5 ANALYSIS OF OPTIONS AND ALTERNATIVES

5.1 Processes / Issues to be Addressed

The DECCW (2010) study showed that environmental conditions within the Lower Myall River are typical of estuarine systems, with no significant difference from this location to other locations within the wider Port Stephens area. Therefore, the constriction of the Eastern Channel is not currently impacting on the ecosystem health or ecological condition of the River. As such, there is no overriding ecosystem health justification for removing the restriction in the Eastern Channel.

Irrespective of the DECCW (2010) scientific study, members of the community still perceive that the condition of the estuary has deteriorated over the past decade. Analyses presented in Chapter 3 highlight that the past 10 years or so has been characterised by a progressive infill of the Eastern Channel, and that this has impacted on the efficiency of oceanic flushing of the River. It is possible that this has manifest as a reduction in water clarity and/or a greater influence from freshwater flows, thus leading to the community's perception of deteriorating river conditions.

Furthermore, the infill of the Eastern Channel has forced the main flows in the channel to be redirected to the western side of the relic ballast rock pile, which has placed additional pressure on the Corrie Island foreshore, leading to bank erosion and toe scour of the foreshore embankment (exposing Coffee Rock in some locations).

Commensurate with this progradation has been the erosion of the shoreline west of Barnes Rock, where local wetland values are now being compromised. Simple volume estimates (refer Appendix D) suggest that the progradation of the new spit into the Eastern Channel can be approximately accounted for by the recession and loss of material along this part of the foreshore. This implies that infilling of the Eastern Channel is not significantly influenced by erosion of Jimmy's Beach.

5.2 Do Nothing

The 'Do Nothing' condition is a realistic scenario for the Lower Myall River. There are no significant environmental gains to the waterway condition and aquatic ecosystem if something is done, and commensurately, there is no significant environmental loss to the waterway if nothing is done. At risk from the do nothing option, however, would be further loss of dune vegetation and wetland habitats associated with on-going shoreline recession on Corrie Island and west of Barnes Rock, as well as further loss of access to the end of Winda Woppa Spit.

Also, it is difficult to predict how the Lower Myall River will behave in the future given current trends in hydrodynamic and sediment transport processes. Based on an appreciation of these processes and observations of changes that have occurred over the past few years, it is reasonable to assume that the Eastern Channel will continue to infill with sediment transported along the shoreline from the west of Barnes Rock. This on-going infill will continue to reduce tidal flows through the Eastern Channel, whilst the Northern Channel will continue to increase its relative share of tidal conveyance.

It is also reasonable to assume that there is a fair likelihood that that the Eastern Channel will eventually close, although the timeframe for such circumstances is unknown. A catalyst such as a large coastal storm may be required to initiate the final and sudden closure of the channel. Other factors and events, including flood events, may accelerate or retard the progressive closure process. Based on the analyses discussed in Section 5.5.5.2, complete closure of the Eastern Channel would more than double e-folding (flushing) times in the River at Tea Gardens. This may lead to further reduction in water clarity and salinity within the lower reaches of the Lower Myall River.

5.3 Development of Options

A number of potential options for addressing the issues associated with the Lower Myall River entrance were generated by the Study Team, in close consultation with the MRAG (representing the concerns of the community) and Council representatives.

The desire of the MRAG was stated as "*to return the Lower Myall River to its former healthy and well-flushed condition, and thus improve water quality and clarity, and reduce incidents of marine disease and sand build-up within the river*".

The scientific study (DECCW, 2010) demonstrated that water quality and ecosystem health of the Lower Myall River is not currently in a poor condition.

The key issues for the MRAG are therefore aesthetics and amenity, with water clarity possibly affected by the reduced efficiency of oceanic flushing caused by progressive infill of the Eastern Channel.

A range of options were developed that aim to reverse the changes in hydrodynamics and sediment transport processes that have occurred over the past decade or so. Central to the options was the restoration (i.e. dredging) of the Eastern Channel to a size and capacity that would dominate tidal flows into and out of the Lower Myall River.

5.3.1 Dredging of the Eastern Channel and Winda Woppa Spit

In about 2001, the Eastern Channel contained a deeper section east of the relic ballast rock pile. This section conveyed the majority of tidal flows through the Eastern channel. Since then, Winda Woppa spit has grown, encroaching into this part of the channel and rendering it ineffective. The Spit now extends past the rock pile.

This option involves physical removal of the sand that has recently encroached into the Eastern Channel from Winda Woppa (refer Figure 5-2). Up to 100,000 cubic metres of sand would need to be removed, potentially through land-based and water-based equipment.

The aim of the dredging would be to re-establish a channel on the eastern side of the ballast rock pile comparable to the channel in width and depth that was present prior to 2001.

Whilst there are other shallow sections of the Eastern Channel to the west of the ballast rock pile, it is not intended to dredge these areas because 1) having too large a channel will simply reduce tidal velocities and promote sedimentation (possibly in undesirable locations), and 2) dredging close to Corrie Island may further compromise the stability of its foreshores. Indeed, realignment of the main channel away from Corrie Island will likely promote sedimentation in the nearshore area adjacent to the foreshore, which would help to stabilise foreshores, or at least stop or slow the current rate of shoreline recession.

The dredging may result in improved navigation through the channel, however, the intention of the works is not to provide safe navigable passage for vessels, but rather, to enhance and promote tidal exchange within the Lower Myall River. Navigability is intended to be maintained through the Northern Channel, which is less prone to sedimentation (with the possible exception of the drop-over edge, which was subject to dredging in late 2010).

5.3.2 Disposal of Dredged Sediments

As outlined previously, dredging of the Eastern Channel is not expected to have significant benefits for the water quality and aquatic ecosystem health of the Lower Myall River. However, dredging in the Eastern Channel may be beneficial in terms of supplying sand for on-going nourishment needs.

For the last three years, sand has been dredged from a nearshore sand sheet adjacent to Yacaaba Headland and placed on Jimmy's Beach as part of a specific 3 year nourishment trial. The volume nourished over the past three years has been approximately 70,000 – 80,000 cubic metres, although a proportion of this volume is likely to have already been lost through beach adjustment and natural reprofiling. Prior to this latest multi-year campaign, Jimmy's Beach was nourished using land-based material taken from large sand dunes behind Hawks Nest Beach, as well as some sand from the Lower Myall River. Approximately 372,000m^3 of sand was placed on Jimmys Beach up to 1998 (Watson, 2000). It is possible that the Eastern Channel can be dredged for the purposes of providing an on-going source of nourishment sand for Jimmys Beach.

Dredging typically requires considerable effort and cost with respect to deployment and set-up of equipment. Therefore, it is not feasible to take small quantities of sand on a regular basis. Alternatively, larger quantities of sand dredged from the Eastern Channel can be stockpiled locally at the end of Winda Woppa Spit, and used for nourishment of Jimmy's Beach on a smaller but more regular basis. A ready supply of locally stockpiled sand could reduce costs and time delays associated with on-going dredging of the Yacaaba sand sheet. It is possible that capital dredging of the Eastern Channel could provide enough sand for up to 10 years+ of nourishment at Jimmys Beach.

Another option for disposal is to place the material back onto the shoreline that is actively receding to the west of Barnes Rock. This is essentially the origin of the sand in the Eastern Channel, and at present, on-going erosion of the foreshore is compromising the values of a small estuarine wetland. If the erosion continues, the risk of a break-through of the Winda Woppa Spit will increase. Already, the pre-existing road access to the end of the spit has been severed by erosion. Nourishment of this shoreline could be expected to promote, and possibly accelerate, on-going longshore transport rates, given the relative unconsolidated nature of the placed material and lack of dune/beach vegetation. Thus, infill back into the Eastern Channel may become part of a looping cycle.

5.3.3 Permanent Sand Pumping System

Given the dynamic nature of the entrance, sand will need to be removed from the Eastern Channel on a regular basis if the channel is to remain open. The mobilisation and establishment of dredging equipment at such frequent timeframes would mean that a disproportionate amount of costs are attributed to non-dredging activities. An alternative is to install a permanent sand pumping system within the dredged Eastern Channel. For this option, sand is extracted from the channel via a fixed induction and sand transportation system.

An example of this type of system would be the “Sand Shifter” Unit from Slurry Systems Marine (www.ssm.com.au) (refer Figure 5-1). This system involves an inductor unit buried within the area where sand accumulates. The inductor unit uses a water jet to fluidise the sand and mobilise the material into a vacuum line (the same as a suction dredger). The sand would be subsequently discharged to a nearby location (or locations). For this option, the sand could be disposed directly onto the foreshore either on Jimmys Beach, or west of Barnes Rock, or both. The Sand Shifter unit is self-burying and does not require a supporting pier or in-channel frame. The buried units are protected from storms and do not obstruct navigation, public access or interrupt the channel flows.

The Sand Shifter technology is used at Noosa, whereby sand is pumped from the Noosa River estuary onto Noosa Beach for sand nourishment. The sand equipment has also been used at the Port of Portland, Lakes Entrance, Patterson Lakes and on Adelaide Beaches. Although on a much larger scale, the permanent sand bypassing systems of Tweed River and The Broadwater, also use similar technologies and methods.

One of the major advantages of this system is its flexibility, adaptability and reversibility. Adaptive management is considered to be essential in highly dynamic environments such as the Lower Myall River entrance. Experience of the past has shown that fixed solutions to one problem in such areas often result in new problems elsewhere. Having an adaptive approach to management will enable these flow-on effects to be mitigated in the future as (and if) they become evident. A disadvantage, however, would be its need for active management and control. Past experience at Jimmy’s Beach shows that active management and control is preferable, with reactive works often very limited in effectiveness.

Figure 5-1 Sand shifter Permanent Sand Pumping System (source: Slurry Systems Marine)

Title:

Preliminary Options: Dredging and Construction of Western Groyne

Figure: 5-2

Rev: A

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5.3.4 Western Groyne to Capture On-going Longshore Sediment Supply

Another option to reduce the on-going encroachment of sand into the Eastern Channel, once dredged, is to construct a groyne at the western end of Winda Woppa spit (refer Figure 5-2). The shore-normal groyne would capture sand transported alongshore west of Barnes Rock, primarily as a result of shoreline recession in this area. This option therefore would only be suitable in combination with the dredging of the Eastern Channel, as outlined above, and would only be effective until sand bypasses the groyne and resumes infill of the channel.

In order to minimise bypassing of sand around the groyne, either:

- the groyne would need to realign the local shoreline planform profile sufficiently to stop or significantly reduce the potential for longshore sediment transport around the structure, or
- sand accumulated on the updrift side of the groyne would need to be removed periodically (this would be an easier and cheaper process than periodic channel dredging, as it could be done in the dry using land-based equipment). The longer the groyne, the greater potential storage of sand, leading to less frequent sand removal (but greater construction cost).

The groyne would need to be designed to engineering standards and to withstand coastal storm conditions, and as such, would be a significant coastal structure.

5.3.5 Flow Constriction in Northern Channel

Part of the reason that the Eastern Channel has been subject to on-going sedimentation is that tidal flows can, alternatively, be conveyed through the Northern Channel. Prior to about 1900, the Northern Channel was very shallow (possibly inter-tidal). Dredging carried out circa 1910, to enable navigable access from Tea Gardens to Pindimar Bay, subsequently created a substantial tidal channel.

An option is to reduce the flow conveyance in the Northern Channel thus forcing tides to preferentially flow through the Eastern Channel (refer Figure 5-3). This increased flow through the Eastern Channel may be sufficient to reduced or prevent further sedimentation. If combined with the dredging option described above, the increased flows may be able to establish a self-scouring channel profile that would limit the potential for on-going sand infill from Winda Woppa Spit.

The conveyance of the Northern Channel could be reduced by constructing a constriction within the channel. At present the channel is about 80 metres wide. The constriction would need to be substantial in order to restrict tidal flows, with a width of less than 20 metres say, over a channel length of several hundred metres. The down-side with this option is that safe navigation through the Northern Channel would likely be compromised, whilst navigation through the Eastern Channel could not be assured.

There a number of unknowns associated with this option that would need to be clarified if the option was to be pursued further. For example, the optimum constriction profile would need to be established (width, depth, length) to meet the needs of redirecting tidal flows through the Eastern Channel. Ideally, the Northern Channel would be infilled completely, however, it is appreciated that some degree of navigation, albeit limited, would still be necessary.

Title:

Preliminary Options: Constrain Northen Channel

Figure: **5-3**

Rev: **A**

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5.3.6 Tombolo to Re-establish Myall Point

An option raised through the community was to re-establish Myall Point (refer Figure 5-4). An elongated finger of sand, or tombolo, extending southward from Winda Woppa spit would stabilise the shoals and channel behind. There would still likely be some sedimentation and flow constriction issues at the outlet of the channel behind the spit. The finger of sand would require an anchor at the southern end in order to maintain shoreline alignment and stability.

This option may be appealing as historical maps indicate a wide channel located behind the former natural Myall Point sand barrier. However, it must also be recognised that the Northern Channel was much smaller at that time, with the bulk of tidal flows to the Myall River conveyed through the Eastern Channel.

As the Eastern Channel is currently heavily shoaled, this option would still require dredging to re-establish a suitable channel profile that would attract a greater proportion of tidal flows and thus enhance tidal flushing and exchange in the river. Indeed, dredging would be required along the full length of the proposed new channel to construct a suitable and unconstricted flow path.

This option would involve construction of a substantial engineering structure. The tombolo would need to be approximately 800 metres long and minimum 80 metres wide (volume > 200,000m^3), with the end anchor structure comparable to a coastal breakwater/groyne. The sand could be sourced from dredging the channel behind.

It needs to be recognised that Myall Point was previously destroyed by a large coastal storm in the last 1920s, and that a new similar structure may suffer a similar fate given similar extreme ocean conditions.

5.3.7 New Alternative River Entrance

One of the main reasons for sedimentation issues in the Eastern Channel is that the entrance coincides with an area of high sediment dynamics, on the distal edge of the Port Stephens marine flood tide delta. Thus, no matter what works are carried out at this location, there will always be instability and ongoing adjustments due to the dynamism of waves and tides.

A more drastic option is to relocate the entrance of the Lower Myall River to an area that is less prone to bed sediment dynamics. Ignoring initially the scale of such an option, a new Eastern Channel that is not subject to sedimentation would potentially improve oceanic flushing within the Lower Myall River. One possible location would be to the west of Barnes Rock, in the area that is currently exhibiting rapid shoreline recession (refer Figure 5-5). The new channel would need to be stabilised, possibly with training walls that extend beyond the shoreline alignment.

