Table 3.1 Summary of Main Historical Events and Associated Impacts

Event	Impact or Associated Impact on		
	Tidal Hydraulics	**Wave Propagation**	**Sediment Transport Process**
Ocean entrance training - removing shoals at entrance (late 1800's)	• Increased tidal range/tidal prism within estuary • Associated increase in flows and velocities	• Increased wave penetration to Salts Bay	• Reduction in direct supply of sand from beach system • Shoreline recession and realignment within Salts Bay with sand being transported into channel • General net upstream transport of sediment with erosion and accretion as channel tries to evolve to a new equilibrium
Swansea Bridge and reclamation of northern approach (late 1800's)	• Likely to have had minimal effect in the natural situation prior to entrance training • Became a significant constriction for the increased tidal prism and flows following entrance training • Associated large water surface gradients and velocities through section.	-	• High velocities resulted in significant scour under and near the bridge
Ocean entrance channel dredging (around 1981)	• Likely to have further increased tidal range, flows and velocities (outside dredged area) • Relatively small change compared with original training works • Impacts likely to have mitigated with subsequent shoaling	• Likely small increase in wave penetration to Salts Bay	• Associated small increase in sediment transport rates and exacerbation of requirements to reach tidal regime equilibrium. • Dredged channel subject to siltation.
Drop-over dredging with no reclamation or reclamation outside active tidal flows (various since 1950's)	• Likely to have further increased tidal flows and velocities through channel. • Change in overall flow distribution with more flow through the dredged channel. • Relatively small change compared with entrance training works. • Impacts likely to have mitigated with subsequent shoaling. • Dredging adjacent to Marks Point likely to have assisted the development of this as the dominant channel.	-	• Associated changes in sediment transport patterns with changes in velocities. • Exacerbation of requirements to reach new tidal regime equilibrium. • Dredged channel subject to siltation • Development of channel past Marks Point as the dominant flow path likely to have assisted erosion of adjacent reclaimed islands and could be influencing erosion processes at Pelican Flat.
Drop-over dredging with associated reclamation within a flow path (eg. Elizabeth Island) (various since 1950's)	• Impact dependent on balance between dredged flow area and blocked flow area. • Not likely to have resulted in a net reduction in overall flows. • Change in overall flow distribution with more flow through the dredged channel • Likely to have helped further development of channel past Marks Point as the dominant flow path	-	• Overall impacts to sediment transport processes remote from site likely to be less than with no reclamation. • Localised changes in sediment transport patterns as above.

