6 DEVELOPMENT AND ASSESSMENT OF POSSIBLE FUTURE MANAGEMENT OPTIONS / STRATEGIES

6.1 Formulation of Options / Strategies

Management options or strategies are the tools that will be used to try to achieve the management targets or objectives. Management options include a range of different types of activities, such as on-ground works, community education, planning and development controls, and future monitoring.

For each of the 14 management objectives (which are based on the specific issues as discussed in Section 4.4), a number of management strategies / options were formulated for addressing (at least in part) the objective.

A total of 33 different options were formulated, each with the primary aim of improving the future sustainability of Saltwater Creek and Lagoon. These options are presented below under the general headings of water quality, ecology / biodiversity, entrance management (and flooding), and future development (as per the issues definitions, see Section 4.4).

6.1.1 Possible Water Quality Strategies (Addressing Objectives 1 to 5)

WQ-1 Assess water quality to determine the appropriateness of primary and secondary contact recreation activities in the estuary, as well as to assess general environmental health.

WQ-2 On-going monitoring of water quality, particularly immediately following catchment runoff events, to determine risk to human health and the environment.

WQ-3 Undertake additional investigations through periodical groundwater, surface water and estuarine sediment quality monitoring in the vicinity of the former oil terminal sites to assess impacts on the environment.

WQ-4 Provide appropriate signage at popular recreation areas to inform public of water quality risks (especially following rainfall events).

WQ-5 Artificially open the entrance, as necessary, to maintain water quality suitable for primary recreation in designated areas of the estuary – may be carried out during peak recreation times only (ie summer holidays, easter etc).

WQ-6 Construct an ocean outfall for stormwater adjacent to the mouth of Saltwater Creek, instead of discharging stormwater directly into the creek behind the entrance berm.

WQ-7 Retrofit stormwater filtration devices and wetlands (incorporating sediment and nutrient removal) to major drains discharging into Saltwater Creek and Lagoon.

WQ-8 Community education (including the temporary community during holiday seasons) regarding the sensitivity of Saltwater Creek and Lagoon, and the need for treatment of urban runoff, including litter control, collection of animal droppings, and lawn / garden runoff.

WQ-9 Encourage on-site stormwater management (eg rainwater tanks, absorption trenches, grass swales) through education and incentive schemes and streetscape works (grass swales etc).

WQ-10 Conduct an audit of all on-site sewage systems to determine adequacy and enforce upgrading of unsatisfactory systems, as required.

WQ-11 Assess existing and future capacity of reticulated sewerage system to determine the frequency of sewage overflows to Saltwater Creek and Lagoon, and to identify options to reduce this frequency in the future.

6.1.2 Possible Ecology / Biodiversity Strategies (Addressing Objectives 6 and 7)

Bio-1 Introduce new planning instrument(s), or modify existing instruments, to prohibit the removal or any existing native vegetation, including sedges and reeds, located between the estuary and existing urban development. This would include addressing the deficiencies in the current tree preservation order, which is only applicable to trees greater than a certain size.

Bio-2 Identify and rehabilitate degraded habitats through revegetation (especially using fire-resistant species) and soil stabilisation, particularly around periphery of urban development areas.

Bio-3 Increase enforcement of existing fishing regulations (particularly with respect to size), especially during peak holiday periods.

Bio-4 Prevent unleashed dogs and other domestic animals from the natural environment around the estuary, and enforce the prohibition of dogs from the sections of lagoon foreshore that are located within Hat Head National Park.

Bio-5 Monitor biological indicators to help assess environmental health of the estuary, including benthic fauna, seagrass distribution and condition, and seagrass depth limits. Monitoring should include sites around the oil terminal site to determine possible ecological impacts of groundwater and soil contamination.

Bio-6 Education of community (particularly rural-residential landholders) and assistance where possible regarding good environmental behaviour, bushland friendly plants, garden maintenance, fire management and weed control.

Bio-7 Adjust boundaries of Arakoon State Conservation Area / Hat Head National Park to include Saltwater Creek and Lagoon and fringing wetland environments (some of which are currently in private ownership and would need to be acquired or dedicated).