With a new river entrance, the current Eastern Channel would infill rapidly, given the tendency for sedimentation and the significant reduction in tidal flows through the channel area. This would likely relieve existing erosional pressures of the eastern shoreline of Corrie Island.

Title:

Preliminary Options: Reconstruct Myall Point

Figure: 5-4

Rev: A

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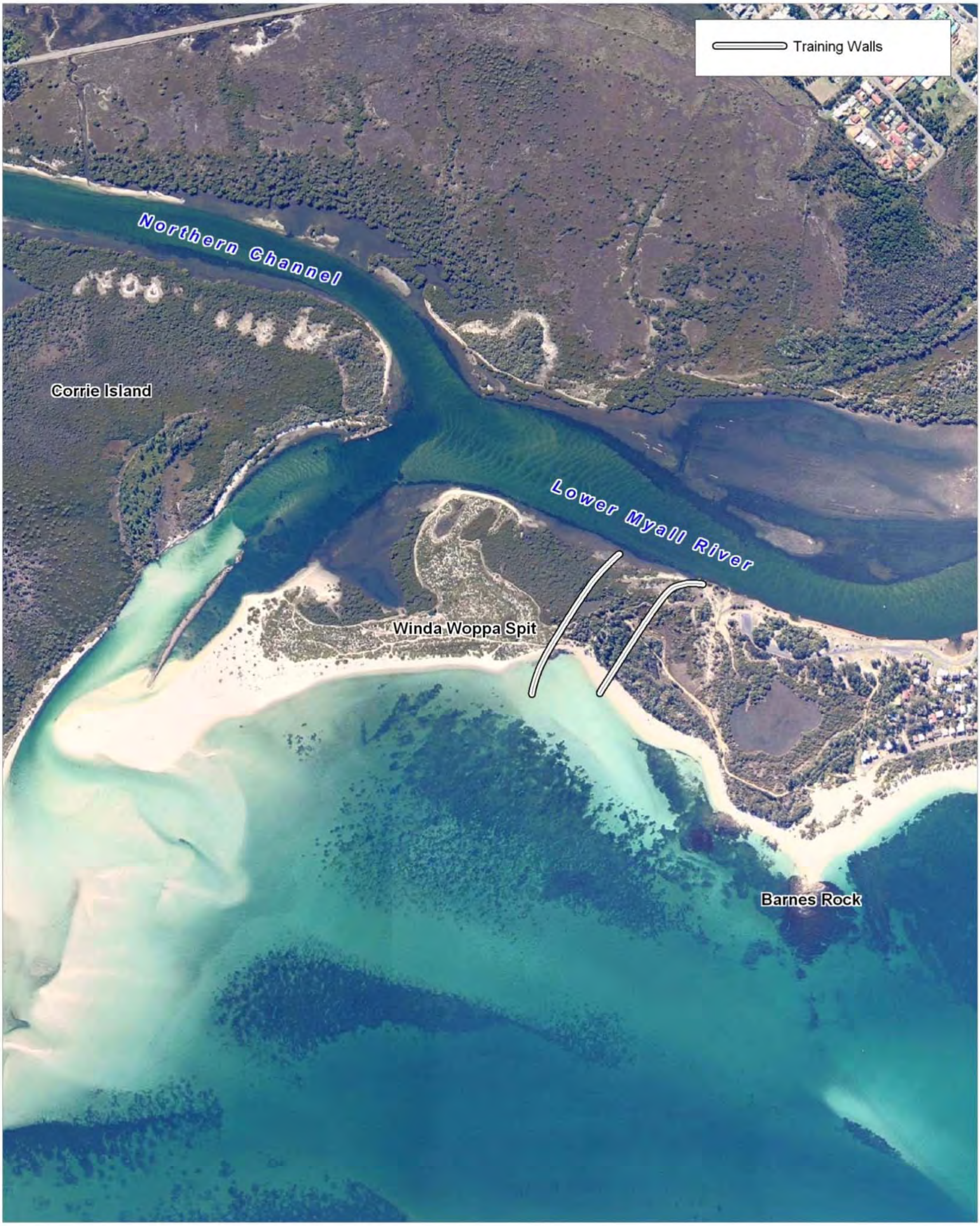

Title:
Preliminary Options: Alternative River Entrance

Figure: 5-5

Rev: A

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If this option were to be considered further, significant investigations would be required to optimise the location and dimensions of a new entrance. Careful assessment of localised sediment processes would be required to ascertain the likely infill rate, any need for on-going channel maintenance, and whether the channel should actually be navigable or not. Careful assessment of other environmental impacts elsewhere along the Lower Myall River would also be required, including the impact on flooding, and sea level rise vulnerability of Tea Gardens.

5.4 Initial Assessment and Short-listing of Options

A first pass qualitative multi-criteria assessment (considering environmental, social, economic, adaptability factors) was carried out to provide a relative analysis of the different options developed (refer Table 5-1). These were also compared to the 'do nothing' scenario, which involves future closure of the Eastern Channel.

From a purely economic perspective, all options will have a significant financial demand, which will require sourcing of special funding, as they are independent of any existing funding programs. There is, however, the opportunity to offset costs against future financial demands associated with the on-going nourishment of Jimmys Beach, if such a program of works was to be pursued by Council and the NSW Government. As stated previously, approximately $1m has been spent over the past 3 years nourishing Jimmy's Beach as part of a nourishment trial. Dredging of the Eastern Channel may represent a future source of material for on-going nourishment campaigns, with win-win benefits for both the channel and the beach.

Based on the first-pass qualitative multi-criteria assessment, the various options were given traffic-light ratings as either "has merit", "marginal" or "not suited". Only options considered to 'have merit' or 'marginal' have been assessed in further detail using the advanced hydrodynamic, sediment transport and salinity models that have been established, as outlined in Section 4. These short-listed options include:

- Dredging and nourishment onto Jimmy's Beach;
- Dredging and nourishment west of Barnes Rocks;
- Dredging and installation of a permanent sand pumping system (with nourishment of Jimmys Beach, and optionally the shoreline west of Barnes Rock as needed); and
- Dredging and construction of a groyne at the end of Winda Woppa spit.

Table 5-1 First Pass Qualitative Multi-Criteria Assessment of Options

Options	Environmental	Social	Economic	Adaptability
Do nothing ↔ STATUS QUO	Eastern Channel will eventually close, and oceanic flushing in River will be reduced. Change to ecosystem health unknown (likely to be small if any). Continued shoreline recession west of Barnes Rock, while Corrie Island will likely continue to erode until the channel closes. *Neutral / -ve result*	Loss of navigation through Eastern Channel; reduction in aesthetics (water clarity) and amenity of River due to reduced oceanic flushing *-ve result*	Possible reduction in tourism; No capital funding required. *Neutral / -ve result*	No infrastructure or construction works that would inhibit the ability to undertake actions in the future, although dredging of a fully closed channel may be more difficult. *+ve result*
Dredging with Jimmy's Beach nourishment ✓ HAS MERIT	No change to ecosystem health of River. Eastern Channel maintained open, with potentially improved oceanic flushing in River. Continued shoreline recession west of Barnes Rock, while erosional pressure on Corrie Island would be reduced *Neutral result*	Amenity of River would be maintained or slightly improved; navigation through Eastern Channel may be improved (but still not assured) *Neutral / +ve result*	High capital dredging costs (c. $2m) but may be offset by other finances dedicated to nourishment of Jimmy's Beach. On-going dredging may also be offset by on-going need for further beach nourishment. *Neutral/-ve result*	No major construction works, so option can be stopped, reversed or modified, as required, depending on the need *+ve result*
Dredging with shoreline nourishment west of Barnes Rock ✓ HAS MERIT	No change to ecosystem health of River. Eastern Channel maintained open, with potentially improved oceanic flushing in River. Shoreline recession west of Barnes Rock would be abated, while erosional pressure on Corrie Island would be reduced *Neutral result*	Amenity of River would be maintained or slightly improved; navigation through Eastern Channel may be improved (but still not assured) *Neutral / +ve result*	Significant capital dredging costs (c. $2m), with frequent on-going dredging required . *-ve result*	No major construction works, so option can be stopped, reversed or modified, as required, depending on the need *+ve result*

Options	Environmental	Social	Economic	Adaptability
Dredging with sand pumping system ✓ HAS MERIT	No change to ecosystem health of River. Eastern Channel maintained open, with potentially improved oceanic flushing in River. Abatement of shoreline recession west of Barnes Rock if sand placement incorporated, while erosional pressure on Corrie Island would be reduced *Neutral result*	Amenity of River would be maintained or slightly improved; navigation through Eastern Channel may be improved (but still not assured) *Neutral / +ve result*	High capital dredging costs (c. $2m) but may be offset by other finances dedicated to nourishment of Jimmy's Beach. Costs for permanent sand pumping system could also be offset by on-going need for further beach nourishment. *Neutral/-ve result*	Installation of sand pumping system is completely removable, and would only operate on an as-needs basis. *+ve result*
Dredging with groyne at end of spit ? MARGINAL	No change to ecosystem health of River. Eastern Channel maintained open, and on-going dredging limited. Possible improved oceanic flushing in River. Likely mitigation of shoreline recession west of Barnes Rock due to new sand accumulation. while erosional pressure on Corrie Island would be reduced. *Neutral result*	Amenity of River would be maintained or slightly improved; navigation through Eastern Channel may be improved (but still not assured) *Neutral / +ve result*	Significant capital works for groyne (c. $3m) in addition to channel dredging (c. $2m), but substantially reduced on-going cost for maintenance. Accumulated sand may be used for nourishing Jimmy's Beach or west of Barnes Rock. *-ve result*	Major construction works. The design could allow for some degree of adaptability, viz: the groyne could be lengthened, shortened or raised as required depending on changing needs *Neutral / -ve result*
Dredging with Northern Channel restriction ✖ NOT SUITED	No change to ecosystem health of River. Eastern Channel maintained open, but frequency of on-going dredging need is unknown. Possible improved oceanic flushing in River. Continued shoreline recession west of Barnes Rock. Sedimentation expected in Northern Channel. *Neutral result*	Uncertain impacts on amenity of River, as improvements to water clarity etc. would be offset by difficulties with navigation through the Northern Channel (whilst navigation through the Eastern Channel is still not assured). *-ve result*	Significant capital works for Northern Channel structure (c. $2-3m) in addition to channel dredging (c. $2m), and may still require on-going maintenance dredging; Expected economic loss due to reduced tourism if navigability is reduced/lost *-ve result*	Major construction works in Northern Channel, which would be difficult to remove or alter once in place. *-ve result*

Options	Environmental	Social	Economic	Adaptability
Dredging with Myall Point Tombolo ✖ NOT SUITED	No change to ecosystem health of River. Eastern Channel maintained open, and on-going dredging limited. Possible improved oceanic flushing in River. Mitigation of shoreline recession west of Barnes Rock and on Corrie Island due to new shoreline alignment. *Neutral result*	Amenity of River maintained or slightly improved with improved water clarity; navigation through Eastern Channel improved (but still not assured); new area of land possibly suitable for recreation *Neutral / +ve result*	Significant capital works required involving marine construction and dredging (c. $10m). On-going maintenance would be limited. *-ve result*	Major construction works, which would be difficult to remove or alter once in place. SLR would potentially cause landward migration of the tombolo compromising benefits *-ve result*
New River entrance ✖ NOT SUITED	No change to ecosystem health of River. New Eastern Channel that would remain open and possibly improve oceanic flushing in River. May cause other detrimental impacts elsewhere, including Northern Channel, and would involve loss of land and habitat. *Neutral / -ve result*	Amenity of River maintained or slightly improved (with improved water clarity); navigation through new Eastern Channel may be feasible (but not assured); loss of access to the end of Winda Woppa spit *Neutral result*	Significant capital works program required involving marine construction and dredging (c. $15m). On-going maintenance would be limited. *-ve result*	Major construction works, which would be difficult to remove or alter once in place. New Eastern Channel may increase exposure of Tea Gardens and River to ocean storms and storm surge. *-ve result*

5.5 Detailed Assessment of Short-listed Options

A semi-quantitative assessment of short-listed options has been carried out to further consider the potential benefits and costs of these options. This includes consideration of broader environmental benefits and costs (if any), as well as capital and on-going expenditure needs.

5.5.1 Comparison Options

In order to evaluate short-listed options, baseline conditions were included in the assessment for comparative purposes. For this assessment, two comparison options have been considered:

1. Existing conditions; and

2. ‘Do nothing’ conditions.

The existing conditions represent the current morphology of the Lower Myall River entrance (as defined by the most recent (2009) bathymetric survey).

As outlined in Section 5.2, the ‘Do Nothing’ conditions represent a hypothetical, but feasible future outcome if there is no intervention of hydrodynamic and sediment transport processes, that is, the ‘Do Nothing’ conditions assume that the Eastern Channel is completely blocked. It is emphasised that the timeframe for such conditions to develop is unknown. As sediment transport can be dominated by episodic events, there is a chance that the channel may close very quickly if a large coastal storm were to occur, and such a storm could potentially occur at any time. There is also a chance that the channel may continue to function near its current condition for many more years in the absence of major events or storms.

5.5.2 Dredging Options

Optimisation of a dredging profile would be the subject of detailed design, which would determine the most effective width and depth of the channel to be dredged, incorporating an agreed allowance for sedimentation over a specified timeframe (i.e. “insurance dredging”).

Two approaches to dredging the Eastern Channel have been considered:

1. Dredge a channel cutting through the existing sand spit, with existing elevations retained except within the direct channel footprint; or

2. Dredge the whole spit, with a deeper dredge profile through the proposed channel section.

The first option would require removal of a smaller quantity of sediment, and thus would be cheaper, however, the second option may result in a more stable morphology (particularly under storm conditions), with less infilling of the channel profile in the future.

A third option was also included within the assessment process, which is the same as Dredge Option B, but with the inclusion of a groyne at the end of Winda Woppa Spit.