Table 4.1 Sedimentation Related Entrance Channel Management Issues

Map Reference	Location	Management Issue	Cause	Discussion	Level of Community Concern
A	Main ocean entrance channel near Blacksmiths Point (See Plate 1 - Appendix H)	Poor navigability into/out of the estuary due to shoaling on north side and an exposed rock/coal seam on the southern side. The navigable depth is typically around 1.5m at low tide.	Shoaling occurs on the northern side under certain wave conditions. Inflow from the beach system is limited by the northern training wall and rocky foreshore to the south.	Navigation is generally between the shoal and the rock/coal seams and can therefore be quite dangerous. The ocean tides allow some use of tidal assistance for navigation but wave action can also reduce the effective depth. Dredging to provide a deeper channel has been carried out in the past but has subsequently infilled.	Medium
B	Entrance channel to Black Neds Bay (See Plate 2 - Appendix H)	A number of commercial and private vessels moor in the channel to Black Neds Bay and shoaling of the entrance restricts access to these vessels. If left unchecked, the shoaling could also lead to reduced flushing of Black Neds Bay with flow-on water quality and environmental consequences for the wetlands.	Shoaling occurs as a result of sediment transport westward along the foreshore from Mats Point and into the entrance. Wave action is the principle cause of the sediment transport with much of the sand originating from the erosion of Salts Bay. While the total quantity is reducing, sediment transport along the foreshore is likely to continue for some time.	The entrance has been dredged a number of times in the past with sediment being deposited making small islands along the channel. The dredged sand has also been used for nourishment of the foreshore in Salts Bay.	Medium
C	Main channel adjacent to Pelican Flat	Poor navigability in a number of locations along the main channel due to shoaling	Significant sediment transport occurs along the channel with flood and ebb tide shoals being generated in response to the local hydraulic conditions.	The sediment transport regime of the estuary is extremely dynamic with continuing sediment movement in response to past works. The high velocities and input of sand from Salts Bay erosion has caused significant sediment transport. Shoals and channels are continually forming and moving as the estuary evolves towards a new equilibrium.	Medium
D	Drop-over near Marks Point (See Plate 3 - Appendix H)	Poor navigability due to shoaling at the Lake entrance restricting the size/draft of vessels able to enter/leave the Lake.	Significant upstream transport of sand through the estuary channel is occurring in response to past works. A large flood tide delta at the Lake's entrance has developed where the flows spread out and velocities/sediment transport rates reduce. A braided system of many broad shallow channels rather than one deep channel has evolved.	The natural tendency is for the estuary to form a broad shallow delta in an attempt to increase frictional losses as it evolves towards a new equilibrium. This is in direct conflict with the desire for a deeper navigational channel. Unlike the ocean entrance, the very small tidal range in the Lake means that virtually no tidal assistance can be used for navigation. Navigation channels have been dredged before but the highly dynamic nature of the area is such that they have rapidly infilled.	High

Table 4.2 Erosion Related Entrance Channel Management Issues

Map Reference	Location	Management Issues	Cause	Discussion	Level of Community Concern
E	Salts Bay foreshore. (See Figure 3.5)	Retreat of the shoreline is damaging the environment and amenity of the foreshore. There is a threat of break through to Black Neds Bay which would damage wetlands and change the environment.	The entrance training works in the late 1800's allowed increased wave penetration into Salts Bay. Major retreat and realignment of the foreshore has occurred in response as the shoreline attempts to readjust to the new conditions. Sediment has been transported along the foreshore by wave action and into the channel. The coastal processes are working to align the shoreline approximately parallel to the incident waves.	As the shoreline adjusts, the sediment transport potential and rate of change reduce. A number of groynes which have been constructed have helped to stabilise the foreshore and slow down the erosion process by assisting with foreshore realignment. The slowing of the changes has been confirmed with additional shoreline evolution modelling.	Medium
F	Pelican Flat foreshore, particularly the parkland to the south of the Coast Guard Station and at the end of the Aeropelican runway. (See Plates 4 to 6 - Appendix H)	Foreshore erosion is resulting in the loss of public parkland and the amenity of the foreshore. Erosion at the end of the Aeropelican runway has resulted in the loss of the Crown Reserve and is severely restricting access to the point that public access past the end of the runway is not possible at high tide.	The mechanisms for the erosion include the combined effects of strong tidal currents and wave action generated by winds and boats. The estuary is responding to the increased tidal prism as a result of the entrance training works. Higher velocities and increased sediment movements have resulted in the main channel adjacent to Pelican Flat migrating eastward with associated foreshore erosion. This erosion is aided by waves generated by strong winds and boats. The waves mobilise the sediments on the edge of the foreshore from where they are carried predominantly offshore into the channel and then away from the local area by the strong tidal currents.	Groynes have been constructed in a number of locations in an attempt to stabilise the foreshore. While they have been effective at their specific location, erosion has continued at intermediate areas. Along most of the foreshore there is only a small erosion scarp at the waters edge with a gradually sloping area and modest currents. Further offshore the bed drops off into the deeper channel where the currents are strong. These characteristics are evidence of the two mechanisms. In the shallow upper region wave action is dominant with the profile being typically wave formed. The steep drop off and stronger currents in the channel reflect the dominance of the currents further offshore. These mechanisms are independent and may occur at different time scales.	High

Table 4.2 Erosion Related Entrance Channel Management Issues (Continued)

