6 SUMMARY OF IMPORTANT PROCESSES

The management of Swansea Channel since the construction of training walls at the entrance to Lake Macquarie has proven to be difficult due to the highly dynamic nature of sediment transport and marine delta morphology.

The overriding concern of the community over the last century has been consistent and safe navigation access into the lake. In the past this has resulted in poor management decisions based on reactive decision making. As a result works have been either ineffective or detrimental in some way.

The main physical process driving the need for management is the continual supply of sediment from downstream under tidal flows. It has been noted that catchment sourced flooding is not dominant in Swansea Channel and that the dominant hydraulic process are tidal. Flooding of the Swansea Channel area is generally associated with high ocean tide levels, which often occur concurrently with high rainfall.

The most likely source for sediment into the study area has been the significant erosion of Salts Bay, brought about by the increased impact of ocean swell energy on the Salts Bay shoreline following training of the entrance. Another potential source is sand from offshore, however, studies reported in the Swansea Channel Waterway Planning Study (PWD, 1976) indicated that the southern end of Blacksmiths Beach has not eroded following training of the entrance and that the sand supply from Blacksmiths Beach into the entrance has been cut off by the construction of Blacksmith's Breakwater.

It is hoped that recent works in Salts Bay, including groyne construction and beach nourishment, will result in stabilisation of the Bay and the reduction and/or cessation of sediment transport upstream from Salts Bay. It seems important that this situation be closely monitored to ensure that sediment transport upstream eventually ceases to interfere with navigation in the area upstream of Swansea Bridge.

The Lake Macquarie Estuary Management Study (Volume 1, WBM, 1997) also reports that Swansea Channel does not currently have a stable channel configuration, and that the cross-sectional area of the channel is gradually adjusting to the impact of entrance training works. The erosion resulting from the 'under-regime' status of the channel has been partially exacerbated by the construction of the road bridges and approaches at Swansea, which cause very high velocities and erosion beneath the bridge.

The expected adjustment required to gain a stable configuration suggests a gradual increase in cross-sectional area, which ultimately means overall erosion of the channel.

The supply of sediment that originated from downstream of Swansea Bridge is the prime cause of the problems that are experienced with respect to navigation within the study area. From year to year, the nature and location of the specific problem changes as pulses of sediment move from one location to another, forming ever changing shoal patterns, and ultimately reflecting a net transport of sediment upstream through the study area for eventual deposition on the tidal dropovers at the entrance to the deep lake basin. This is the underlying process that is of importance to this study.

Currently, in the area downstream of Pelican Flat, erosion is generally occurring at the greatest rate within the deepest part of the channel, which conveys the majority of the flow. Erosion also tends to occur, albeit at a slower rate on the shoals adjacent to the main channel. Significant areas of foreshore erosion and channel deepening occur adjacent to the Swansea foreshore south of Coon Island and adjacent to Pelican Flat.

The area adjacent to, and north of, Pelican Flat is shown on Figure 6-1. Specific locations of interest are numbered and a description of the processes of importance are provided in Table 6-1.

As can be seen from Table 6-1, the processes in the study area are complicated. However, with the community expectation that navigability will be maintained, it is likely that the navigation situation needs to be addressed. At present there exists a system of braided navigation channels which are in conflict with the expectation of a single deep navigation channel. Past attempts to dredge a stable channel have been thwarted by the continued supply of sediment from downstream.

It appears that creation of the southern entrance to Swan Bay to improve water quality in the Bay has encouraged the migration of sand into the entrance. However, it is not the only cause of problems in the area. Another cause is the ongoing movement of sediment upstream of Swansea Bridge. Originally, it was expected that the southern entrance to Swan Bay would tend to close following dredging (Resource Planning, 1988), due to the design of the cross section of the southern entrance. However, this has turned out to not fully represent the events that did occur following the reopening and, while sediment is moving into the entrance, it is also depositing within the main navigation channel, effectively blocking direct navigation through the main channel.

Nevertheless, the movement of sand into the southern entrance of Swan Bay must be considered in conjunction with an expected continuation of sediment infeed from downstream. Eventually, this process may cease as the channel reaches equilibrium and due to the stabilisation of Salts Bay in recent times. However, until that time, it is highly likely that some form of maintenance dredging will be required as a part of any management strategy adopted for the area. The potential management options that are described in the following chapter have been developed based on this assumption.