A summary of the dredging options considered is as follows:

1. Existing Conditions (base case) – this model simulation represents a baseline for comparison with short listed options adopting contemporary (September 2009) bathymetric conditions to represent a partially closed Eastern Channel;

2. 'Do nothing' Option – this model simulation represents possible future conditions in the vicinity of the Eastern Channel should there be no intervention of current morphological processes. The 'do nothing' option assumes that Winda Woppa Spit will continue to grow in a westerly direction resulting in complete closure of the Eastern Channel;

3. Dredge Option A – this model simulation represents dredging of a channel through the sand spit to re-establish connection between the Lower Myall River and Port Stephens via the Eastern Channel;

4. Dredge Option B – similar to Dredge Option A with additional sand removed from the western side of the proposed dredge channel to a level of -1.0 m AHD. Dredge Option B may be advantageous if there is an opportunity to maximise the extent and volume of material to be dredged from the Eastern Channel or should the extensive build-up of sand on the western fringe of the sand spit lead to premature infilling within the Eastern Channel;

5. Dredge Option C - same as Dredge Option B, but with the construction of a coastal groyne east of the dredged channel to increase the longevity of dredging activities by trapping westerly longshore sediment transport; and

6. Dredge Option D – same as Dredge Option A, but with the addition of a Sand shifter permanent sand pumping system for on-going channel maintenance.

Conceptual designs for dredging works adopted in the quantitative assessment have adopted a channel that transitions from the southern side of the spit (approximately -1 m AHD) to the northern side of the spit (where existing bed elevations within the Eastern Channel are about -4 m AHD). The proposed channel would be approximately 400 metres long, with the width varying between 60 metres (northern end) and 160 metres (southern end). Dredge extents would cover an area of approximately 4 ha and include removal of some 55,000m^3 for Dredge Options A & D (i.e. channel cut only), and an area of 8 ha and removal volume of 95,000m^3 of material for Dredge Options B & C (channel cut and removal of sand spit). For Options B & C, the whole spit on the western side of the dredge channel would be lowered to an elevation of approximately -1m AHD.

In Option C the configuration of the western rock groyne (refer Section 5.3.4) would likely adopt a crest width of 4 - 6 metres (depending on proposed functionality of the structure for future works), crest elevation of about 3 m AHD (to minimise overtopping and associated structural damage) and batter slopes of 1V:2H. The groyne would extend approximately 130 metres into Port Stephens along a generally southerly alignment from the current shoreline.

5.5.3 Disposal Options

Disposal options considered as part of this detailed assessment include placing of dredged spoil onto Jimmy's Beach, and placing dredged spoil onto the foreshore west of Barnes Rock. In reality, there are probably many other options available for the temporary or permanent placement of spoil, either as an alternative, or in combination with the two placement options noted above.

For both of these disposal options, numerical modelling analysis was limited, as for the most part, the disposal of sediment represents a removal of material from the immediate hydrodynamic and sediment environment.

5.5.4 Modelling Simulations

In assessing the impacts of the dredging options on hydrodynamics and morphology, two different time periods were utilised:

- On a monthly timescale the impacts of the potential dredge scenarios on flows, water levels and flushing were assessed. The model simulation and associated boundary conditions covered the period 21st September 2009 to 31st December 2009. Part of this data set was utilised for the calibration / validation period and represents typical spring – summer conditions.

- On a daily/weekly timescale the immediate impacts upon sediment transport were assessed. The shorter timescale was considered reasonable under the assumption that any changes to the morphology were likely to occur shortly after dredging, as the channel attempts to reach a steady state under the applied tidal flows and wave conditions. A review of ocean swell wave climate using historical wave data measured at Sydney revealed large SE swell wave events occurred between March-April 2005 (refer Appendix C).

A brief outline of the dredge scenarios modelled is provided in Table 5-2.

5.5.5 Evaluation of Environmental Impacts

5.5.5.1 Impacts on Flow Distribution

Potential changes to tidal flows are shown on Figure 5-6 as a comparison of the relative flow contribution between the Northern Channel and Eastern Channel. The modelling results show that dredging causes the Eastern Channel to become more dominant, and would contribute more tidal flow than the Northern channel. Under existing conditions, tidal flows through the Northern and Eastern Channels are approximately equal. For the ‘do nothing’ scenario, 100% of the flow would be through the Northern Channel, while for the dredge options (A, B, C & D), the Eastern Channel would take approximately 75% of the total tidal flow, and is similar to the flow distribution that was recorded by gaugings in 1975 (refer Section 3.2.2). There was a marginal increase in flows through the Eastern Channel for Dredge Option B (and C) compared Dredge Option A (and D), given the larger scale of channel dredging.

Table 5-2 Summary of Model Scenarios

Management Scenario		Bathymetry* Changes *The base bathymetry for all scenarios is the 2009 Hydrosurvey	Boundary Conditions	Simulation Period	Impact Assessment
1a	Existing conditions (base case)	Base bathymetry	Tides	21st Sept – 31st Dec 2009	Hydrodynamics
1b			Wind, tides, waves	17th Mar – 17th Apr 2005	Morphology
2	'Do nothing' option	Closure of the Eastern Channel	Tides	21st Sept – 31st Dec 2009	Hydrodynamics
-			Wind, tides, waves	Morphology not assessed, as eastern channel is assumed to be completed shoaled.	
3a	Dredge Option A	Dredge channel through the Myall Spit	Tides	21st Sept – 31st Dec 2009	Hydrodynamics
3b			Wind, tides, waves	17th Mar – 17th Apr 2005	Morphology
4a	Dredge Option B	Dredge channel through Sand Spit **AND** dredging of recurved spit to a depth of -1mAHD	Tides	21st Sept – 31st Dec 2009	Hydrodynamics
4b			Wind, tides, waves	17th Mar – 17th Apr 2005	Morphology
5a	Dredge Option C	Dredge channel through Sand Spit **AND** dredging of recurved spit to a depth of -1mAHD **AND** a Groyne	Tides	21st Sept – 31st Dec 2009	Hydrodynamics
5b			Wind, tides, waves	17th Mar – 17th Apr 2005	Morphology
-	Dredge Option D	Dredge channel through Sand Spit **AND** dredging of recurved spit to a depth of -1mAHD **AND** installation of a permanent sand pumping system	Tides	Same as Dredge Option A (run 3a)	
-			Wind, tides, waves	Same as Dredge Option A (run 3b)	

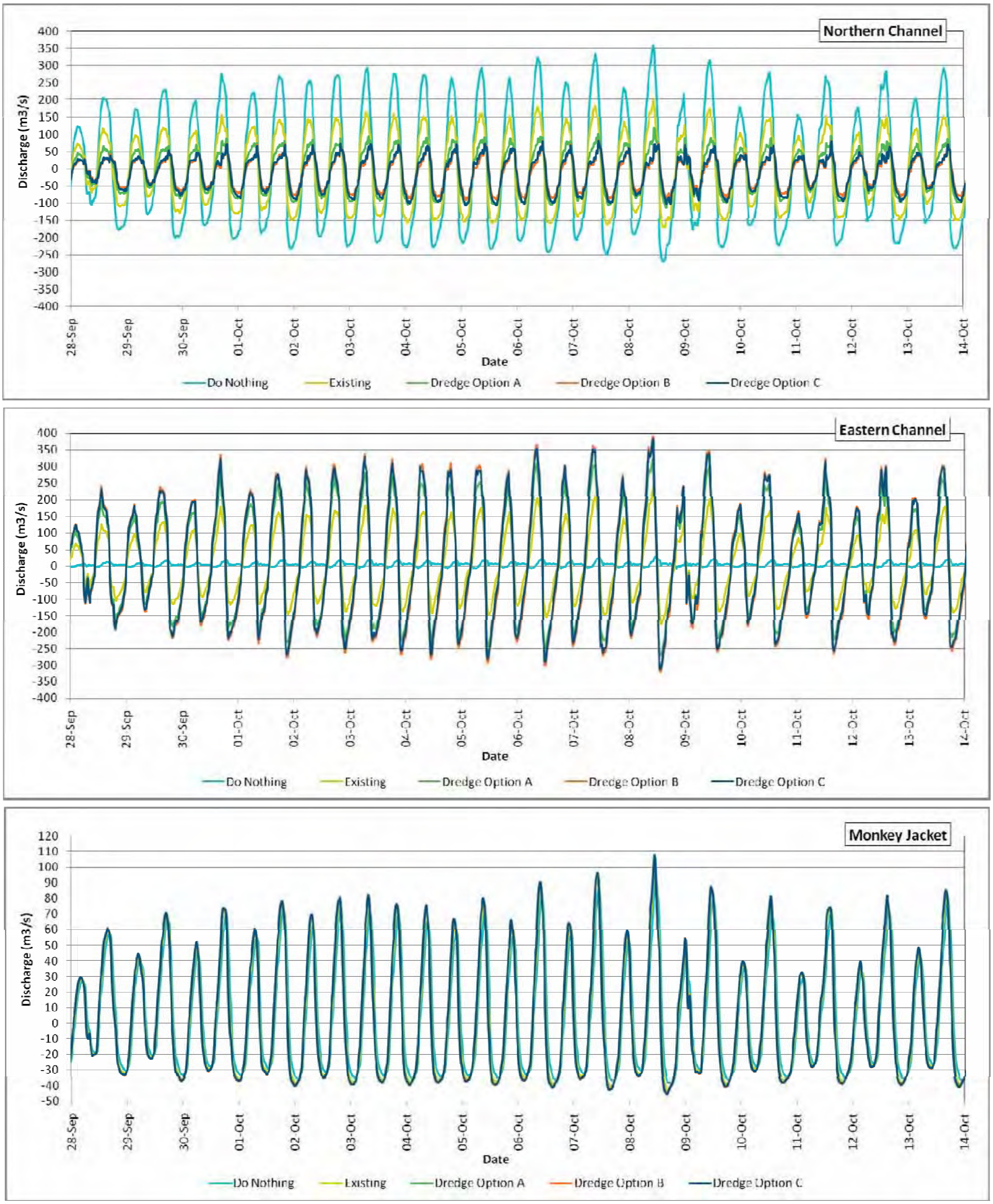


Figure 5-6 Simulated Change to Tidal Flows

5.5.5.2 Impacts on Oceanic Flushing

For the purposes of this assessment, oceanic flushing is assessed in terms of an e-folding[1] flushing time. The smaller the e-folding time, the better the efficiency of oceanic flushing and tidal exchange.

Changes in the e-folding time for the dredging options and comparative options are shown in Figure 5-7. The results show that e-folding times within the lower reaches of the Myall River would decrease (i.e. improved efficiency of oceanic flushing) with increased flow through the Eastern Channel compared to existing condition). E-folding time in the lower reaches is reduced from 20 days (existing) to less than 15 days (dredge options). As expected, for the condition of no flow through the Eastern Channel (i.e. 'do nothing' conditions), e-folding times in the river would increase, up to about 40 days.

Dredge Option B is predicted to result in marginally improved oceanic flushing compared to Dredge Option A although differences are minor and typically in the order of 2 days for areas including the confluence and Pindimar Bay. E-folding times for Dredge Option C are comparable to those predicted for Dredge Option B, while results for Option D would be the same as Option A.

Dredging in the Eastern Channel also improves tidal flushing within Pindimar Bay, as a proportion of the 'clean' seawater carried into the River through the Eastern Channel during the flood tide is then diverted through the Northern Channel and into Pindimar Bay during the subsequent ebb tide.

There is also a tidal lag between the Eastern Channel and Northern Channel meaning that, for between 1-2 hours during each tidal cycle, the Eastern Channel is flooding while the Northern Channel is still ebbing. This also facilitates the transfer of clean seawater to Pindimar Bay. Under existing conditions, e-folding time within Pindimar Bay exceed 25 days, however, with increased contribution of seawater via the Eastern Channel, e-folding time is reduced to approximately 15 days or less. For the 'do nothing' scenario, e-folding times in Pindimar Bay increase to about 30 days.

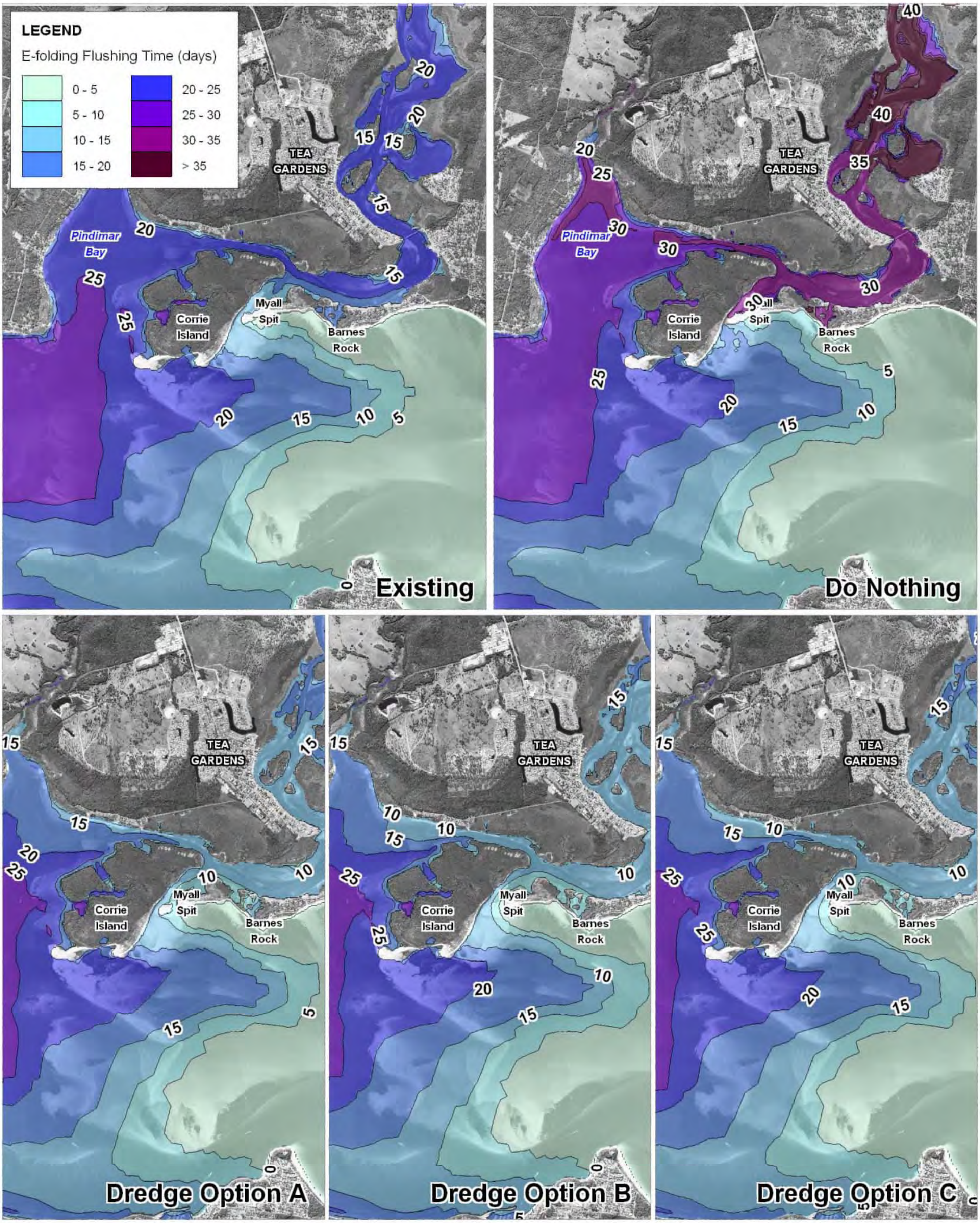
5.5.5.3 Impacts on Salinity

To determine potential impacts on salinity, a hypothetical scenario was constructed where an elevated water level was applied in Bombah Broadwater (Myall Lakes), generating a consistent freshwater discharge into the upper reaches of the Myall River. Changes in resulting salinity profiles along the river were determined for the different dredging options.