6.1.3 Possible Entrance Management (and Flooding) Strategies (Addressing Objectives 8 to 12)

EMF-1 Prepare and implement a formal Entrance Management Policy that clearly and easily outlines if, when and how to artificially manipulate the entrance of Saltwater Creek. Entrance management should be triggered by water levels and the extents of inundation on surrounding lands, as well as the risks to flood-liable assets. The Policy could also consider

entrance manipulation to manage water quality within the lower reaches of Saltwater Creek (at least during peak recreation periods).

EMF-2 Flood-proof or relocate low-lying assets around the estuary to minimise the need to artificially open the entrance due to inundation problems, including filling of lands, raising of assets, and construction of low level flood exclusion bunds.

EMF-3 Review existing flood policy following outcomes of flood study and entrance management policy.

EMF-4 Increase capacity of Phillip Drive bridge to reduce peak flood levels upstream (as indicated by results of Flood Study).

EMF-5 Periodically allow the full hydrological range of Saltwater Creek and Lagoon to be met (i.e. achieving a maximum water level in the lagoon well in excess of RL 2m AHD), and thus cater for the fringing ecological communities that are dependent on occasional inundation at high lagoon levels. This may only be possible outside of peak holiday times, when the potential impacts to existing assets and infrastructure are at a minimum, and would need to be preceded by a detailed assessment of private and public risk ascribed to different lagoon water levels (typically done as part of a Floodplain Risk Management Study).

EMF-6 Voluntary buy back of private lands within the vertical buffer limits of the lagoon and wetland.

EMF-7 Acquisition of easements to inundate over private and public lands within the vertical buffer limit of the lagoon and wetland.

6.1.4 Possible Future Development Strategies (Addressing Objectives 13 and 14)

Dev-1 Prevent any further rezoning of urban land within the Saltwater Creek and Lagoon catchment unless future development can result in net positive benefits to the estuary. Development conditions that generate the net positive benefits (e.g. local stormwater management, revegetation activities, etc) would be incorporated into a local DCP and Masteplan.

Dev-2 Prepare new planning instrument(s), or modify existing instruments, to enforce 'best practice' on-site stormwater treatment for all new developments and redevelopments within the Saltwater Creek and Lagoon catchment. This would include adoption of total integrated water cycle management and water sensitive urban design principles.

Dev-3 Prepare new planning instrument to specify an appropriate buffer between existing and future urban development and the estuarine and wetland environments, and prohibit any future development from within this buffer, including any earthworks or clearing of vegetation.

Dev-4 Maintain and enforce existing policies regarding the sensitivity of the area with respect to future development (eg visual, height restrictions, vegetation clearing etc)

Dev-5 Review status of existing 1(d) urban investigation land taking into consideration the environmental sensitivity of the land and the potential impact of development on the land on Saltwater Creek and Lagoon

Dev-6 Rezone important habitats and estuarine fringes (as defined by scientific investigations) that are currently zoned urban investigation to a suitable environmental protection zoning. Consideration should also be given to rezoning other lands (other than urban investigation lands) to a suitable environmental protection zoning, if considered warranted.

Dev-7 Place controls and/or exclusion on pets within future developments that are located within close proximity to the wetlands and estuarine environments (although it is acknowledged that such controls or exclusions are difficult to police).

Dev-8 Ensure there is suitable provision for vegetated wildlife corridors between key habitats as part of future urban planning and individual developments within the Saltwater Creek catchment and the surrounding areas.

6.2 Assessment of Possible Options / Strategies

Even though each of the 33 possible management options would go some way towards achieving the goals and objectives of this Estuary Management Plan, the greatest benefits will be gained if the most effective options are implemented first. To determine which options are likely to be the most effective, a multi-criteria decision making process was adopted to compare and prioritise the 33 options initially formulated.

Preferred management options were determined by consideration of the following criteria:

1 Effectiveness of the options in addressing the specific management issues;

2 Acceptance of the options by the community and stakeholders;

3 Indicative costs of implementation;

4 The number and priority of objectives addressed by each individual management options;

5 Requirements for the prior completion of other management options;

6 Options should have a range of different implementation approaches;

7 Options should have a range of different implementation timeframes.

For criteria No. 6, 'different implementation approaches' include:

- Administration;
- Education;
- Investigation and Review;
- Planning and Controls;
- On-ground Works; and
- Monitoring.

