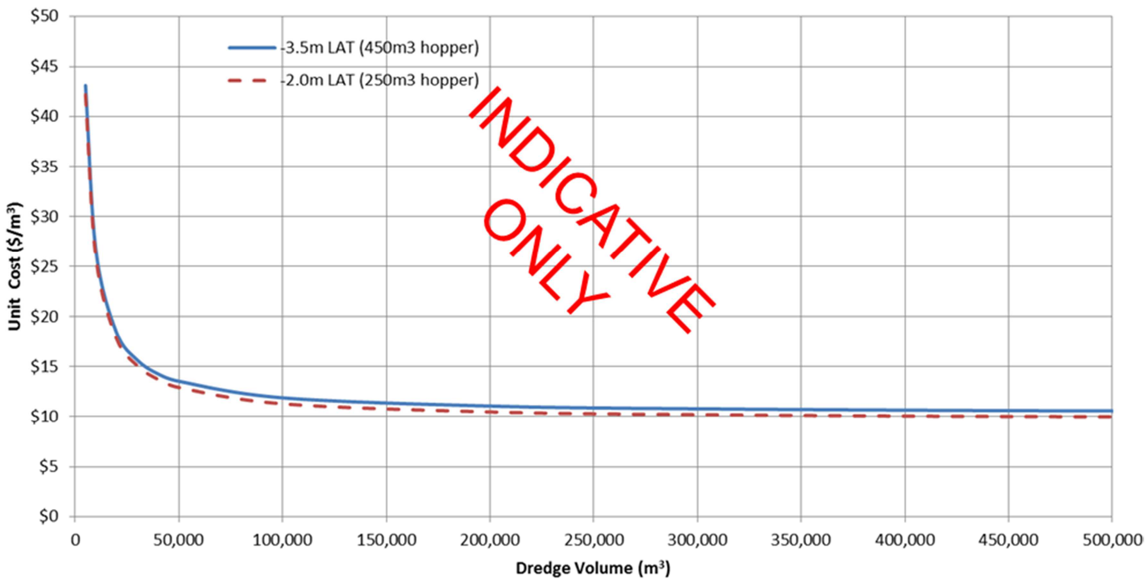

Figure 3 – Indicative Dredge Unit Cost by Volume

The indicative unit dredge costs are relatively insensitive to the hopper fill volume which for smaller fill volumes, requires more trips to transport the same volume of material, hence significantly increasing the dredge unit transport cost. For major dredging programs, use of a larger dredge can significantly reduce unit transport rates. Figure 4 demonstrates that the dredge unit transport cost remains constant for campaign volumes greater than about 5,000 cubic metres for a particular transport distance.

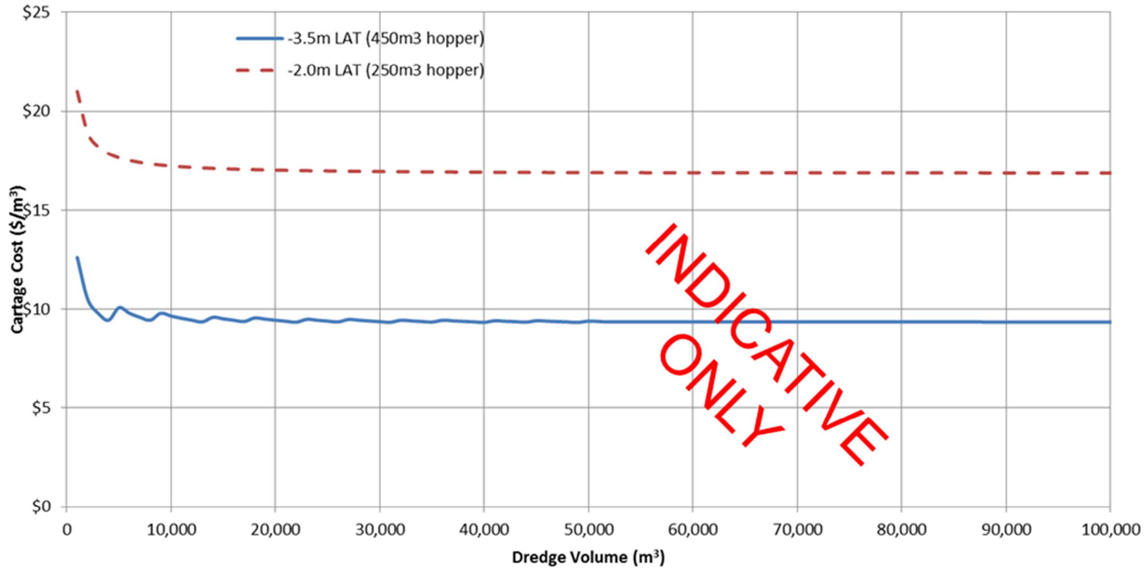

Figure 4 – Indicative Dredge Unit Transport Cost by Volume for 10km Steam

Figure 5 shows the relative dredge unit transport costs by transport distance, indicating that for transport distances greater than about 7 km for the 250 m^3 filled hopper, and greater than about 16 km for the fully laden 450 m^3 hopper, the total project costs are doubled. Indicative dredge unit transport costs of $1.69 per kilometre per cubic metre for the 250 m^3 filled hopper and $0.94 per kilometre per cubic metre for the fully laden 450 m^3 hopper have been estimated to help evaluate the feasibility of the proposed Bar to Beach program.