The elevated water level adopted in Bombah Broadwater for this assessment was determined by analysing historical data from Bombah Point (refer to Figure 3-2 for location). Three significant peaks in water level have been recorded over the last ten years. An initial water level of 0.84 m AHD within Bombah Broadwater (as recorded in June 2007) was chosen for modelling purposes. Resulting flows and water levels from Myall Lakes are shown in Figure 5-8 for the 100 day long simulation.

Salinity results have been examined for Brasswater, Monkey Jacket, Tea Gardens, Pindimar Bay and Corrie Island Confluence (refer to Figure 3-2 for locations) for the different dredging options. The results of the salinity analysis (daily averaged salinities) are presented in Figure 5-9.

[1] E-folding is a measurement of flushing. Starting with a concentration of 1.0 inside an estuary, the e-folding time is that time taken for tides to reduce the concentration to 1/e (or 0.37) at a particular location.



Title:

Simulated Changes to Tidal Flushing with and without dredging

Figure: **5-7**

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Figure 5-8 Simulated Water Levels and Flows from Myall Lakes for Salinity Analysis

The modelling results showed that there was no change in salinity at Brasswater (results not shown), while only small changes were observed at Monkey Jacket, highlighting the dominance of freshwater flows at the upstream end of the estuary. Similarly, in Pindimar Bay, at the downstream end of the estuary, there was relatively little difference in dredging scenarios considered.

The greatest difference was predicted at Tea Gardens, which is approximately mid-way along the estuary. At Tea Gardens, salinity can be impacted significantly by freshwater flows from Myall Lakes. As observed in Figure 5-9, dredging within the Eastern Channel could increase salinities by 20 – 40% compared to existing conditions, while complete closure of the Eastern Channel could reduce salinities by about 30% compared to existing levels. Dredge Options B & C showed marginally higher salinity levels at Tea Gardens compared to Dredge Option A, reflecting the larger tidal flows, and thus greater oceanic flushing, through the Eastern Channel.

Salinities at Tea Gardens also show a distinct spring-neap cycle, with higher salinities during spring tides, and lower salinities during neaps, reflecting the increased propensity of tides during springs.

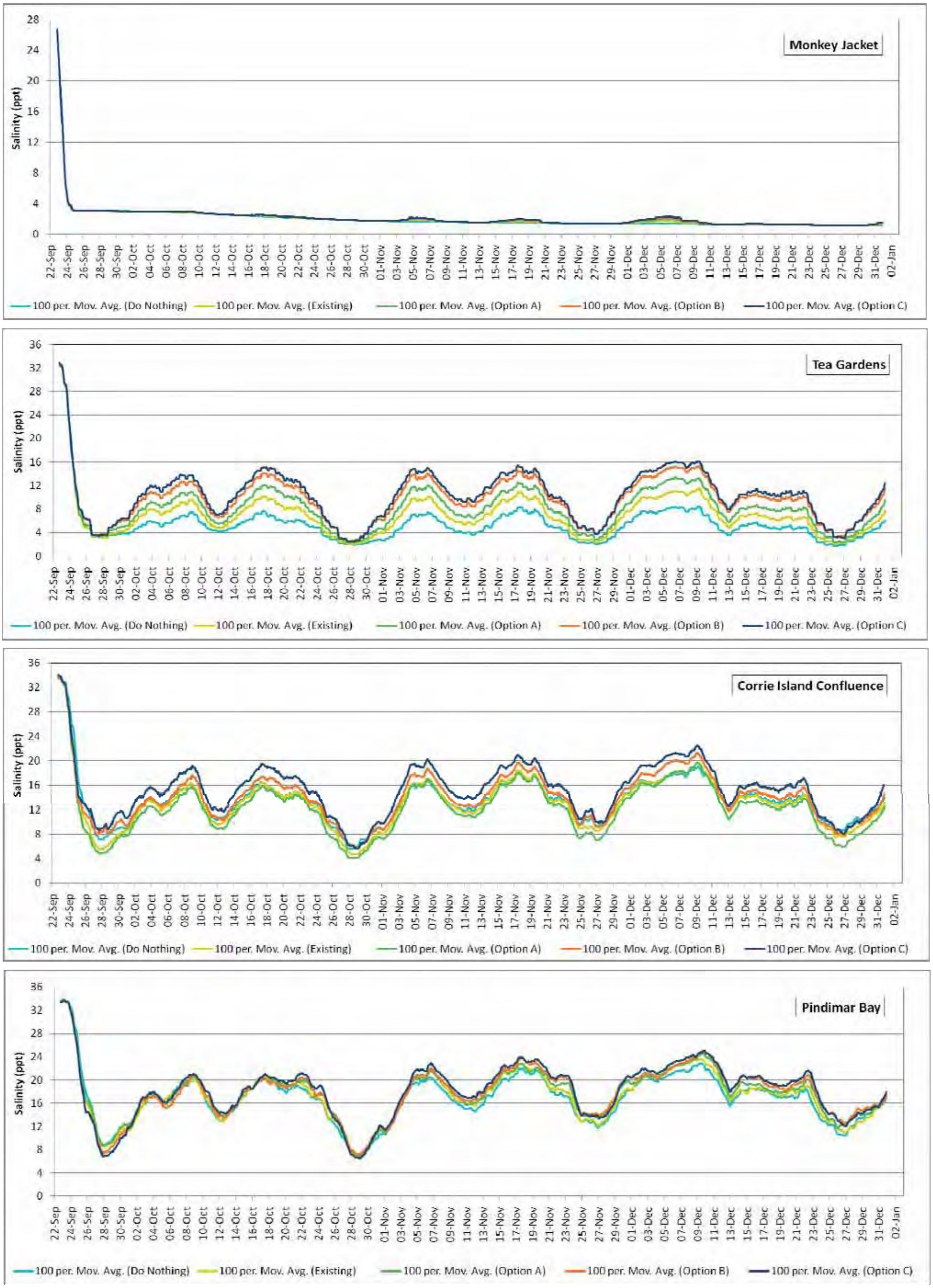


Figure 5-9 Simulated Changes to 24 hour Moving Average Salinity With and Without Dredging

5.5.5.4 Impacts on Entrance Morphology

The study region at the end of Winda Woppa spit comprises a complex interaction of geomorphologic features and different sediment transportation processes. One month long simulations involving waves, tides, wind and morphology were executed for the “existing condition” (for comparison) management Options A, B and C with results provided on Figure 5-10 through Figure 5-13 respectively. The do nothing scenario was not assessed for entrance morphology, as the Eastern Channel is fully closed under this scenario. Importantly, this month long period does not consider a full set of possible combinations of winds, waves and tides. Combined with limitations of the model in replicating beach face transport processes (refer Section 4.3.6.2) this means that the results need to be carefully interpreted.

For the Existing Condition, the month-long simulation indicates that the initial morphology is not “in equilibrium”, and that substantial changes would occur around the fringes of the main flow channel. Paddy Mars Bar in front of the Eastern Channel entrance would also be subject to varying degrees of erosion and accretion. When waves are present, such as on Paddy Mars Bar, sediment transport is considerably enhanced due to the sediment stirring action of the wave motions resulting in larger sediment concentrations, which are subsequently transported by the currents (generated by tides, waves and/or wind).

For Dredge Option A, the simulation indicates that the dredged channel would tend to widen, with the bar on the ocean side of the new channel scouring.

For Dredge Option B the simulation indicates that, like Option A, the dredged channel would tend to widen (migrating westward), while the area of extra dredging (i.e. the end of the spit) may also tend to scour. This becomes possible because tidal flows are now able to reach this area, which is shoaled above the high tide mark in Dredge Option B.

For Dredge Option C the fixed boundary of the groyne tends to force a more pronounced widening of the new channel to the west, with erosion of the bar at the ocean side of the channel.

For Dredge Option D, results would be the same as Option A.

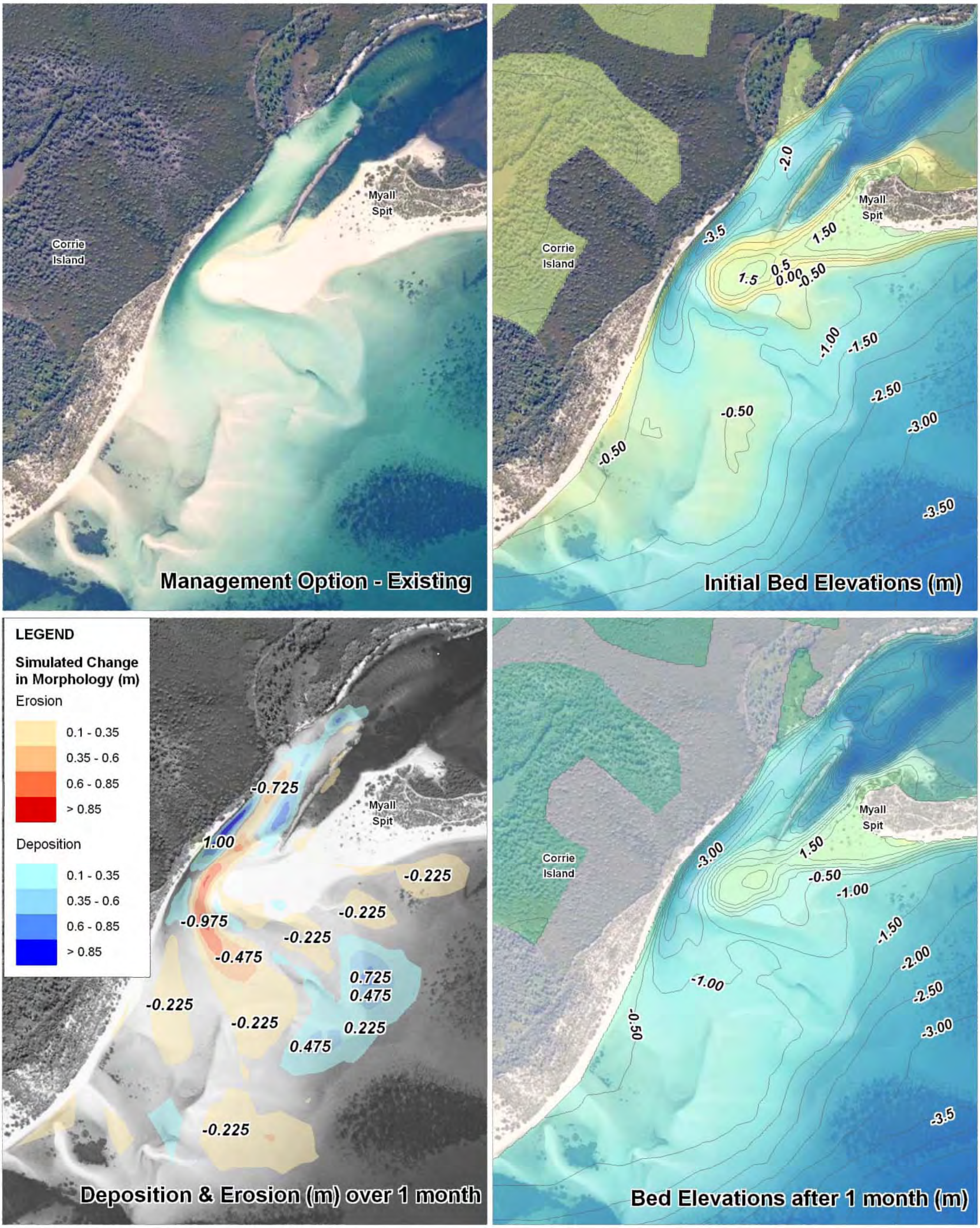
Accretion patterns for all simulations are reasonably consistent, showing deposition of eroded sediments on the ocean side of the shoals, in slightly deeper water. There was also little difference in erosion and accretion patterns on the river side of the entrance region, or within the broader Lower Myall River environs.

An alternative analysis, involving transects across the bed, has been undertaken. The locations of the adopted transects are shown on Figure 5-14. Charts showing the changes of bed elevations along those transects during the simulation are shown on Figure 5-15 through Figure 5-18 for transects 1 through 4 respectively.

This analysis also shows there is significant simulated re-adjustment in all of the dredging options, and the existing conditions scenario.

Furthermore, the entrance morphology response to episodic events has not been considered, and it is these extreme events that may be more significant in terms of the longevity of works.

Further afield, no significant changes to morphology were modelled for Dredge Option A or the existing scenario. In Dredge Options B and C, deposition and erosion was modelled at the end of the Northern Channel, on the southern corner of the Northern Channel where the channel enters Pindimar Bay. In addition deposition and erosion were also observed on the southern corner of the Northern Channel, where the channel enters the confluence region, and the northern corner of Winda Woppa Spit directly opposite the confluence, with similar rates. The patterns of erosion and accretion for all four areas are shown in Figure 5-19 for Option B. Similar values of erosion and accretion were simulated for Option C. These erosion and deposition patterns are related to the redistribution of tidal flows and velocities through entrance area.