Map Reference	Location	Management Issues	Cause	Discussion	Level of Community Concern
G	Coon Island Foreshore	Foreshore erosion is resulting in the loss of SEPP 14 wetland on Coon Island. Ongoing erosion may also generate a future threat to the public carpark adjacent to Coon Island on the western foreshore.	The mechanisms for the erosion include the combined effects of strong tidal currents and wave action. The estuary processes are subject to continuing change as a result of natural and man made influences. The overall estuary is responding to the increased tidal prism as a result of entrance training works. As the flood tide delta of the drop-over grows, the dominant channels and shoals will change. The channel past Coon Island is a relatively short path from the entrance channel to the Lake and therefore the high velocities are likely to be the result of relatively large tidal gradients and shallow depths. Therefore, it is probable that this channel is tending to become more dominant. The high velocities in combination with wave action are resulting in erosion of the foreshore. The waves mobilise the sediments at the edge of the foreshore from where they are carried along shore and offshore into the channel and then away from the local area by the strong tidal currents.	Aerial photography indicates that substantial changes to the foreshore of Coon Island have occurred (see Figure 3.6). Such erosion can be expected as natural fluctuations in an estuary system. As the channel past Coon Island develops, the sediment is transported into the Lake forming more extensive shoals at the end of the channel. This is evident from the photographs which show recent growth of the shoals adjacent to Coon Island with deposition of sand extending out over seagrass areas. This process would ultimately begin to restrict this channel with dominance switching once again. While erosion may presently be causing the loss of wetland areas, the natural character is being retained. There is also evidence that wave action on the western side is also pushing sand up into the wetland forming a natural berm which is providing protection for the areas behind. While the erosion may ultimately threaten the public carpark on the western side, there is still a small buffer remaining to accommodate recession.	Medium
H	Western foreshore of channel at Swansea, north of the Swansea Bridge.	Rubble walls of varying standards have been constructed along much of the foreshore. The recreational amenity of these walls is low and their long-term stability is unclear. In addition, some relics of past foreshore works are potentially dangerous.	High velocities through Swansea Channel and natural meandering tendencies have resulted in a deep channel adjacent to the foreshore along this reach. This, together with local wave action, has caused erosion of the foreshore in the past. In an attempt to halt this recession, rubble walls have been constructed along most of the foreshore. It appears that the majority of these have been constructed by simple dumping of building rubble and rock rather than as a properly designed and built wall. In addition, past development on Coon Island which has now been removed included rubble walls, boat ramps, slipways and jetties. Many of these old foreshore works still remain in a deteriorated state.	To be effective in preventing foreshore erosion, revetment walls need to be properly designed and constructed. Simple rubble dumped walls typically do not provide long term protection and require ongoing maintenance. In addition, the visual and recreational amenity of such walls is often low. In some areas, such as on Coon Island, some of the rubble and relics remaining are also potentially dangerous.	Medium