For criteria No. 7, the 'different timeframes' considered include:

- Immediately (next 12 – 18 months);
- Short term (1 – 3 years); and
- Medium term (3 – 5 years).

Much of the information used in the decision making process was obtained from the community and stakeholder groups via feedback from workshop discussions and one-on-one communications, particularly in regards to the first two criteria.

The final preferred order of implementation represents the most efficient and effective approach from an outcomes viewpoint, and as such, provides the most 'bang for your buck'.

6.2.1 Results of Multi-Criteria Assessment

The results of the multi-criteria assessment are detailed in Appendix B, however, a summary of these results are outlined below. Figure 6-1 shows the relative scores representing the results of the multi-criteria assessment. These scores take into consideration the number of objectives addressed by each option, the relative importance (score) of each objective addressed (refer Section 5.6), the relative cost of implementation, and the relative effectiveness and acceptability of each option. From Figure 6-1 it can be seen that one option stands out as the best value option, this being EMF-1: Development of a formal Entrance Management Policy. There are also a further eight or so options that have higher relative assessment scores than the bulk of options developed for this project.

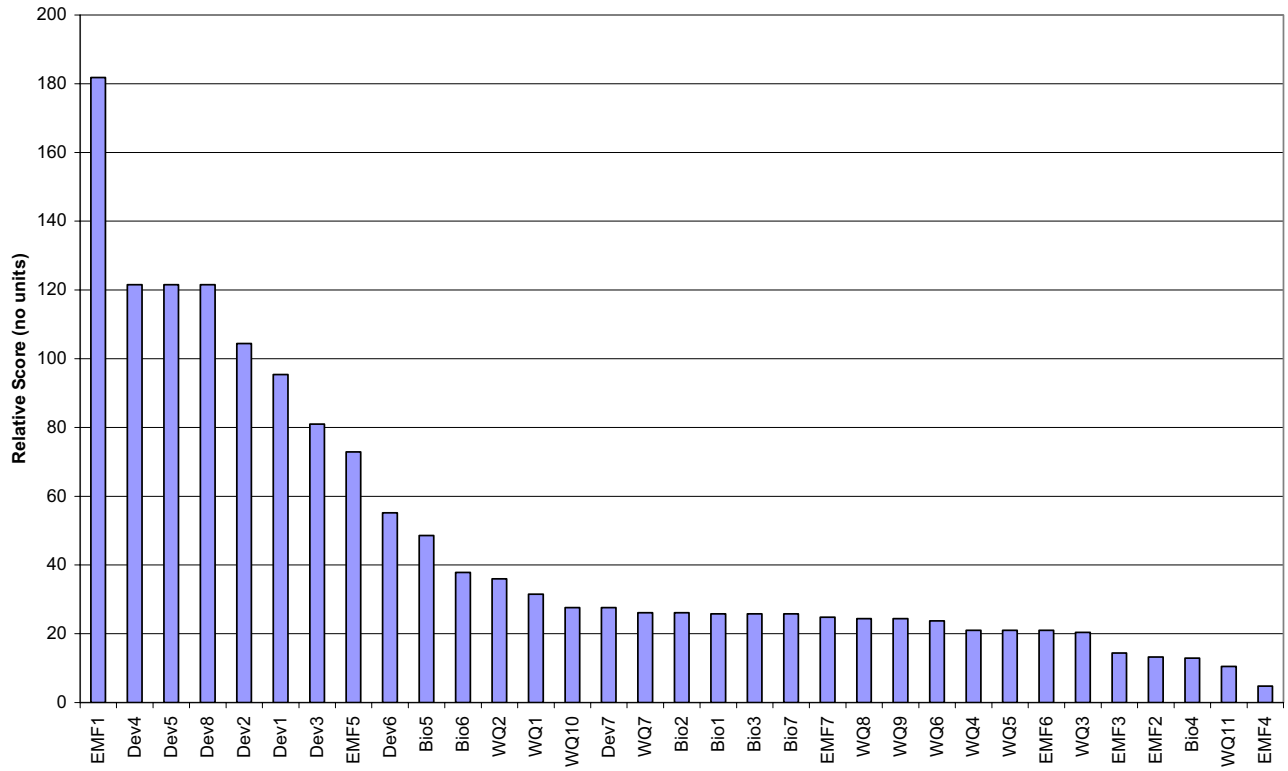


Figure 6-1 Relative Scores for Possible Management Options

A large number of possible options have an approximately equal relative assessment score (with values between 20 and 30, refer Figure 6-1). Although these options are not the highest ranking options, it is considered that the implementation of many of these would be of significant benefit to Saltwater Creek and Lagoon, particularly as they introduce a range of different management approaches and timeframes when compared to the highest scoring options, thus complying with Criteria 6 and 7, as discussed above.