Title:

Management Option Existing Case - Simulated Changes to Morphology

Figure: **5-10**

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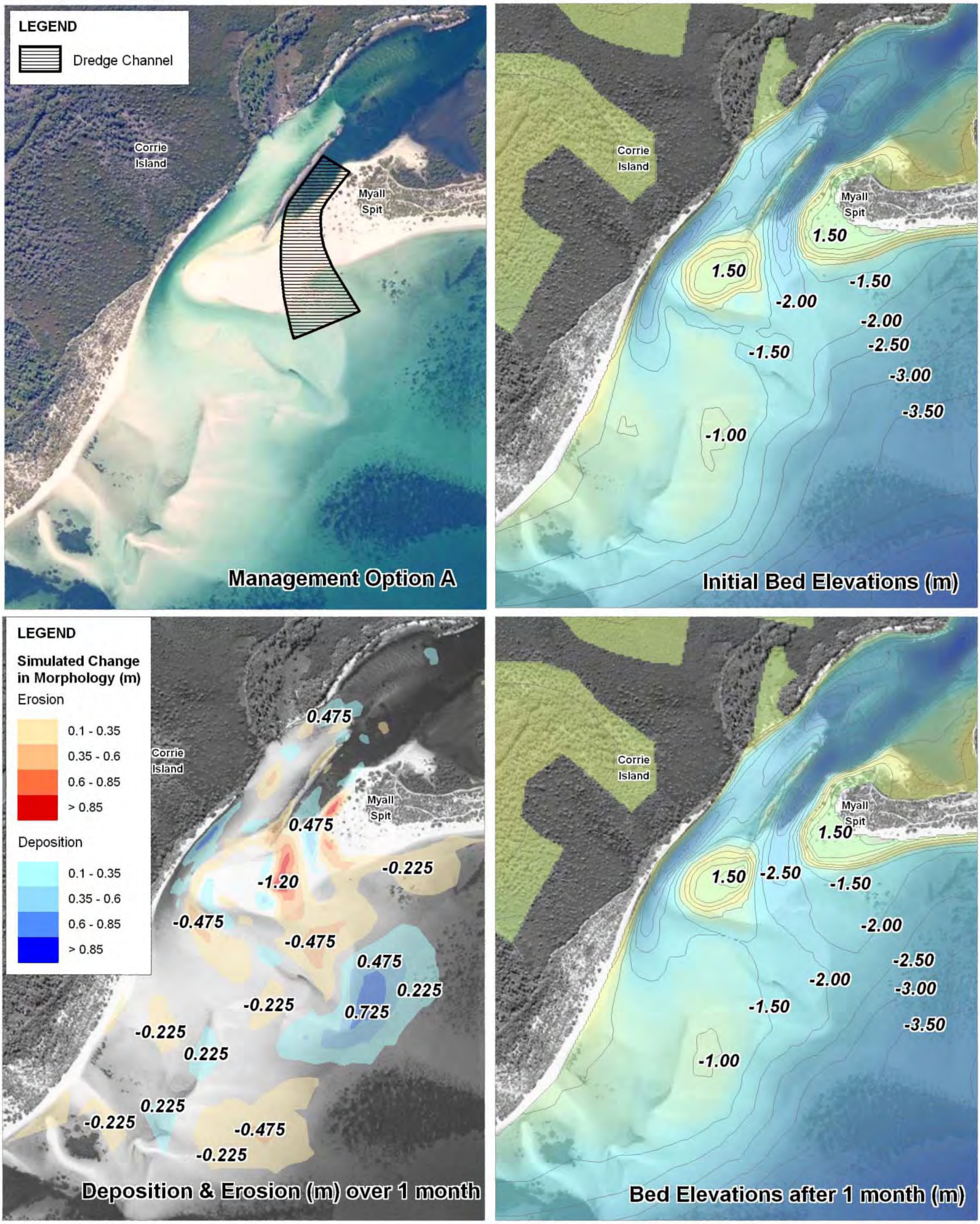

Title:

Management Option - Dredge Option A
Simulated Changes to Morphology

Figure: **5-11**

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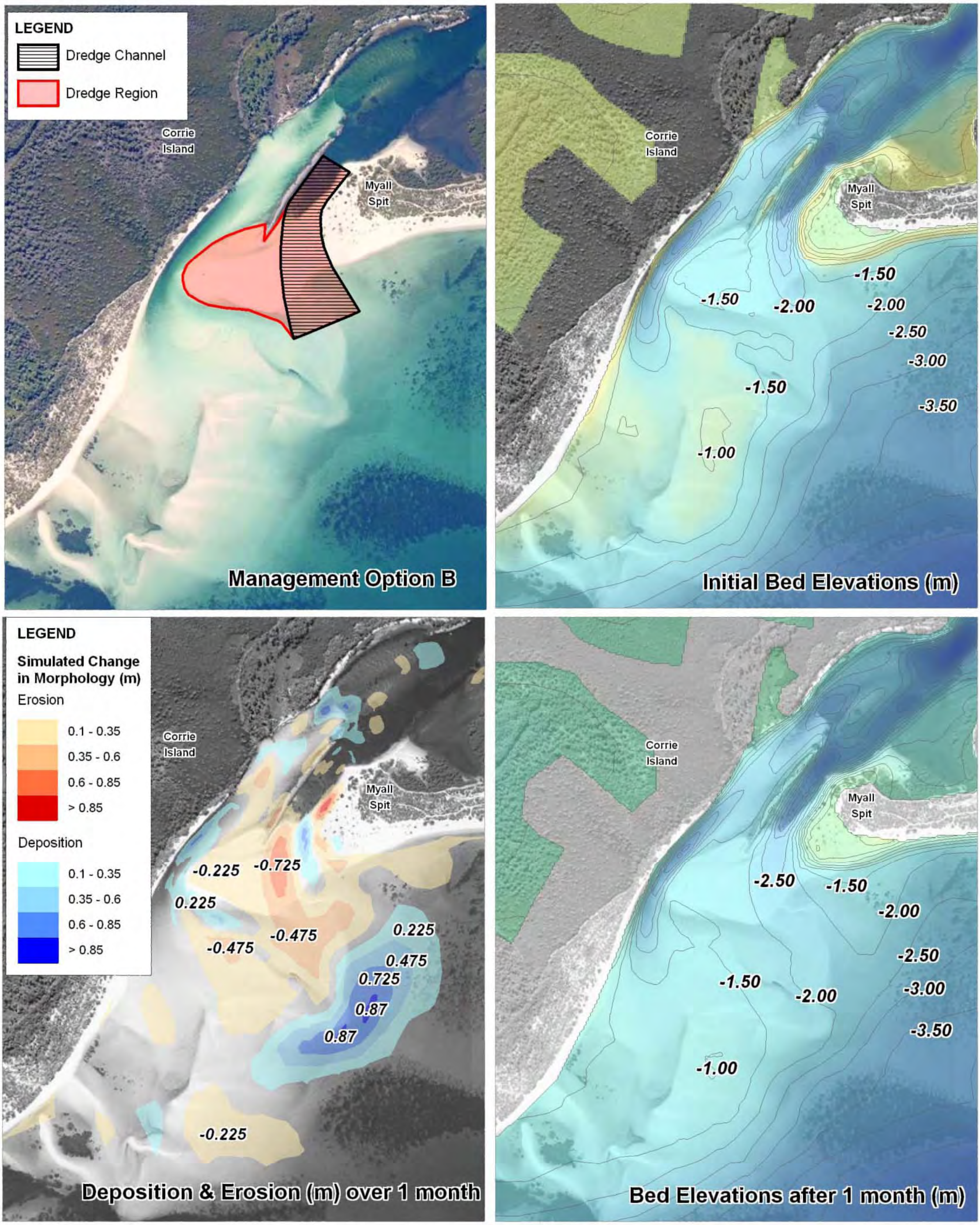

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Management Option - Dredge Option B
Simulated Changes to Morphology

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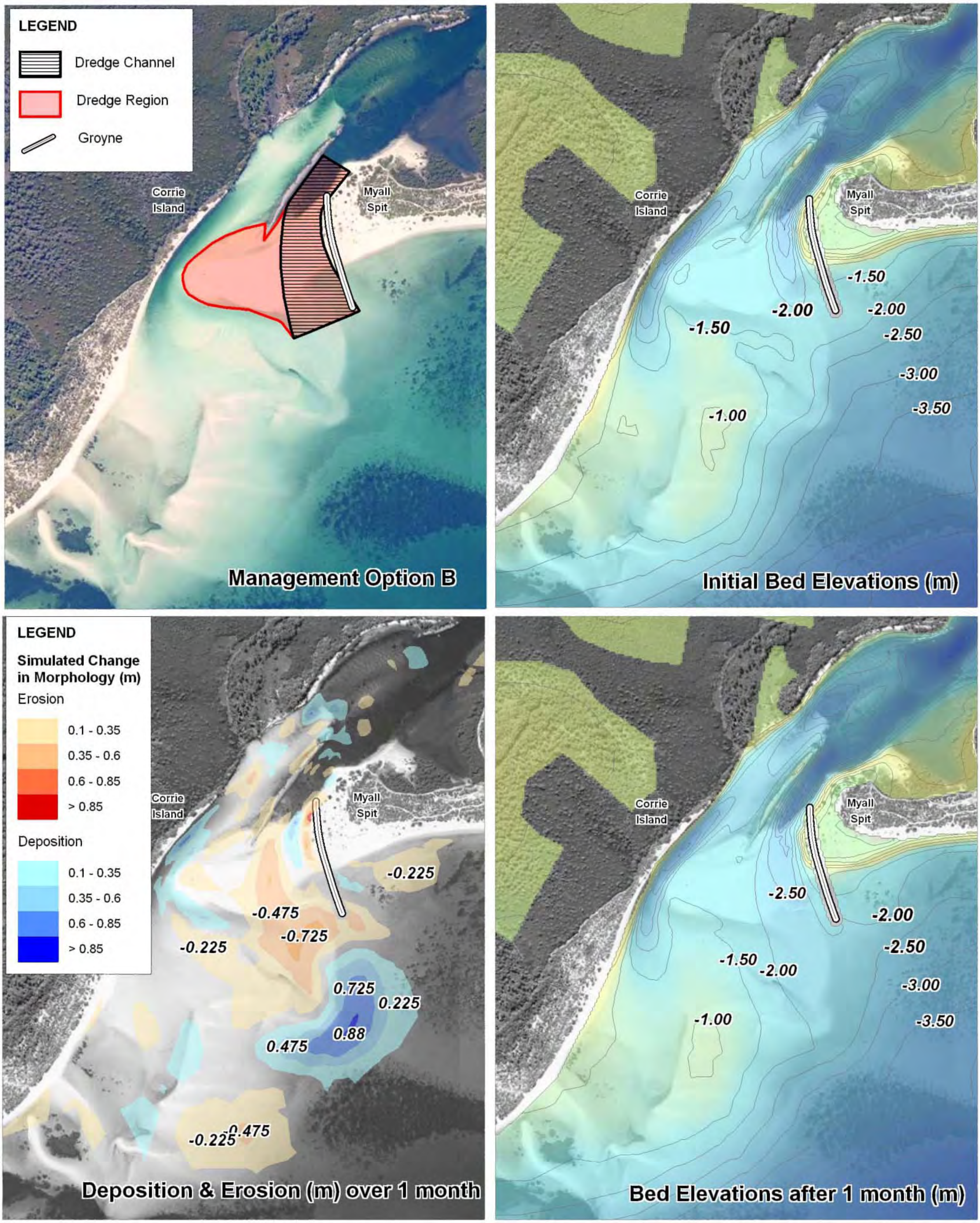

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Management Option - Dredge Option C
Simulated Changes to Morphology

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Title:

Transect locations for morphology modelling results

Figure: **5-14**

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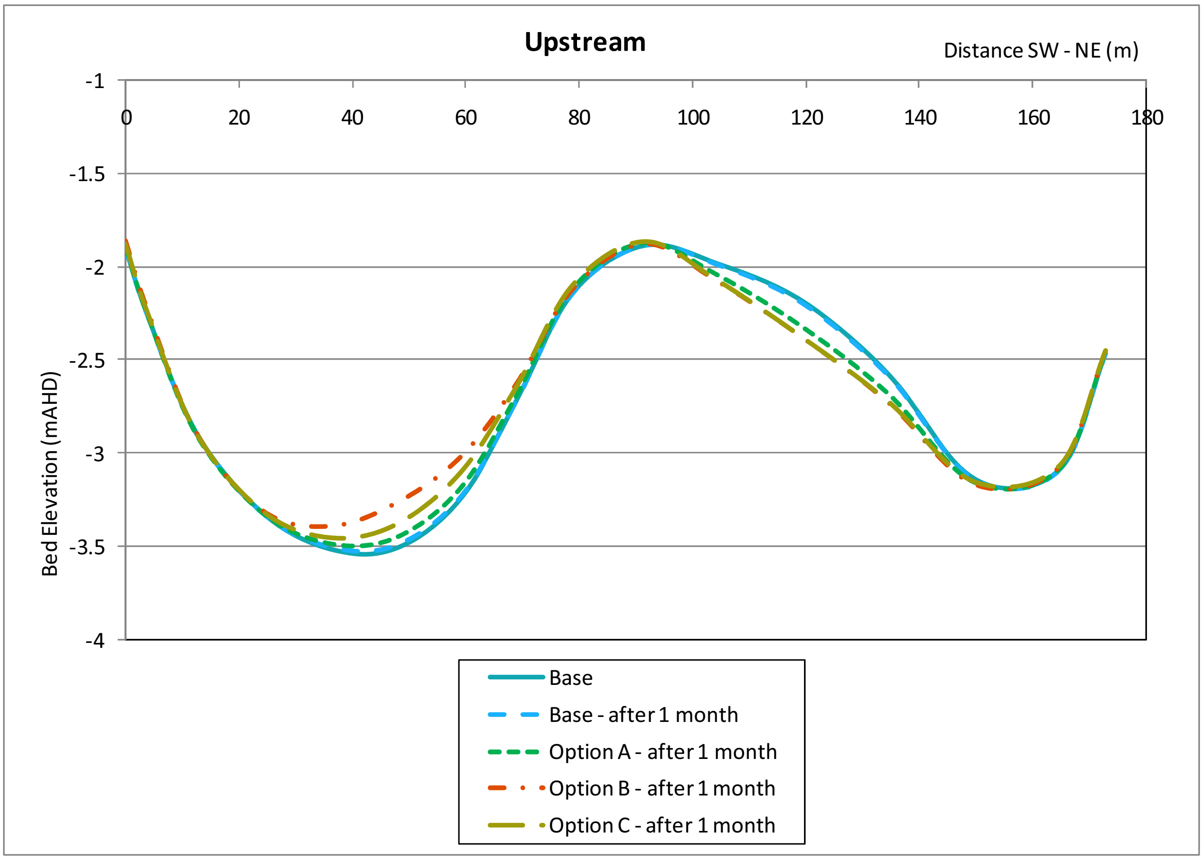