Table 5.1 Specific Management Options for Sedimentation Related Issues

Option	Advantages	Disadvantages	Comments	Estimated Capital Cost*	Estimated Maintenance Cost*	Community Acceptance
A. Issue - Poor Navigability at Main Ocean Entrance (Medium Community Concern)						
(i) Do Nothing	• No direct expenditure • Estuary continues to evolve to a new equilibrium	• Navigation will still be restricted for larger draft vessels • Negative socio-economic impacts from reduced access	• Requires acceptance of use of tidal assistance for access by larger draft vessels if dredging carried out elsewhere. • Navigation for large vessels is already somewhat restricted by the Swansea Bridge. • Could be considered if the number of deep draft vessels using the channel does not warrant works.	-	-	Low
(ii) Dredging channel through Entrance Shoal (see Figure 5.1(ii))	• Will remove navigation restriction. • Dredged sand could be used for beneficial purposes (beach nourishment). • Can be carried out on an as required basis.	• Working against natural shoaling tendencies of the estuary. • Will be subject to siltation and require ongoing maintenance dredging. • Makes channel more efficient increasing flows and velocities elsewhere (although not substantially).	• Will not result in any major changes to Lake flushing or ecology. • The extent of impacts will be dependent on the extent of dredging. • Would not be of any benefit if dredging is not undertaken elsewhere to improve navigation to Lake.	-	Moderate	Medium
(iii) Dredging plus reclamation/construction training wall to narrow the entrance and maintain a flow balance (see Figure 5.1(iii))	• Will remove navigation restriction. • Dredged sand could be used for reclamation (although this would be a net loss to beach system). • Ongoing maintenance requirements will be reduced. • Overall flow balance can be maintained minimising impacts.	• Some maintenance dredging will still be required, primarily at end(s) of trained section. • Will alter the wave exposure to Salts Bay and may cause further realignment (which could be predicted and catered for).	• Appropriate design will be required to ensure flow balance is maintained and changes to wave exposure catered for. • Would not be of any benefit if dredging is not undertaken elsewhere to improve navigation to Lake. • No impact on Lake flushing or ecology.	High	Low	Medium

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.1 Specific Management Options for Sedimentation Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order Maintenance Cost*	Community Acceptance
B. Issue - Access Restricted into Black Neds Bay (Medium Community Concern)						
(i) Do Nothing	• No direct expenditure	• Navigation will still be restricted and may become worse with time. • Continued siltation could ultimately lead to reduced flushing of Black Neds Bay and associated ecological impacts.	• Considered to be not a viable option.	-	-	Low
(ii) Dredging channel	• Will remove navigation restriction. • Dredged sand could be used for other beneficial uses (eg. foreshore nourishment in Salts Bay). • Will ensure flushing and environmental characteristics of Black Neds Bay are retained.	• Will be subject to ongoing siltation and need repeated maintenance dredging.	• The gazetted wetland areas of Black Neds Bay may pose a constraint to the methods used.	-	Low	High
(iii) Dredging channel plus construction of a groyne downstream (eastward) of the entrance to trap the sand.	• Advantages as for (ii) above. • Groyne will intercept supply of sand to entrance and reduce further siltation. • Trapped sand may be used for beneficial purposes such as beach nourishment.	• Access for construction of groyne may be limited by Black Neds Bay gazetted wetland. • Ultimate build up of sand behind the groyne may lead to leakage around the end and into the entrance.	• The location and configuration of the groyne could be investigated with respect to deflecting the sand into deep water with stronger currents from where it would be carried away. • Sediment supply is not generally required to maintain downdrift foreshore which is revetted.	Moderate	Minimal	High

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.1 Specific Management Options for Sedimentation Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
C. Issue - Poor Navigability Along Main Channel due to Shoals (Medium Community Concern)						
(i) Do Nothing	• No direct expenditure • Estuary continues to evolve to a new equilibrium	• Navigation will still be restricted at certain stages of the tide for larger draft vessels.	• Generally not a major constraint and tidal assistance could be accepted as a viable option. • Could be considered if the number of deeper draft vessels using the channel does not warrant works.	-	-	Low
(ii) Dredging channel through shoaled areas	• Will remove navigation restriction. • Dredged sand could be used for beneficial purposes (eg. beach nourishment) • Can be carried out on an as required basis.	• Working against natural sediment transport processes of estuary. • Will be subject to siltation and require ongoing maintenance dredging. • Makes channel more efficient increasing flows and velocities elsewhere (eg. through Swansea Bridge) although not substantially.	• Will not result in any major changes to Lake flushing or ecology. • The extent of impacts will be dependent on the extent of dredging. • Would not be of major navigation benefit if dredging is not undertaken at the drop-over to improve access to Lake.	-	Moderate	Medium
(iii) Substantial dredging in conjunction with other training/reclamation works	• Will remove navigation restriction. • Dredged sand could be used for other beneficial uses (eg. beach nourishment). • If designed appropriately, can reduce velocities adjacent to Pelican Flat and be used as an option for foreshore protection as well. • Training works can maintain flow balance and reduce maintenance dredging requirements.	• Some maintenance dredging will still be required, primarily at the end of any trained section. • Training walls may affect the amenity and usage of the waterway.	• Appropriate design will be required to ensure the desired effects are achieved. • Would not be of major navigation benefit if dredging is not undertaken at the drop-over to improve access to Lake. • Has the potential to address more than one issue.	High	Low	Medium