6.2.2 Short-List of Preferred Management Options

A short list of preferred management options was developed based on the results of the multi-criteria assessment, and presented to stakeholders and the community as part of the public exhibition of the document. The short-listed options generally represented the options that scored the highest in the assessment as well as some options that provide diversity in terms of implementation approaches and timeframes. Also, some options were selected for the short-list in order to ensure that every management objective (refer Section 5) is to be addressed by at least one management option / strategy. Similarly, some a few high-scoring options were not included in the short-list as the objectives were already adequately covered by the provisions of other short-listed options.

In response to the public exhibition, a small number of short-listed options have been modified, to better accord with broad community and stakeholder acceptance of the document. The modifications included the amalgamation of two strategies (Dev-1 and Dev-2) into a new strategy (Dev-1a), and the incorporation of two strategies (Dev-3 and EMF-2) into the provisions of other short-listed strategies. For a further two strategies (Dev-8 and Bio-1), wording of the option descriptions has been modified to better reflect an achievable and agreeable outcome.

The short-listed options represent the best potential for meeting the management objectives and thus making significant improvements to the system, when implemented fully. The short-listed management options are presented in Table 6-1.

Table 6-1 List of Preferred Management Options

Option No.	Option description	Relative Score	Management Approach	Relative Timeframe
EMF-1	Prepare & implement Entrance Management Policy	182	Planning	Immed.
Dev-4	Maintain & enforce existing policies re: land sensitivity	122	Administr.	Immed.
Dev-5	Review status and rezone existing 1(d) lands	122	Planning	Immed.
Dev-8	Investigate opportunity for wildlife corridors b/w SEPPs	122	Planning	Immed.
Dev-1a	Prepare stormwater strategy for new development	95	Planning	Immed.
EMF-5*	Periodically allow full hydrological range in wetlands	73	On-ground	Short term
Dev-6	Rezone important habitats to 'environmental protection'	55	Planning	Short term
Bio-5	Monitor biological indicators to assess enviro. health	49	Monitoring	Short term
Bio-6	Education of community re: weeds and pests	38	Education	Short term

Option No.	Option description	Relative Score	Management Approach	Relative Timeframe
WQ-2	Monitoring of water quality to determine health risks	36	Monitoring	Short term
WQ-1	Assess water quality to determine appropriate usage	32	Investigation	Immed.
WQ-10	Audit on-site sewage treatment systems	28	Investigation	Short-term
Bio-2	Rehabilitate degraded habitats via reveg., soil stab., etc	26	On-ground	Short term
WQ-7	Retrofit stormwater filtration devices and wetlands	26	On-ground	Med. term
Bio-3	Increase enforcement of fishing regulations	26	Administr.	Immed.
Bio-1	Review existing EPIs regarding native veg. removal	26	Planning	Short term
WQ-8	Community education re: land and water sensitivity	24	Education	Short term
WQ-9	Encourage lot-based on-site stormwater management	24	Education	Short term
WQ-4	Provide signage at recreation areas regarding risks	21	On-ground	Immed.
WQ-5*	Artificially open entrance to improve water quality	21	On-ground	Immed.
WQ-3	Periodically monitor for hydrocarbon leachate	20	Monitor	Short-term
WQ-11	Assess capacity of sewerage to determine overflows	11	Investigation	Med. term

** These strategies can be effectively achieved through implementation of Strategy EMF-1, however they have been identified separately given their direct linkages to Management Objectives.*

A total of 22 options were short-listed from the initial list of 33. It is considered that 22 individual options / strategies would be a sensible number to aim for within the Estuary Management Plan given the realities of funding and resourcing difficulties within the State and Local Government authorities that will be responsible for implementation.