Figure 6-1 Processes in the Study Area

Table 6-1 Description of Current Processes

Location	Comment
1	A large shoal has gradually been established in this area during the 1990's. Movement of sand onto this shoal has been responsible for partially closing the Airforce channel which was noted to have shallowed.
2	The pulse of sediment represented by the shoal described at location 1 has gradually moved further northwards into the channel between Elizabeth Island and the Spoil Island in Swan Bay.
3	Previous analysis undertaken by Resource Planning Pty. Ltd in 1988 for the Ventilation Dredging EIS has noted that there is a tendency for the navigation channel to move eastwards with time although the impacts of maintenance dredging in facilitating this process may be significant. This process is being exacerbated by the growth of the shoal described at Location 2 into the channel between Elizabeth Island and the Spoil Island. This shoal increasingly constrains the channel, encouraging erosion along the western edge of the spoil island. The movement of this shoal has been exacerbated by the direction of flows through Swan Bay which has resulted in lower flows and deposition in the main channel.
4	Analysis of DEM's indicates that in the last five years there has been significant accretion along the northern edge of this shoal. Large sediment transport rates at locations further downstream indicate that material is being eroded from the bed and banks of the channel south of Naru Point and is being deposited in this area as the flow spreads and allows sediment to settle on the edge of the shoal during the flood tide.
5	Poorly consolidated sediment deposited on the northern edge of the shoal during flood tide processes is transported southwards along the northern edge of the 'dog-leg' during the ebb tide where it is eventually deposited at the point where currents slow down. The shape of the dog-leg is largely dictated by the greater deflection of ebb tides by the open entrance to Swan Bay when compared to the deflection of flood tides.
6	Some sediment is deposited in this area during the flood tide, as velocities drop with flows partly directed into Swan Bay. This sediment helps to boost the mass of sand in the 'dog-leg' shoal and exacerbates deposition along the northern edge by the processes described at location 5.
7	The distortion of ebb tide currents causes high sediment transport rates adjacent to Naru Point, which has been eroding rapidly in recent times. The loss of vegetation on Naru Point is a direct result of currents impacting against this foreshore.
8	Inspections of vegetation along this length of foreshore indicate that it has been accreting. The bathymetry adjacent to this foreshore is particularly irregular. The cause of this is uncertain, however, dredging practices in the area may be affecting local processes. No reliable details of the progress and extent of ventilation dredging in Swan Bay have been found during this investigation.

9 The impact of ongoing dredging in the area is unknown as no records have been located. However, the continued removal of material from the bed of the bay inside the entrance may be exacerbating the movement of the shoal into Swan Bay.

10 The groyne located immediately to the south of Naru Point plays a dominant role in deflecting tidal flows. Notably, it seems to assist in partially deflecting flood flows away from the entrance to Swan Bay. The groyne creates turbulent eddies, which represent the dissipation of energy that is trying to move the channel towards the east, but is hindered by the groyne.

11 The channel is deepening significantly adjacent to the end of the Belmont Airport Runway. This may ultimately lead to destabilisation of the foreshore, which is currently protected by a sloping concrete wall.

12 Swift currents run through Pelican Marina. South of Pelican Marina, along Pelican Flat, the foreshore is somewhat protected by the construction of groynes which appear to have maintained a stable beach in this area. Erosion of the channel bed offshore of this beach may eventually destabilise this section of foreshore.

13 Following the movement of a sediment slug into the area during the 1990's causing partial blockage of the Airforce channel, a new channel appears to be forming as shown at location 13.

14 A secondary channel from Swansea Channel and into the Lake around the northern foreshore of Coon Island appears to be deepening in a response to increased tidal flow. As the main channel becomes increasingly constrained in the vicinity of the southern entrance to Swan Bay, it is highly likely that more flow is being encouraged through the channels at Locations 13 and 14. This is commensurate with ongoing accretion where these two channels 'drop-over' into the Lake.

15 The tidal shoal west of Marks Point is the most active location for sediment deposition from Swansea Channel. Analysis of DEM's shows a deepening of the channel in recent times, although this is most likely due to dredging that was undertaken in 1998 and 1999. This channel has remained stable, which is surprising considering that this has traditionally been the location of most navigation difficulties.

16 The lobe of the dropover in this location has gradually grown eastwards, blocking what used to be a viable navigation channel into Swan Bay. Recently, with the introduction of tidal flows through Swan Bay (by the ventilation dredging) the northern channel into Swan Bay is now subject to greater current velocities.

17 Increased wave energy along the south eastern foreshore of Swan Bay may be causing increased erosion. The increase in wave energy has been caused by opening the southern entrance to Swan Bay which enables penetration of wind generated waves from Lake Macquarie into Swan Bay from the south west. Field inspections did not note significant erosion of the foreshore in this area. Structural failure along this area appears to be generally due to poor design. Whether or not the increased wave energy has caused the design capacity of structures to be exceeded or not is difficult to assess without a record of the structures prior to

opening of the southern entrance.

18 Based on shoal and island mapping, Pelican Island appears to have reduced in size due to erosion of the northern foreshore in the past five years. This appears to be due to the increase in flow that wraps around the eastern and northern sides of the island. This change in flow regime has been brought about as a new connection between the Airforce channel and Swansea Channel has been established to the south.