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.1 Specific Management Options for Sedimentation Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
D. Issue - Poor Navigability due to Shoaling at Drop-over (High Community Concern)						
(i) Do Nothing	• No direct expenditure. • Estuary continues to evolve to a new equilibrium.	• Navigation will still be restricted for larger draft vessels. • Negative socio-economic impacts from reduced access.	• No opportunity exists for the use of tidal assistance for navigation. • Could be considered if the number of deep draft vessels using the channel does not warrant works.	-	-	Low
(ii) Dredge channel through shoaled area (see Figure 5.2)	• Will remove navigation restriction. • Dredged sand could be used for beneficial purposes (eg. beach nourishment).	• Working against natural shoaling tendencies of the estuary. • Will be subject to siltation and require initial overdredging and ongoing maintenance dredging. • Makes channel more efficient increasing flows and velocities elsewhere (eg. along Pelican Flat and at Swansea Bridge) although not substantially.	• Will not result in any major changes to Lake flushing or ecology. • The extent of impacts will be dependent on the extent and location of dredging. • Dredging through the Marks Point Channel involves less material than dredging through the channel adjacent to Pelican Island. However, the Marks Point Channel dredging results in a greater increase in velocities past Pelican Flat. • Monitoring could be undertaken to ascertain the usage and benefit of this or other options.	-	High	High
(iii) Dredging plus reclamation/training to maintain flow balance (see Figure 5.2)	• Will remove navigation restriction. • Dredged sand could be used for reclamation or other beneficial purposes (eg. beach nourishment). • Ongoing maintenance requirements will be reduced. • Overall flow balance can be maintained minimising impacts. • If designed appropriately, can be used to train flows away from foreshore and therefore used as an option for foreshore protection.	• Some maintenance dredging will still be required, primarily at the end(s) of the trained section. • Training walls or reclamation may affect the amenity and usage of the waterway.	• Appropriate design will be required to ensure flow balance is maintained. • Consideration will need to be given to access and flushing of areas blocked by training/reclamation works, particularly Swan Bay. • Appropriate design can be used to address more than one issue eg dredging an alternative channel past Pelican Island and blocking the existing channel past Marks Point offers benefits in reducing velocities adjacent to Pelican Flat.	Very High	Low	High

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.2 Specific Management Options for Erosion Related Issues

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
E. Issue - Retreat of Salts Bay Foreshore (Medium Community Concern)						
(i) Do Nothing	• No direct expenditure required. • The natural character and amenity of the foreshore is retained.	• Continued erosion could result in a break-through to Black Neds Bay with associated consequences for the wetlands.	• Although the foreshore is stabilising and realignment is slowing, there is still the potential for further erosion, primarily during a major storm event.	-	-	Low
(ii) Groynes - construct a new groyne immediately to the west of the potential break-through zone and extend the existing central groyne	• Provides direct protection for the potential break through zone. • Will aid realignment to a stable condition.	• Environmental damage may be caused during construction. • Depends on existing sand for supply in realignment of the foreshore and so erosion will still occur at the eastern ends of the embayments.	• Consideration will have to be given to access to the site and methods of construction which minimise impacts to the designated wetlands. Appropriate approvals in this regard will also be required.	Low	Minimal	High
(iii) Beach nourishment	• Maintains natural sandy foreshore and amenity. • Provides increased buffer to accommodate erosion.	• Shoreline will realign unless nourishment is carried out in such a manner that a stable alignment is achieved.	• An appropriate source of sand will need to be identified. • Dune stabilisation works will also be required to prevent wind erosion. • Design will need to consider ultimate stable alignment.	Moderate	Minimal	Medium
(iv) Groynes with nourishment	• As above for groynes and beach nourishment. • Reduced loss rate of nourishment.	• Environmental damage may be caused during construction. • Some shoreline realignment will occur until a stable configuration is achieved.	• As above for groynes and beach nourishment.	Moderate	Minimal	High