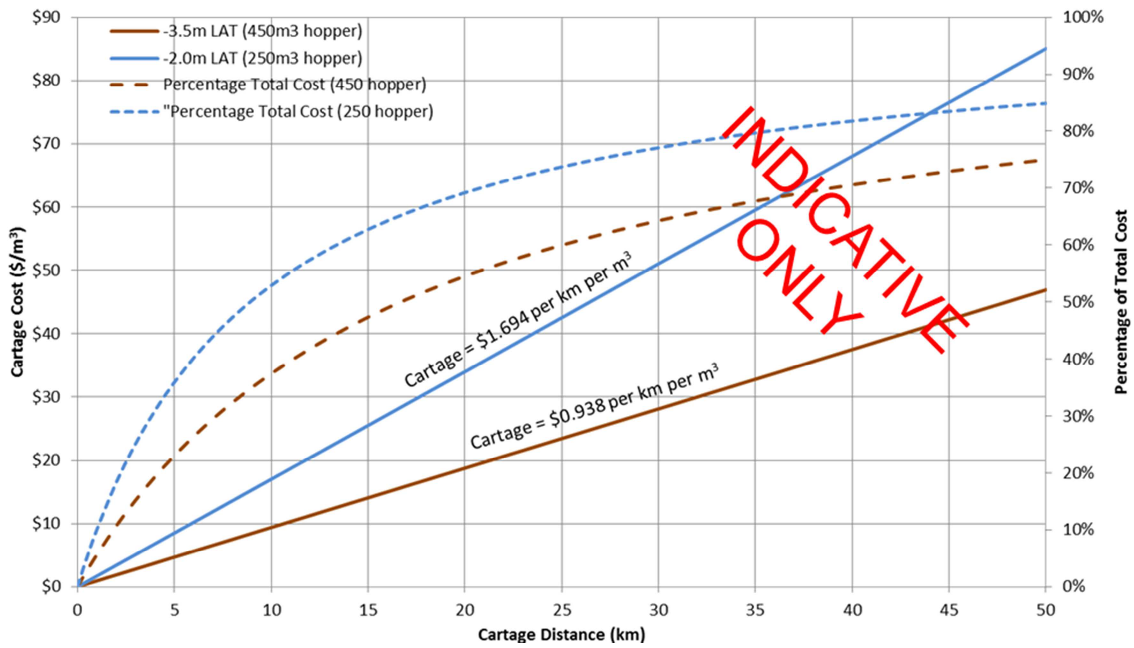

Figure 5 – Relative Dredge Unit Transport Cost by Cartage Distance

Key Stakeholder Engagement

Effective stakeholder and community engagement is well recognised to be a critical factor in the success of any major project or program (Herriman, 2011). Key stakeholders for the Bar to Beach Program comprise government agencies and responsible authorities, local councils, local communities and commercial entities. Stakeholder engagement with a number of key government agencies (Commonwealth, State and Local) has been undertaken to gauge the interest and level of support for the proposed program and to better integrate navigation dredging and beach nourishment needs across the state. The stakeholder engagement aimed to provide valuable input to the development of the business case and external support for the proposed program.

Overall the proposed NSW Bar to Beach Program was supported by the individuals from the agencies involved in the stakeholder engagement process. The feedback captured highlighted the expected benefits that would likely be obtained via a well-managed strategic dredging program linking entrance bar management with sand nourishment activities. In comparing alternative options, it was well recognised that complete abandonment of any dredging of NSW trained entrances and harbours is unrealistic given local community and industry pressures. Abandonment of any dredging would eventually result in concurrent devaluing/loss of significant associated coastal infrastructure, regional industries and local community assets. Continuation of sporadic dredging campaigns to address local issues with associated opportunistic beach nourishment works was also widely recognised to not be providing the best value for public money spent in past programs due to lost economies of scale, synergies and industry capability development opportunities.

Areas of concern which were highlighted that are likely to require further consideration to progress the proposed Bar to Beach Program include equity issues regarding funding and proportional stakeholder contributions to the cost of the program and the expected limited or negligible benefits with regard to water quality improvement. Based on the findings of the stakeholder engagement, a program managed by a central authority at the State level, featuring consistency, monitoring, data management and project learnings for ongoing improvement was strongly recommended. Ongoing consultation with the local community and agencies divisions including consideration of the idiosyncrasies of individual estuaries will be required to successfully implement and manage a NSW Bar to Beach Program to best maximise the program benefits and minimise the risks of an expanded state wide dredging and beach nourishment strategy.

Conclusions

Following a comprehensive review of waterway access and boating safety initiatives in NSW, it is concluded that despite some measurable improvements in the number and severity of commercial and recreational boating incidents, the dynamic and naturally shoaling characteristics of many NSW coastal harbours and river entrances requires that maintenance dredging works be periodically carried out to help achieve the NSW Government's objects of providing improved access and safety in our waterways and river entrances. Furthermore, a review of coastal hazard areas in NSW and their proximity to many river entrances that may benefit from dredging works has identified that there are significant opportunities for linking dredging operations with coastal hazards mitigation and beach amenity improvements. The proposed Bar to Beach Program would provide a consistent basis for evaluating competing demands for dredging and would involve key stakeholders to maximise local benefits through concurrent beach nourishment and the ability to leverage funding from local councils and other beneficiary stakeholders (providing significant economies of scale benefits to those stakeholders concurrently).

Preliminary indications are that a Bar to Beach Program has potential to maximise the sustainability and value of any necessary dredging operations to maintain the serviceability of our coastal harbours and river entrances while working with nature to best utilise our limited sand resources for the benefit of NSW coastal communities. Detailed evaluation of priority locations is proposed as part of any implementation, including evaluation of key coastal processes, potential impact on the tidal range and storm surge ingress, source and placement sediment characteristics including grain size, basic minerology and potential contaminant analysis, expected longevity of dredge channels, infill rates, and impacts on adjacent beaches. There may also be further opportunities to include in the Program other untrained entrances that are managed by local councils for flood mitigation and other purposes, and benefit from the economies of scale and expertise to be developed by the Program.

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