19 Erosion is apparent in this area as flow is forced through a narrow channel. Sediment eroded is currently being transported northwards and deposited adjacent to and north of the southern entrance to Swan Bay.

20 An increase in the width of the gap halfway along the spoil island is probably due to erosion of the western foreshore of the island, which has reduced resistance to flow through this gap, causing additional erosion. Flows across this gap are still minor.

21 Analysis of aerial photography indicates that this island is reducing in size. This is likely to be in direct response to an increased flow through the northern entrance to Swan Bay.

22 The western shoals have migrated considerably into the main navigation channel since 1996. This has resulted in a substantial narrowing of the navigation channel, and an accompanying deepening of the channel, by up to 5 metres, in the vicinity of Pelican Marina. The channel is deepening at this location because the eastern foreshore of the channel cannot recede due to hardening of the foreshore (by concrete lining etc) – refer points 11 and 12. Migration of the shoal into the main navigation channel has been a result of increased flows across the western shoals (due to the shoaling of the main navigation channel in the vicinity of Swan Bay), and may be exacerbated by sediment transport associated with waves induced by dominant westerly winds.

23 The shoal can tend to migrate in an easterly direction under the influence of westerly winds. The winds generate waves over the shallow shoal, which can cause mobilisation and transport of surface sediment. Rapid shoal migration into the entrance of Swan Bay can occur under the influence of strong and persistent westerly winds, which reportedly occur at the end of the winter months.

6.1 Conceptual Model

The processes described above have been summarised in a conceptual model presented as Figure 6-2 and Figure 6-3.