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.2 Specific Management Options for Erosion Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
F. Issue - Foreshore Erosion at Pelican Flat (High Community Concern)						
(i) Planned Retreat or Do Nothing	• No direct expenditure. • Foreshore continues to behave naturally.	• Loss of property occurs. • No potential to provide alternative access past Aeropelican runway.	• Not a viable option for the Aeropelican area. • Likely to have high public reaction against such an option.	-	-	Low
(ii) Revetment Wall	• Can be implemented quickly as an emergency situation. • Effective in preventing further erosion.	• May result in loss of amenity and character of access depending on type of wall. • May cause localised scour and loss of beach.	• The nature and extent of wall will depend on its location eg. a small wall along the existing foreshore will be required to prevent wave erosion while a more extensive wall will be required to prevent channel migration. • Options exist for different types of walls but all need to be properly designed and constructed to be effective.	Moderate-High	Minimal	High
(iii) Groynes	• Can provide stability to the immediately adjacent foreshore.	• Changes the character and amenity of the foreshore. • Can restrict or inhibit access along the foreshore. • High velocities and turbulence around the end of the structures will increase scour.	• Need a number of regularly spaced structures to be effective in protecting a length of foreshore. • Can be used together with sand nourishment to improve amenity.	High	Minimal	Low
(iv) Dredging and/or training out from shore	• Can be effective in redirecting currents if designed appropriately. • Training walls may also provide protection from wave attack. • Can be combined with option for navigation issues.	• As per dredging and training options for sedimentation issues. • Training walls may change amenity of foreshore.	• Opportunities exist to combine benefits for navigation issues and would usually be carried out with such options.	Very High	Low	High

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.2 Specific Management Options for Erosion Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
G. Issue - Foreshore Erosion at Coon Island (Medium Community Concern)						
(i) Do Nothing or Planned Retreat.	• No direct expenditure. • Foreshore continues to behave naturally and retain its natural character.	• Loss of some wetland area could occur. • May ultimately create a threat to the public carpark on the western foreshore necessitating relocation further landward.	• Public perceptions are often that foreshore erosion should be prevented. • Considered to be a viable option to retain the natural character of the area.	- (Minimal if relocation of carpark required)	-	Not discussed
(ii) Revetment Wall	• Can be implemented quickly as an emergency situation to protect assets (e.g. carpark). • Effective in preventing further erosion if properly designed.	• May result in loss of amenity and character of foreshore. • May cause localised scour and loss of beach. • May prevent critical inflow/outflow of tidal water to wetland unless properly designed. • Will not prevent channel from developing further.	• The nature and extent of wall will depend on its location eg. a small wall along the existing foreshore adjacent to the carpark would be sufficient to prevent wave erosion, while a more substantial wall would be required to prevent erosion due to strong currents around the tip of Coon Island. • Options exist for different types of walls but all need to be properly designed and constructed to be effective and prevent damage to the wetland. • Coon Island is SEPP 14 wetland and approval would be required for works adjacent to it.	Moderate-High	Minimal	Not discussed
(iii) Training/Reclamation to effectively block channel or redirect flow (e.g. reclaim to small island on other side of channel).	• Addresses the cause directly and removes the main mechanism (high currents). • Can be combined with other options by using sand from dredging to carry out reclamation.	• Will influence overall distribution of flow and may need dredging elsewhere to compensate. • Will prevent any boating access directly through this channel. • Depending on configuration, may influence flushing of wetlands directly or through siltation of blocked channel.	• Would require careful design and an impact assessment study for effects on SEPP 14 wetlands. • Options exist for different configurations and could potentially be combined with dredging elsewhere to improve navigation.	High	Low	Not discussed