Figure 5-15 Changes to bed elevations at Transect 1

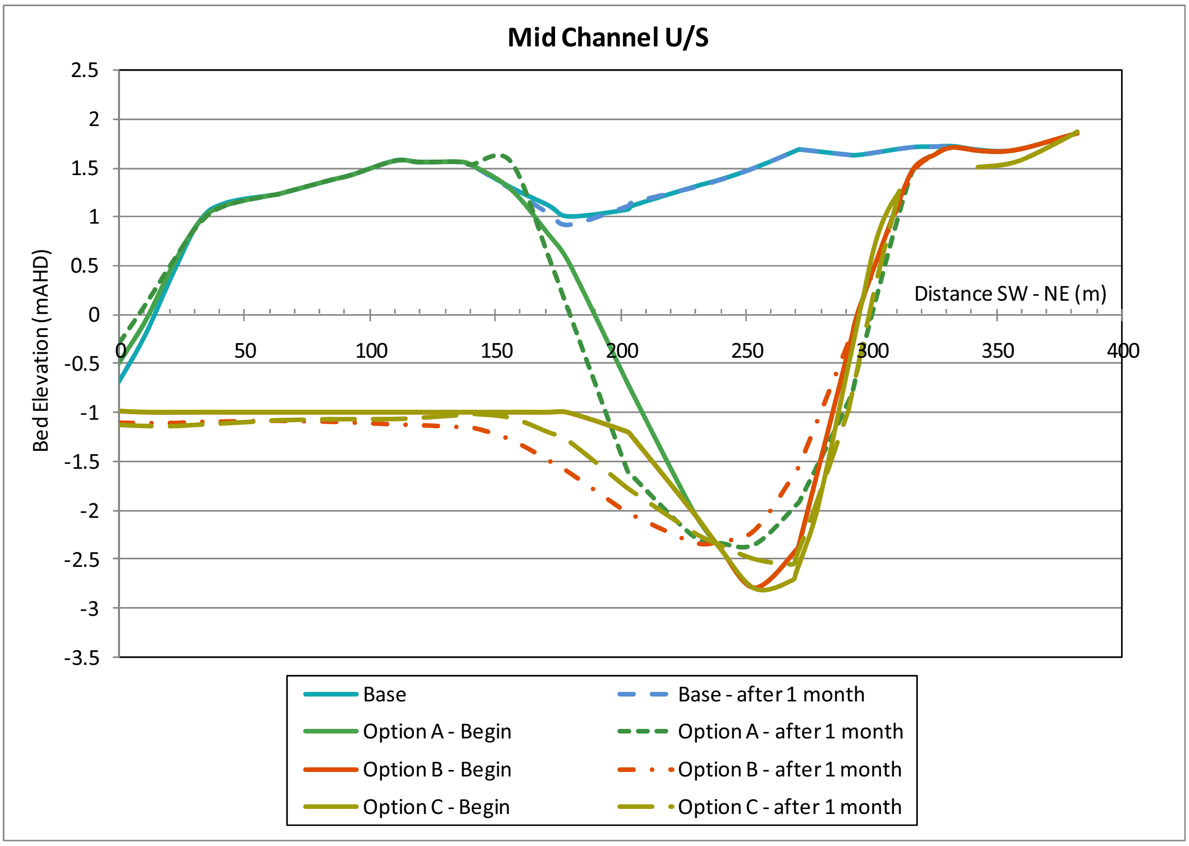


Figure 5-16 Changes to Bed Elevations at Transect 2

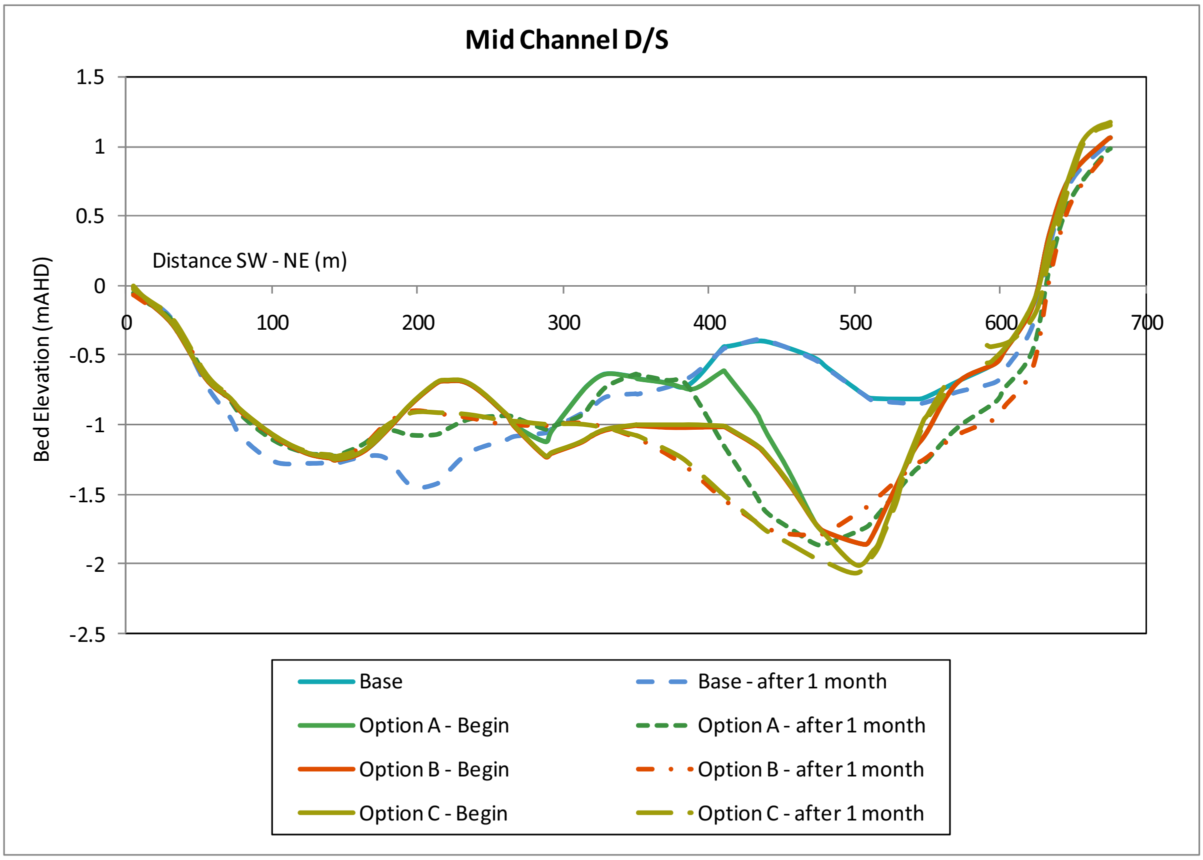


Figure 5-17 Changes to Bed Elevations at Transect 3

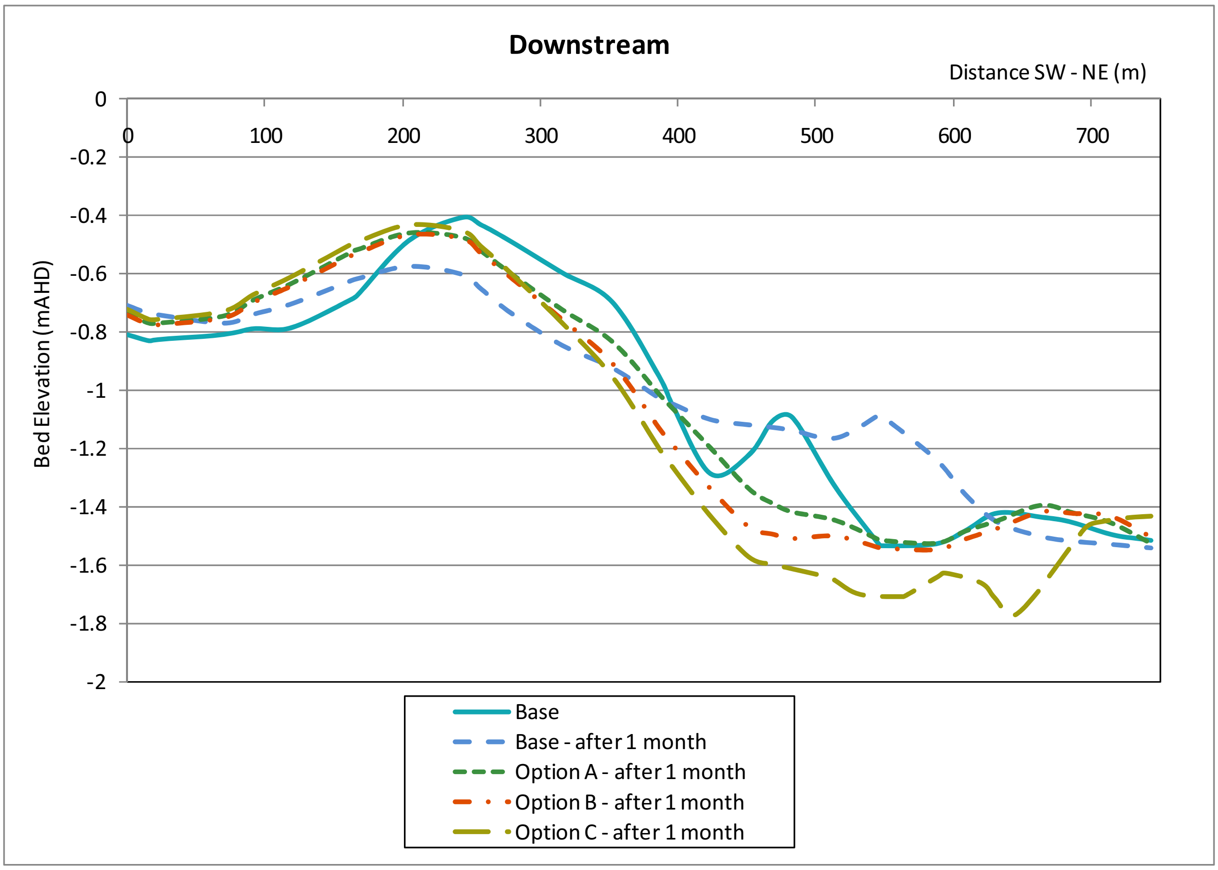
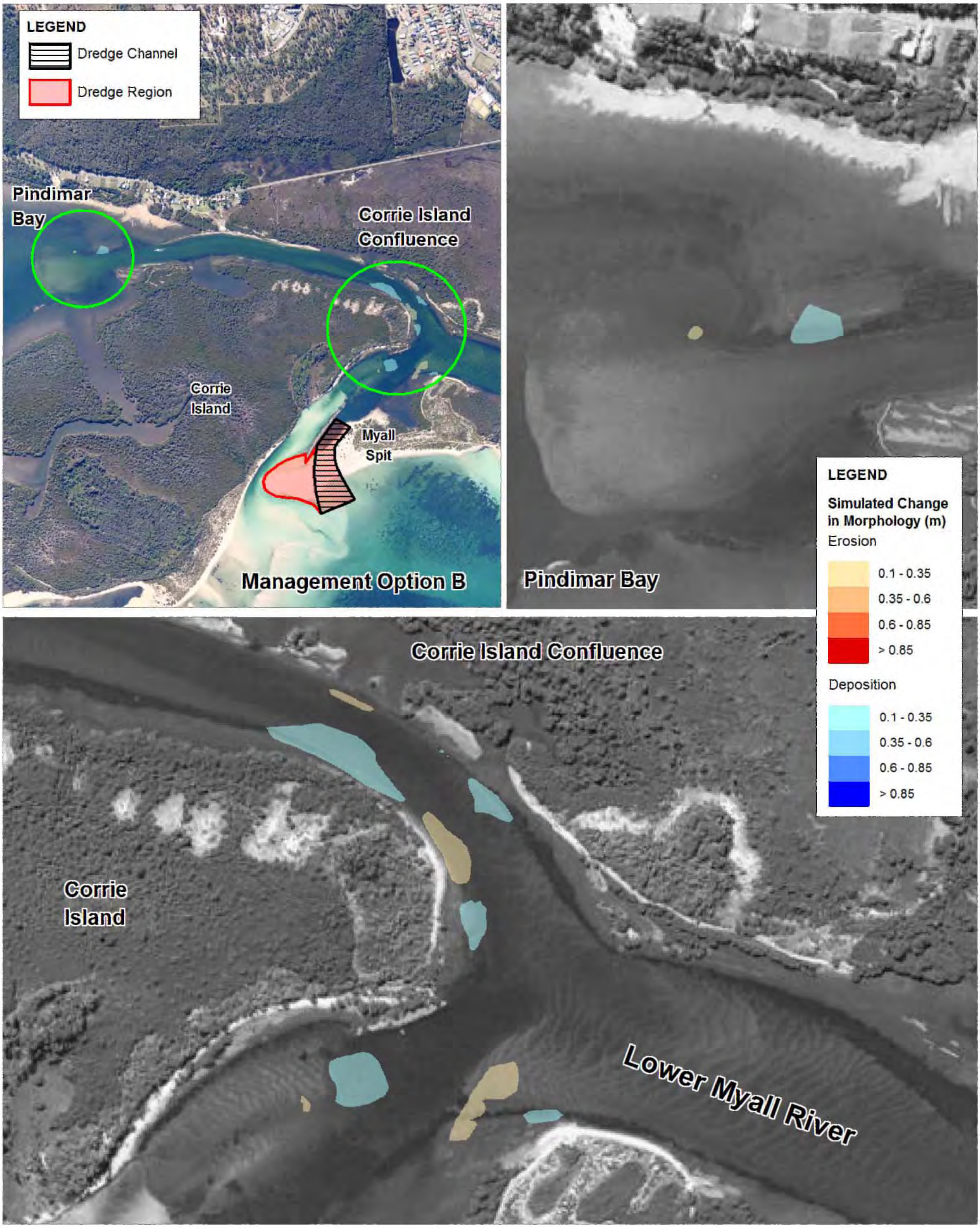


Figure 5-18 Changes to Bed Elevations at Transect 4



Title:

Simulated Morphological Changes further afield

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5.5.5.5 Impacts on Longshore Drift

Dredging of the Eastern Channel will not have any direct effect on longshore drift along the Winda Woppa spit shoreline, however, the options involving construction of a groyne and placement of dredged material on the shoreline west of Barnes Rock are expected to impact on longshore transport rates.