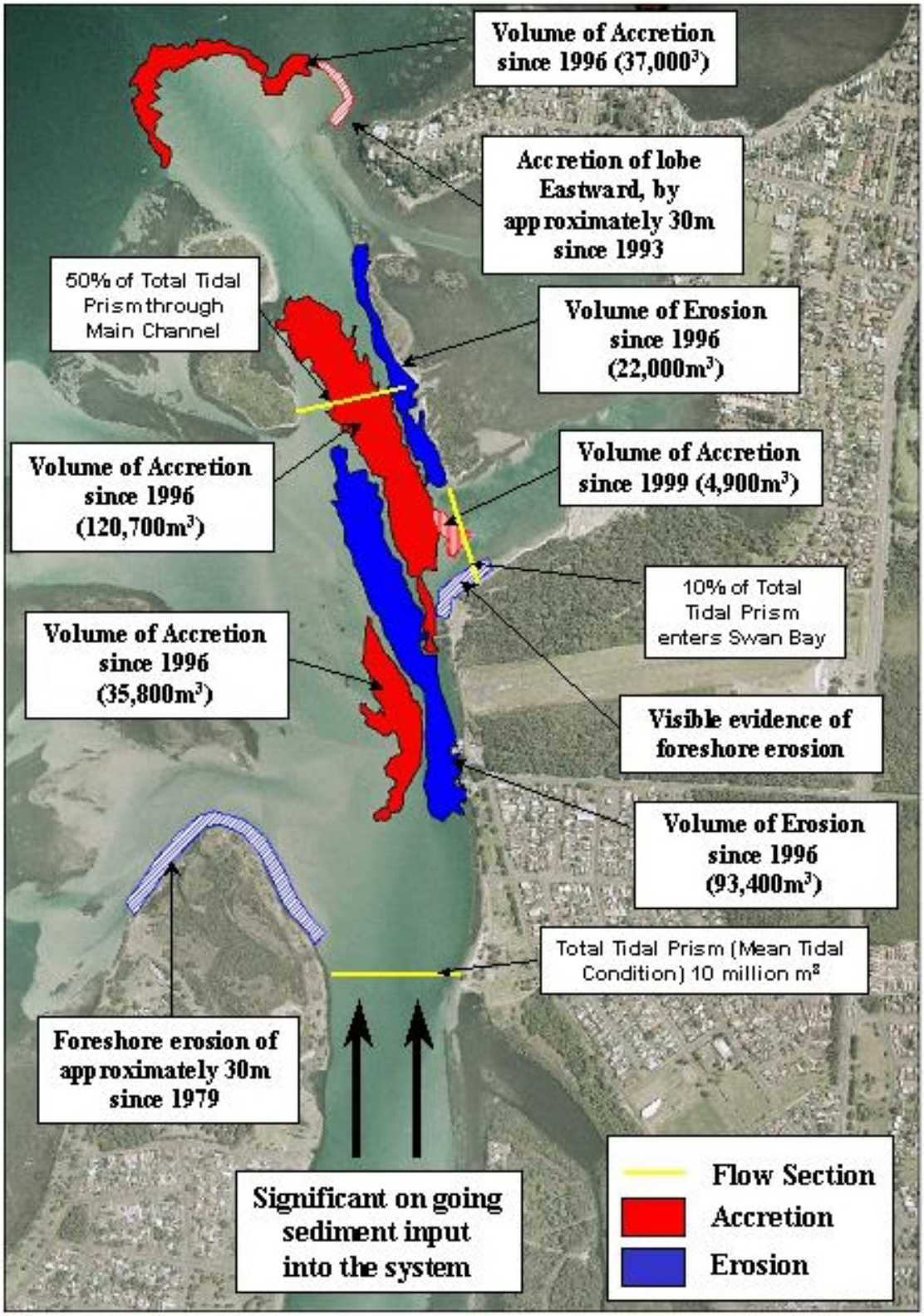

Figure 6-2 Important Processes in Study Area

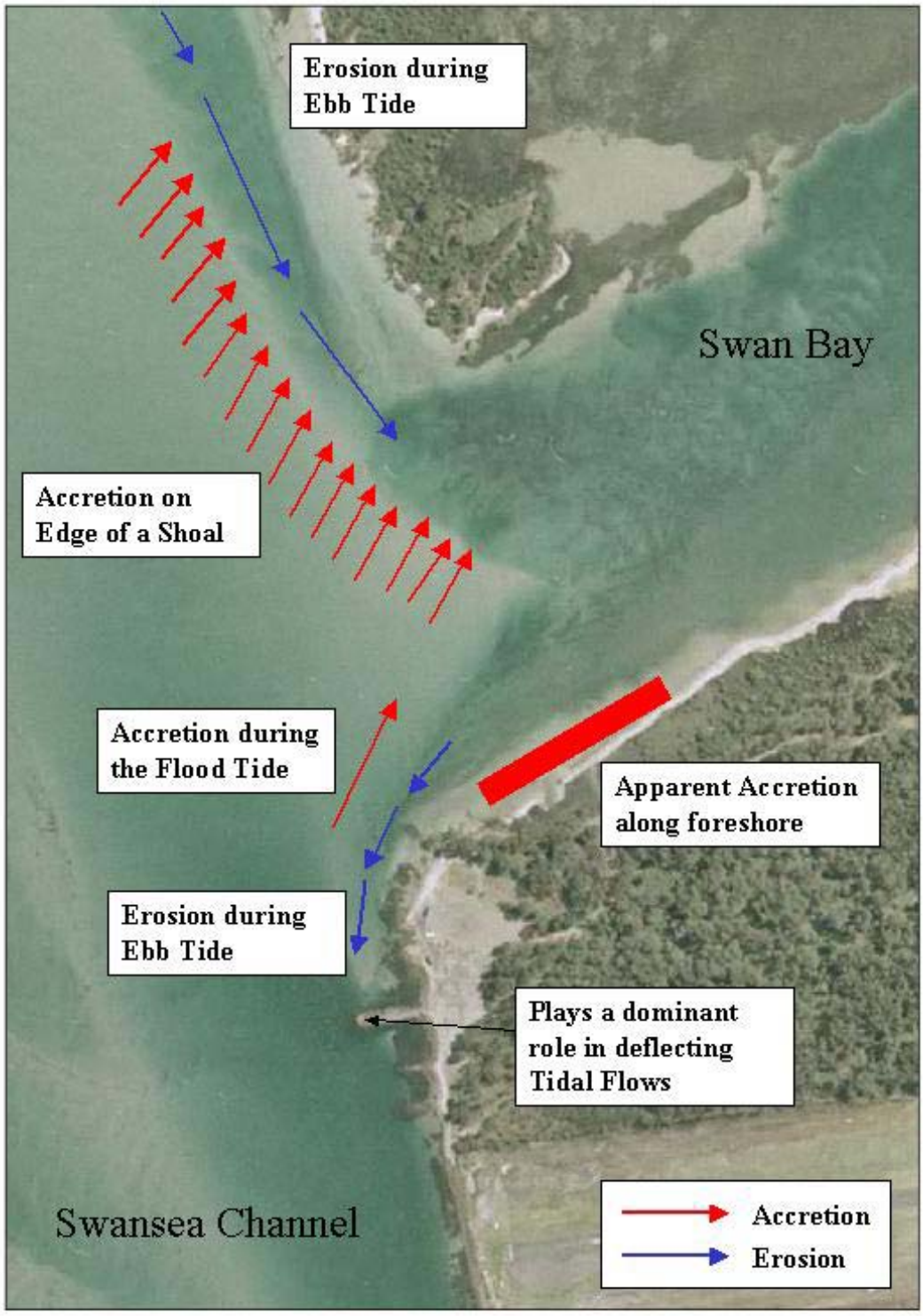

Figure 6-3 Important Processes in the Southern entrance of Swan Bay