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table 5.2 Specific Management Options for Erosion Related Issues (Continued)

Option	Advantages	Disadvantages	Comments	Order of Capital Cost*	Order of Maintenance Cost*	Community Acceptance
H. Issue - Poor Amenity and Limited Long-Term Stability of Revetments at Swansea (Medium Community Concern)						
(i) Do Nothing.	• No direct expenditure.	• Poor amenity remains. • Long-term failure of revetments may occur.	• Not likely to be favoured as a long-term strategy.	-	-	Not discussed
(ii) Improve standard and amenity of wall.	• Can be implemented quickly and therefore carried out on as required or opportunistic basis. • Effective in preventing long-term erosion. • Visual and recreational amenity can be improved with appropriate design.	• Natural character of foreshore will not return.	• Options exist for different types and configurations of walls but all need to be properly designed and constructed to be effective. • Can be incorporated with other recreational planning concepts to improve the overall amenity and usage of the foreshore. • Can be carried out on an opportunistic basis or as required, provided overall plan is co-ordinated.	Moderate-High	Minimal	Not discussed

* Cost Categories: Minimal <$0.1M; Low = $0.1M-$0.5M; Moderate = $0.5M - $1.0M; High = $1.0M - $5.0M; Very High > $5.0M

Table G.1 General Management Option Alternatives for Sedimentation Related Issues

Management Option	Description	Advantages	Disadvantages	Discussion
Do Nothing	No works undertaken.	• No direct costs. • Estuary continues to evolve to a new equilibrium.	• Navigation will still be restricted for larger draft vessels. • Navigation difficulties likely to increase resulting in further restrictions to access. • Negative socio economic impacts from reduced access.	• Could be considered if the number of deep draft boats using the channel and the flow on socio-economic effects do not warrant works.
Dredging	Direct removal of shoaled area to provide a navigable channel.	• Will remove navigation restriction. • Dredged sand could be used for other beneficial purposes. • Can reduce velocities in general cross-section of dredged area and elsewhere by changing the flow distribution. • Modest cost.	• Working against natural shoaling tendencies of the estuary. • Will require initial overdredging and ongoing maintenance dredging to provide continual access. • Makes channel more efficient increasing flows and velocities elsewhere with potential adverse consequences for erosion. • Has the potential to increase the tidal range upstream of the dredging.	• One off dredging will not be a permanent solution - continual maintenance will be required. • The extent of impacts will be dependent on the extent of dredging. • Monitoring could be undertaken initially to ascertain boat usage and ongoing costs/benefits of this or other options.
Dredging and Training/ Reclamation	Direct removal of shoaled area plus other training or reclamation works aimed to form a compensatory blockage and thereby maintain the same overall flow balance while inducing a self scouring tendency.	• Will remove navigation restriction. • Dredged sand could be used for associated reclamation. • Appropriate design can maintain flows and velocities through dredged channel such that it is self scouring • Appropriate design can maintain overall flow balance and minimise impacts. • Ongoing maintenance costs will be reduced.	• Likely high initial capital cost. • Sediment transport will still occur resulting in deposition at the ends of the channel where flows spread out and slow down. • Maintenance dredging at the end(s) of the channel may still be required. • Compensatory blockages may introduce other flushing/access/ wave penetration issues.	• Concept requires appropriate design to ensure flow balance is maintained. • Unless uniform flow patterns can be maintained throughout the channel, shoaling will occur somewhere.
Dredging and Interruption of Sediment Supply	Direct removal of shoaled area plus a structure such as a groyne to interrupt and trap the sediment supply to the shoaling area.	• Will remove navigation restriction • Dredged sand could be used for other beneficial purposes. • Sediment trapped by the structure could enhance/stabilise the foreshore on the updrift side (ie. the site from which the sediment is being transported). • Modest cost.	• May induce further erosion on downdrift side (to where sediment is being transported) if the sediment that is blocked is an important supply to maintain a beach. • The sediment build up behind the structure will ultimately start passing around its end and could reduce its effectiveness.	• Only practical in certain situations such as where sediment transport to the shoaling area is along a foreshore. • May not be a permanent solution if there is a continuing supply of sand unless the sand trapped is redirected or used elsewhere.