Longshore sediment transport generated by swell waves on Jimmys Beach and the foreshore west of Barnes Rock has been calculated to be an order of magnitude larger than longshore transport under the action of wind generated waves. Furthermore, wind-generated longshore transport can occur in both directions, depending on prevailing wind conditions, whereas swell-generated transport is largely from the one direction given the limited window of exposure to swell through the entrance to Port Stephens.

For Options A, B & D, the longshore drift would not be notably different than under existing conditions. For Option C, however, the construction of the groyne will result in shoreline deposition on the updrift (eastern) side of the structure, which will realign the shoreline more perpendicular to the direction of the incoming swell waves. This will reduce the rate of longshore transport along the shoreline. Based on estimated longshore transport rate of up to 15,000m^3/yr, the groyne could reach a maximum sand volume within about 4 – 5 years, after which time the groyne would bypass and deliver sand into the entrance channel. However, as the shoreline adjusts, it will align itself more to the incoming swell wave direction, and transport rates will decrease. For this reason the time taken to bypass the groyne may be somewhat longer, although this depends significantly on the frequency and nature of coastal storms and large winds over the years following construction. Analysis of the probabilities related to various bypassing times would need to be undertaken using a model of shoreline evolution, during detailed design of the groyne, if required.

Placement of sand onto Jimmys Beach is unlikely to have a significant impact on the longshore drift occurring west of Barnes Rock and into the Eastern Channel. Whilst there may be some scope for small amounts of westerly sand migration behind Barnes Rock (Vila-Concejo et al, 2007), this study considers that the sediment processes on Jimmys Beach are largely disconnected from the Myall River entrance.

Placement of dredged sands onto the foreshore west of Barnes Rock is expected to have an impact on local longshore drift. Any changes to alignment of this section of the shoreline would alter the obliquity of waves as they strike the shoreline. This wave obliquity is the primary driver for longshore transport. Placement of sand on this section of the shoreline would at least maintain existing rates of longshore transport (i.e. up to 15,000m^3). Given the unconsolidated and unvegetated nature of the deposited spoil, transport rates could be higher.

5.5.5.6 Impacts on Aquatic Ecology

Direct impacts of the dredging options would be restricted to the immediate areas of dredging and placement activities. Most of the dredge footprint comprises unvegetated sand (both subaqueous and subaerial). Benthic fauna present within the sandy material would be directly impacted. Similarly, for the proposed placement areas, which again contain mostly unvegetated sand, existing benthic fauna would be smothered by the nourishment works. It is expected that mortality rates would be high for benthic fauna directly impacted, however, as the dredging and placement footprints are relatively small in a local context, this loss would not be considered detrimental. There may also be some loss of small patches of existing seagrass (refer previous discussion in Section 2.1.6 and Figure 2-5). These impacts would need to be confirmed through the course of a more detailed environmental impact assessment for any proposed works.

5.5.5.7 Impacts on Terrestrial Ecology

Possible dredging or nourishment works would not have any direct impact on fringing terrestrial ecology. When considering indirect effects, however, impacts on terrestrial habitats will occur associated with continuing recession of foreshores west of Barnes Rock and the eastern shore of Corrie Island. The ‘do nothing’ option is expected to have continuing erosion of both these areas. All channel dredging options (A, B, C & D) are expected to relieve erosional stress on the Corrie Island foreshore, which should reduce future recession. Options that involve placement of sand on the foreshore west of Barnes Rock would additionally relieve erosional stress on this section of the foreshore.

5.5.5.8 Impacts on Ecosystem Health and Community Structure

As outlined previously, DECCW (2010) concludes that the existing shoaled condition of the Eastern Channel has not had a detrimental effect on the water quality and overall condition or health of the Lower Myall River. As such, improvements in the degree of oceanic flushing of the River borne out by the various dredging options for the Eastern Channel would not necessarily improve the already healthy condition of the estuary. The impact of the ‘do nothing’ option, which assumes complete closure of the Eastern Channel, on ecosystem health of the Lower Myall River, is not known. Based on comparable locations elsewhere in Port Stephens, it can be hypothesised that the impacts of channel closure would be limited. Nonetheless, if such circumstances occur, then further ecological investigations should be carried out and compared with the DECCW (2010) study, to quantify any impacts.

As outlined in Section 5.5.5.3, the dredging options could potentially modify the salinity structure of the lower sections of the River, with slightly more saline conditions with the Eastern Channel dredged, and less saline conditions if the Eastern Channel closes. Salinity within the Lower Myall River is already variable, with communities adapted to such conditions. It is expected therefore that the overall tendency for more saline conditions in the River associated with the dredging options would not have a significant impact on the estuarine community structure, although it may tend to be slightly more favourable for marine species if dredged, and less favourable for such species if left to close.

It should be recognised that marine species would occupy the Lower Myall River opportunistically only, when conditions are suitable within the estuary.

5.5.5.9 Other Considerations

<u>Option C: Construction of a Groyne</u>

The construction of a hard structure, such as a groyne, within an environment as dynamic as the Lower Myall River will invariably have impacts that are not readily apparent. History shows that most coastal structures have resulted in unintended consequences in the form of erosion or changes to sediment dynamics and morphological responses.

Hard structures tend to be easily placed but notoriously difficult to remove. As such, the construction of a groyne at the end of Winda Woppa Spit would have to be considered in a permanent context. As the local sediment dynamics and hydrodynamic environment changes with time, the influence of the groyne will also change. Thus, the construction of a permanent structure is a 'leap of faith' that the environment in the future will be largely similar to that experienced today. In such a dynamic location, and considering the potential for future climate change, there is much uncertainty regarding the future environment. Such a 'leap of faith' may be unsupported.

Options A – D: Nourishment of Jimmy's Beach

As outlined previously, the sediment processes acting on Jimmy's Beach are largely independent of the sediment processes acting within the Eastern Channel and along the foreshore west of Barnes Rock. Placement of sand from the channel onto Jimmy's Beach would represent an 'external' source of sand to the Jimmy's Beach sediment cell. While nourishment has occurred on Jimmy's Beach for several decades, there is still significant uncertainty regarding the fate of such nourishment material.

Options involving the placement of sand on Jimmy's Beach should be approached with caution and should be accompanied by a detailed sediment dynamics assessment for the Jimmy's Beach sediment cell. It is understood that the NSW Government has allocated funds for further investigations into the long-term management plan of Jimmy's Beach, including nourishment sources and fate of sediments. Any assessment undertaken by the NSW Government should include the option of sand extraction from the Eastern Channel, either as one-off dredging campaigns, or as an 'on-demand' sand pumping system (e.g. sand shifter). The assessment should also consider the same approach and configuration (including a fixed in place sand pumping system) for extraction from alternative sand sources, including the Yacaaba sand deposit currently used for nourishment purposes.

5.5.6 Evaluation of Longevity of Works

The morphodynamic assessment (refer Section 5.5.5.4) highlights the dynamism of the area, with significant areas of sediment erosion and accretion under all modelled scenarios, including the existing conditions (emphasising a near-constant imbalance given the ever-changing influences of waves, tides, wind and floods). It is therefore very difficult to determine the expected longevity of any dredging and nourishment works undertaken.

In order to provide a ball park indication of longevity, the longshore transport rates west of Barnes Rock have been used to determine approximate rates of channel infill. This is considered reasonable in the first instance, as this mechanism is introducing an external source of sand to the entrance area.

Longshore sediment transport potential has been estimated to be up to about 15,000m^3. For nourishment onto Jimmys Beach, and in the absence of a groyne at the end of Winda Woppa spit (i.e. Dredge Options A, B & D), it can be assumed that sediment would be reworked into the Eastern Channel at a rate of about 10 – 12,000m^3 per year. For nourishment onto the shoreline west of Barnes Rock, this could increase up to the maximum potential of around 15,000m^3. Following an initial readjustment period, Dredge Option D would aim to extract sand at a rate in the order of 10,000m^3 per year, and place the material on Jimmys Beach as well as the foreshore west of Barnes Rock, as required.

If a groyne is constructed, then there would be a period of time that the groyne would fill before bypassing of sand into the Eastern Channel. The potential volume of sand that can be stored by the groyne is approximately 70,000m^3.

Approximate estimates of durations for 50% infill of the dredged volume are presented in Table 5-3. These durations should be interpreted with caution, and are provided mostly for comparative purposes.

Table 5-3 Approximate Longevity of Short-Listed Options to Reach 50% Infill of Dredging

	Jimmys Beach nourishment	West of Barnes Rock nourishment
Dredge Option A (55,000m^3)	2.5 – 3 yrs.	2 yrs.*
Dredge Option B (95,000m^3)	4.5 – 5 yrs.	3 yrs.*
Dredge Option C (95,000m^3 + groyne)	11.5 – 12 yrs.	8 yrs.*
Dredge Option D (55,000m^3 + pumping)	Would not reach 50% infill if sand is regularly pumped ashore	

Note

* Sand placed on the foreshore west of Barnes Rock will be influenced by swell waves and will be eroded and reworked back into the Eastern Channel. As such, the longevity of dredging works that involve placement of sand onto this foreshore would is lower than if the sand was placed external to the 'sediment cell' (e.g. onto Jimmy's Beach, where sand is not reworked back into the Eastern Channel).

5.5.7 Evaluation of Economic Impacts

5.5.7.1 Benefits

Economic benefits of the short-listed options are difficult to calculate. Rather than enhancing the local economy, the potential works may simply maintain status quo. But this would need to be compared to the 'do nothing' scenario, whereby the continuing shoaling and potential closure of the channel may have an adverse impact on tourism and boating related income in Tea Gardens, and particularly if the River continues to deteriorate in clarity and amenity.

The significance of the River to the local community also incorporates a range of intangible factors, which cannot easily be evaluated purely on an economic scale.

5.5.7.2 Capital Costs

Approximate capital costs for the short-listed options are presented in Table 5-4. Cost differential between nourishment on Jimmys Beach versus nourishment west of Barnes Rock relates to the additional pumping distance for the dredged material.

Table 5-4 Approximate Capital Costs for Short-listed Options

CAPITAL COSTS	Jimmys Beach nourishment	West of Barnes Rock nourishment
Dredge Option A (55,000m^3)	\$2.0 m *	\$1.5 m
Dredge Option B (95,000m^3)	\$3.2 m *	\$2.5 m
Dredge Option C (95,000m^3 + groyne)	\$6.2 m *	\$5.5 m
Dredge Option D (55,000m^3 + Sand Shifter)	\$2.8 m*	\$2.3 m

** There is potential for these costs to be offset by separate funding for Jimmys Beach nourishment works.*

5.5.7.3 Maintenance Costs

Estimated on-going costs for maintaining an open entrance through the Eastern Channel are provided in Table 5-5. Although transportation to Jimmys Beach would involve a longer distance, and hence higher costs, if the shoreline west of Barnes Rock was nourished, then the demand for maintenance would be greater, and the longshore transport rate would be higher.

Table 5-5 Approximate Maintenance Costs for Short-listed Options

MAINTENANCE COSTS	Jimmys Beach nourishment	West of Barnes Rock nourishment
Dredge Option A (55,000m^3)	\$280,000 * p.a.	\$360,000 p.a.
Dredge Option B (95,000m^3)	\$300,000 * p.a.	\$380,000 p.a.
Dredge Option C (95,000m^3 + groyne)	\$130,000 * # p.a. for 10yrs, then \$300,000 p.a. thereafter	\$160,000 # p.a. for 6yrs, then \$380,000 p.a. thereafter
Dredge Option D (55,000m^3 + Sand Shifter)	\$150,000 * p.a.	\$150,000 p.a.

** There is potential for these costs to be offset by separate funding for Jimmys Beach nourishment works.*

 # Maintenance works may involve extracting material in the dry from in front of groyne instead of waiting for channel to infill. This would require a more frequent (but potentially cheaper) program of maintenance works.

Costs are estimates only and are provided in present dollar terms. Lower maintenance costs are achieved for Dredge Option C only until the groyne fills and starts to bypass sand directly into the channel. The construction of a groyne does introduce the ability to extract sand on the shoreline (i.e. remove sand trapped in front of the groyne) as an alternative to removing sand accumulated within the channel, however, this would need to happen before the sand starts to bypass the groyne in order to avoid accumulation within the channel. Removal of sand from the shoreline could potentially save significant effort and costs (especially mobilisation costs) for on-going dredging within the channel. It is expected, however, that the dynamics of sediment within the channel and entrance area would still require some degree of channel dredging from time to time.

As discussed previously, the installation of a Sand shifter sand pumping system would provide a relatively low-cost mechanism for maintenance works within the channel.

5.5.7.4 Total Cost Comparison

A rudimentary total cost comparison has been carried out to provide an indication of the relative value of the different options presented, including the 'do nothing' option. Costs over 10 year and 20 year periods have been considered, based on present dollar value (Table 5-6). Costs compared also include the costs of managing of Jimmys Beach through on-going nourishment.

This cost comparison shows that over 20 years, Option D with nourishment of Jimmys Beach would have approximately the same cost as the expected costs of nourishing the beach irrespective of any Eastern Channel dredging works. That is, for little or no additional cost, the Eastern Channel can be used as an alternative source of nourishment material for Jimmys Beach, while providing the additional benefit of maintaining a more open channel configuration.

5.5.8 Evaluation of Social Impacts

Benefits and costs associated with the social and community aspects of the short-listed options have not been evaluated in detail. Engagement with the MRAG during the project has provided an indication of preferences for particular solutions, however, it is envisaged that more extensive consultation during the public exhibition of this document will reveal a wider community perspective.

From discussions to date with community members, an important element of the Lower Myall River entrance solution would be integration with the wider issues of Jimmys Beach. Although there may not be a strong connection between the processes causing erosion of Jimmys Beach and the processes causing shoaling in the Eastern Channel, the opportunity to address both issues in tandem is particularly attractive.