Table G.2 General Management Option Alternatives for Erosion Related Issues

Management Option	Description	Advantages	Disadvantages	Discussion
Planned Retreat or Do Nothing	Allow the natural processes to continue and remove threatened development.	• Foreshore continues to behave naturally. • No direct expenditure required on protective measures. • The natural character and amenity of the foreshore is retained.	• Loss of property occurs. • Improvements may have to be moved. • Public reaction against allowing erosion is usually high.	• This approach could be considered if the loss of property can be accepted and if threatened improvements can be relocated easily. • In spite of its apparent drawbacks, it may be a viable solution in the long run.
Revetment Wall	A robust structure built along the foreshore and designed to withstand wave attack and scour. It may be rigid (eg. concrete) or preferably flexible (loose rock). It depends on sound footings or toe protection for stability.	• Well suited as a last line of defence. • Can be implemented in emergency situations.	• May cause localised scour and the beach in front will progressively diminish on a retreating foreshore. • Changes amenity and character of access (eg. more difficult to enter water over rock wall). • Will probably require ongoing maintenance.	• Only effective if properly designed and constructed. • Should only be used in situations where the changes in amenity are acceptable. • Should be continuous along the foreshore or allowance made for erosion due to end effects.
Sand Nourishment	The importation of sand onto the foreshore to provide a buffer against erosion.	• Provides protection while retaining the amenity and character of the foreshore. • Increases the buffer width. • Allows the foreshore to behave naturally.	• May be rapidly lost if there is significant transport away by waves and currents and there is not continued supply along the foreshore. • Continued renourishment may be required in such a situation. • Can contribute to midge problems.	• Losses can be minimised with the use of control structures such as groynes. • Works best on a sandy foreshore with a natural supply of sand.
Groynes	Robust impermeable structures built at right angles to the foreshore to intercept sand transport and keep strong currents away from foreshore.	• Can provide stability to immediately adjacent foreshore. • Can be effective in building up the foreshore on the updrift side if there is substantial longshore transport of sand.	• Can cause erosion on the downdrift side transferring the erosion problem. • Changes the character and amenity of the foreshore. • Can restrict or inhibit access along the foreshore. • High velocities and increased turbulence around the ends may increase scour.	• Isolated structures have little overall effect - ie. need regularly spaced groynes to protect a length of foreshore. • Can be used together with sand nourishment to improve amenity.

Table G.2 General Management Option Alternatives for Erosion Related Issues (Continued)

Management Option	Description	Advantages	Disadvantages	Discussion
Offshore Training Walls/ Breakwaters	Robust impermeable structures built out from the shore to train currents away from the erosion problem and/or block wave attack.	• Can be effective in reducing erosion if properly designed and constructed. • May be effective in building up a beach in the lee area if longshore transport is present. • Shelters the foreshore from wave attack creating protected beach areas. • Can reduce currents along foreshore and prevent channel migration.	• Cost is usually very high. • Can result in erosion of downdrift areas if longshore transport is present. • Changes the character and amenity of the foreshore.	• Would usually be carried out in conjunction with other options for improvement to navigation.
Channel Dredging	Dredging and maintaining a deeper channel offshore to locally reduce velocities and migration tendencies of channel.	• Can be effective if channel migration is the primary mechanism. • Can be utilised in addressing navigation issues as well.	• Dredging needs to be maintained to maintain the benefit • Other dredging related impacts such as increased flows and velocities elsewhere may occur.	• Would usually be carried out in conjunction with other options for improvement to navigation.