Table 5-6 Total Costs Comparison after 10 Years and 20 Years (Present Dollar Value)

	$ '000,000s			
	After 10 years		After 20 years	
	Eastern Channel only	Eastern Channel and Jimmys Beach Combined	Eastern Channel only	Eastern Channel and Jimmys Beach Combined
Do nothing	0	2.5 *	0	5.0 *
Option A: Jimmys nourish	4.8	4.8	7.6	7.6
Option A: west of Barnes Rk	5.1	7.6	8.7	13.7
Option B: Jimmys nourish	6.2	6.2	9.2	9.2
Option B: west of Barnes Rk	6.3	8.8	10.1	15.1
Option C: Jimmys nourish	7.5	7.5	10.5	10.5
Option C: west of Barnes Rk	7.1	9.6	10.9	15.9
Option D: Jimmys nourish	4.3	3.8 #	5.8	5.3 #
Option D: west of Barnes Rk	3.8	6.3	5.6	10.6

** Assumes an on-going demand of 15,000m^3 per annum at a cost of approx. \$15/m^3, based on historical rates of nourishment and most recent costs.*

 # Assumes that the first 3 years do not require on-going costs, as Jimmys Beach nourishment demand is met by the placement (and possible storage) of material from the initial capital dredging works.

5.6 Summary of Options Assessment

A summary of the options considered as part of this assessment is provided in Table 5-7. This table recaps the environmental, social and economic impacts of Dredge Options A to D, compared with the 'Do Nothing' scenario.

As presented in the table, the 'do nothing' option may have some environmental and social consequences that could be overcome by the dredging options (particularly A, B and D). When considered in combination with the costs for on-going nourishment of Jimmys Beach, Dredge Option D is comparable to the 'do nothing' option, while all other dredging options are notably more expensive. Subject to more detailed assessments, Dredge Option D would appear to be virtually a no-regrets option when considered over a longer time period (20 + years).

Table 5-7 Summary of Options Assessment

Options	Environmental	Social	Economic
Do nothing	Eastern Channel will eventually close, and oceanic flushing in the river will be reduced. The resulting change to ecosystem health of River is unknown, but is likely to be limited. There will be continued shoreline recession west of Barnes Rock, while Corrie Island will likely continue to erode until the channel closes.	When the Eastern Channel closes, there may be a reduction in aesthetics (water clarity) and amenity of river, while navigation through the channel will be prevented. There may be some community backlash when the channel closes.	If the channel closes, there may be economic loss associated with tourism and boating industry. Costs for doing nothing range from $0 to $5m over the next 20 years, depending on whether on-going costs for nourishing Jimmys Beach are included.
Dredge Option A ($55,000m^3$)	There would be no significant improvement in environmental conditions compared to existing. The works may reduce the propensity of future shoreline recession and associated vegetation and habitat loss on Corrie Island and west of Barnes Rock.	The amenity and aesthetics of the river (water clarity) may be improved compared to existing conditions. There would be the potential for improved navigation through the channel, but not assured.	Costs of capital dredging and on-going maintenance dredging to keep the channel open would cost between $7.6m and $8.7m over the next 20 years, depending on where the sand is placed. If sand is not placed on Jimmys Beach, then the on-going cost of nourishing Jimmys Beach would be additional.
Dredge Option B ($95,000m^3$)	As above for Dredge Option A	As above for Dredge Option A	Costs of capital dredging and on-going maintenance dredging to keep the channel open would cost between $9.2m and $10.1m over the next 20 years, depending on where the sand is placed. If sand is not placed on Jimmys Beach, then the on-going cost of nourishing Jimmys Beach would be additional.
Dredge Option C ($95,000m^3$ + groyne)	As above for Dredge Option A. There may be some detrimental effects of on the environment associated with construction of a hard groyne structure. There is also a high degree of uncertainty regarding the potential impacts given the dynamism of the coastal environment.	As above for Dredge Option A. Visual amenity may be impacted by the groyne structure, affecting the 'natural' feel of the area.	Costs of capital dredging and on-going maintenance dredging to keep the channel open would cost between $10.5m and $10.9m over the next 20 years, depending on where the sand is placed. If sand is not placed on Jimmys Beach, then the on-going cost of nourishing Jimmys Beach would be additional.

Options	Environmental	Social	Economic
Dredge Option D ($55,000m^3$ + Sand shifter)	As above for Dredge Option A	As above for Dredge Option A	Costs of capital dredging and on-going maintenance dredging to keep the channel open would cost between $5.3m and $5.8m over the next 20 years, depending on where the sand is placed. If sand is not placed on Jimmys Beach, then the on-going cost of nourishing Jimmys Beach would be additional.

5.7 Further Considerations

The evaluation of short-listed options presented in this report represents a preliminary or first-pass assessment of somewhat idealised conditions (both in terms of dredging and placement). It is envisaged that if any options are to be pursued further, then additional investigations would be required to address various unknowns, including:

- The ideal size of channel to optimise tidal flows and self-scour (to minimise channel infill). It is noted that the morphodynamic simulations suggest a widening of the dredged channel within a relatively short period of time. Therefore, there may be consideration of having a wider channel initially.
- A suitable amount of over-dredging, or "insurance dredging", to cater for a certain degree of channel infill without compromising the objectives of the channel. It is considered, however, that excessive over-dredging will simply promote more rapid infill of the channel, so detailed analysis will be required to optimise design.
- Consideration of land-based operations for dredging, including suitable dredge settlement ponds, and return flows to the waterway, if the material is not to be placed directly onto foreshores (either on Jimmys Beach, or west of Barnes Rock).
- The suitability of the sand for placement on Jimmys Beach. There may be some minor difference in sediment characteristics, however, the consequence of any difference on the response of the shoreline profile would need to be assessed.
- The potential impacts of placement of 'external' sand on Jimmy's Beach, as discussed in Section 5.5.5.9.

6 RECOMMENDED NEXT STEPS

6.1 Overview

Table 6-1 provides a quick reference summary of the major issues that affect the Lower Myall River entrance both now, and theoretically once the Eastern Channel closes.

Jimmys Beach nourishment is an on-going issue for Council and the State Government. Although not directly affecting the Lower Myall River entrance, there is potential that sand build-up within the Eastern Channel can be used as a source of nourishment sand. Sediment processes on Jimmys Beach and the Lower Myall River are essentially disconnected. Therefore, closure of the Eastern Channel would have no impact on the demand for nourishment on Jimmys Beach.

As explained previously in this report, DECCW (2010) concluded that water quality and ecosystem health of the Lower Myall River is not currently degraded. It is uncertain whether this would still be the case when and if the Eastern Channel closes, given the changes in oceanic flushing that would result.

Aesthetics and amenity of the river are expected to be lower than in the recent past due to poorer water clarity (most likely resulting from reduced oceanic flushing). The lower reaches of the River were previously quite marine, with clear waters and a sandy bed. Higher levels of tannin are now present in the river, indicating more estuarine conditions with more prominent freshwater and groundwater influences. When and if the Eastern Channel closes, it is expected that water clarity would be reduced further, given the predicted reduction in oceanic flushing.

Shoreline erosion is a current issue both on the eastern foreshore of Corrie Island, and west of Barnes Rock. In both these locations, erosion is currently impacting on vegetation and degrading local wetland habitat values. Corrie Island is a Ramsar-listed wetland, and will continue to erode until the Eastern Channel closes. Meanwhile, erosion west of Barnes Rock will continue irrespective of the condition of the Eastern Channel. Erosion in this area is in response to the natural realignment of the shoreline based on the approaching dominant ocean swell waves. Much greater erosion of this shoreline can therefore be expected in the future, including a potential breakthrough across the Winda Woppa Spit into the Myall River.

Table 6-1 Relevance of Issues

Issue	Now ?	When Eastern Channel closes ?
Water quality & ecosystem health	No	Don’t know
Water clarity and aesthetics	Maybe	More likely
Shoreline erosion	Yes	Yes, but less likely on Corrie Island foreshore
Jimmys Beach nourishment	Yes	Yes

Recommended next steps for management of the Lower Myall River entrance area are outlined in the decision support framework given in Figure 6-1.

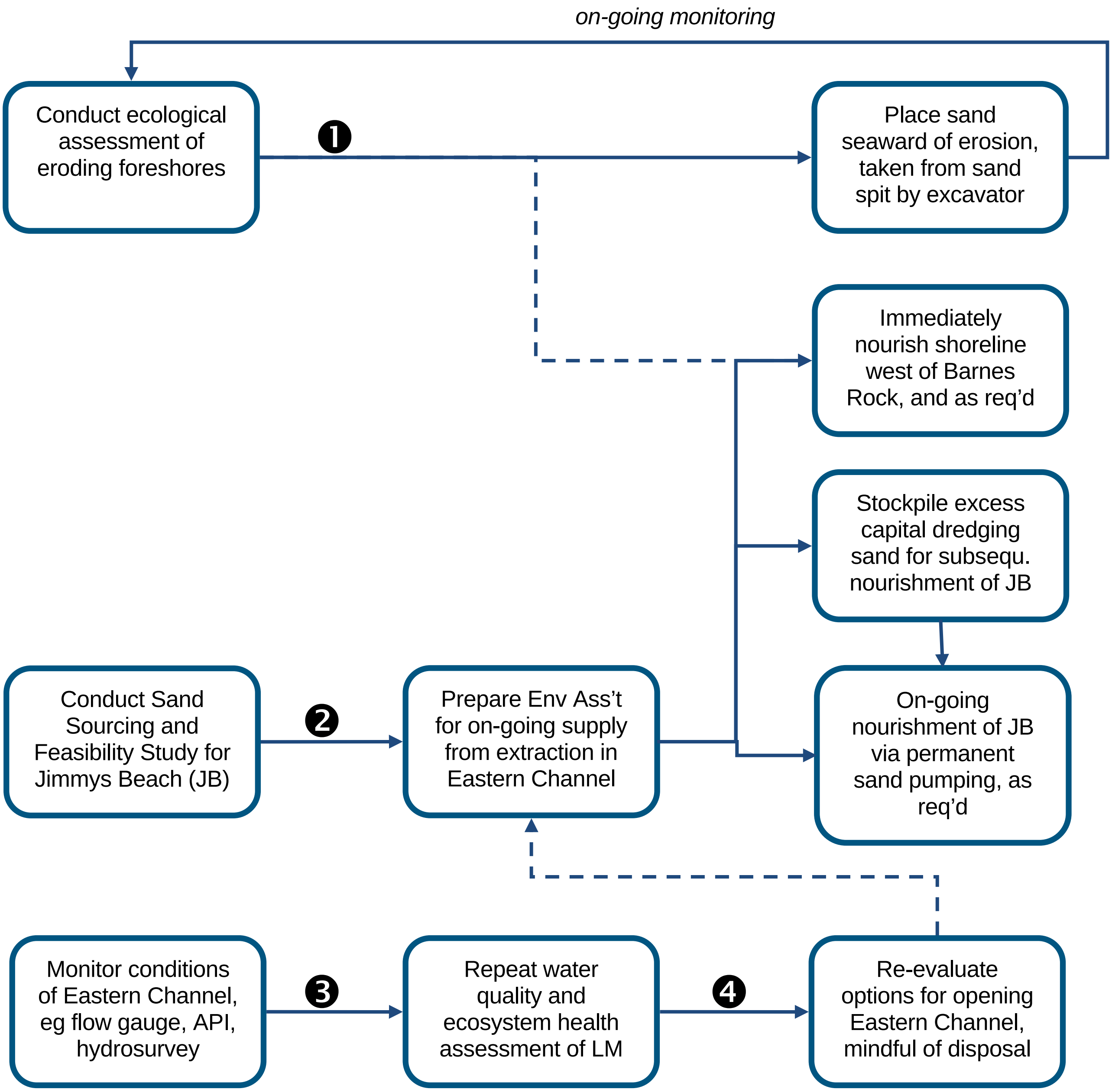

Figure 6-1 Recommended Decision Support Framework

Progression through the Decision Support Framework (Figure 6-1) is controlled by a series of gates, or 'triggers', identified as ❶❷❸❹, which are described further below.

Trigger ➊: If the ecological assessment indicates that the wetland habitats are being impacted significantly, then proceed to the next step, otherwise stop.

Trigger ➋: If the Sand Sourcing and Feasibility Study shows that dredging from the Eastern Channel is a viable and preferable long-term option for nourishing Jimmys Beach (both from an economic and environmental impact perspective), then proceed to the next step, otherwise stop.

Trigger ➌: If monitoring shows that the Eastern Channel has closed completely, then proceed to the next step, otherwise continue monitoring.

Trigger ➍: If the water quality and ecosystem health assessment of the Lower Myall River indicates that the health or condition of the river system has been degraded as a result of the closed channel, then proceed to the next step, otherwise stop.

If sourcing of sand for nourishment of Jimmys Beach from the Eastern Channel is indeed viable and a preferable option (i.e. Trigger ➋ is open), then a detailed *Eastern Channel Sand Sourcing Strategy* should be prepared, which aims to optimise the methods of extraction, delivery and placement of sand, as well as the location and size of extraction areas, and frequency of extraction. Placement of sand at multiple locations should be accommodated through various outlets within the discharge pipelines. The Strategy should also describe the conditions required for on-going extraction, triggered by a need for nourishment on Jimmys Beach, or possibly the need for nourishment west of Barnes Rock to protect existing wetlands (if determined to be a significant issue, as per Trigger ➊) or to maintain access to the end of Winda Woppa Spit to support sand sourcing infrastructure. In combination with the Strategy, relevant environmental assessment documents and approvals / consents should be obtained, so that there is minimal delay in providing nourishment when required by Jimmys Beach (noting that a single storm event could deplete the beach of significant sand volume).

Monitoring of the success of the overall system would also need to be carried out to determine if operational changes to the on-going strategy are required.

6.2 Approvals and Consents

Any works associated with extraction of material from the Eastern Channel would require various approvals and consents from a range of authorities. The works would be carried out within the Port Stephens Marine Park, and near Ramsar-listed wetlands. A full Environmental Impact Statement (EIS) would be required, fully documenting the impact of the works to all physical, chemical, sedimentological and ecological processes. The EIS would also need to justify the works from an Ecologically Sustainable Development (ESD) perspective, as espoused by various Council, State and Federal Policies, as well as from an economic perspective. In this regard, consideration of the ‘do nothing’ scenario will be important, as a baseline comparison for the works.

It is envisaged that sea level rise and other climate change impacts would also need to be considered as part of the EIS. In this regard, adaptable and reversible options such as the Sand shifter, are particularly attractive when compared to other fixed hard engineering structures, such as groynes and seawalls.

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