All selected and non-selected options can be re-considered during future reviews of the Estuary Management Plan. Future reviews of the document will be very important to ensure that the Plan remains relevant, and is considerate of new technologies, approaches and methods for environmental management (i.e. achieves adaptive management).

An options and objectives matrix is shown in Table 6-2. This matrix illustrates the connection between defined management objectives (refer Section 5) and the 22 short-listed options, as defined in Table 6-1. From Table 6-2 it can be seen that all objectives are addressed by at least one management option, while most objectives are addressed by multiple options (maximum of 13 options is respect of Objective No. 6). Option EMF-1 addresses a total of seven (7) separate objectives, while many other options address only one or two objectives.

Table 6-2 Management Options and Objectives Matrix

Strategies	Management Objectives													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WQ-1		■												
WQ-2		■			■									
WQ-3			■											
WQ-4		■												
WQ-5*		■												
WQ-7	■					■								
WQ-8	■	■				■								
WQ-9	■	■				■								
WQ-10		■		■										
WQ-11		■												
Bio-1						■								
Bio-2	■					■								
Bio-3						■								
Bio-5						■			■					
Bio-6						■	■							
EMF-1		■			■			■	■	■	■	■		
EMF-5*						■			■					
Dev-1a *(prev. Dev-1 & Dev-2)*						■		■					■	■
Dev-4						■							■	■
Dev-5						■							■	■
Dev-6													■	■
Dev-8						■							■	■

** These strategies can be effectively achieved through implementation of Strategy EMF-1*

6.2.3 Proposed Implementation Order

While the possible management options cover a range of different implementation timeframes, it is also acknowledged that some options are reliant on the prior successful implementation of other options. Consequently, it is important that these options that influence the implementation of later options are actually carried out relatively early, to prevent unnecessary delays in implementation of later options.

Based on a review of the possible management options formulated, the following critical linkages were identified:

- Option EMF-1 needs to precede Options EMF-5, WQ-5, and EMF-3;
- Option WQ-1 needs to precede Options WQ-4 and WQ-5.

Given the above limitation and the results of the multi-criteria assessment, a final recommended order of implementation for the preferred management options has been developed, as shown in Table 6-3.

Table 6-3 Implementation Order for Preferred Management Options

To be implemented immediate (within 12 – 18 months)	**Rank**
EMF-1: Prepare and adopt a formal Entrance Management Policy	1/22
WQ-1: Assess water quality to determine appropriate usage	2/22
Dev-5: Review status of existing 1(d) urban investigation lands	3/22
Dev-4: Maintain & enforce existing policies re: land sensitivity	4/22
Dev-1a: Prepare stormwater strategy for new development	5/22
Dev-8: Investigate opportunity for wildlife corridors b/w SEPPs	6/22
Bio-3: Increase enforcement of fishing regulations	7/22
WQ-4: Provide signage at recreation areas regarding risks	8/22
WQ-5*: Artificially open entrance to improve water quality	9/22
To be implemented in the short term (within 1 – 3 years)	
EMF-5*: Periodically allow full hydrological range in wetlands	10/22
Dev-6: Rezone important habitats to 'environmental protection'	11/22
Bio-5: Monitor biological indicators to assess environmental health	12/22
Bio-6: Education of community re: weeds and pests	13/22
WQ-2: Monitoring of water quality to determine health risks	14/22
WQ-10: Audit on-site sewage treatment systems	15/22
Bio-2: Rehabilitate degraded habitats via revegetation, soil stab., etc	16/22
Bio-1: Review existing EPIs regarding native veg. removal	17/22
WQ-8: Community education re: land and water sensitivity	18/22
WQ-9: Encourage lot-based on-site stormwater management	19/22
WQ-3: Periodically monitor for hydrocarbon leachate	20/22
To be implemented in the medium term (within 3 – 5 years)	
WQ-7: Retrofit stormwater filtration devices and wetlands	21/22
WQ-11: Assess capacity of sewerage to determine overflows	22/22

** These strategies can be effectively achieved through implementation of Strategy EMF-1*

6.3 Descriptions of Preferred Options / Strategies

The following sections present detailed descriptions of the 22 short-listed management options / strategies. Where necessary, maps have also been presented to illustrate the area relevant to the specific options / strategies. Options have been collated and described according to their different management approaches, viz: planning, administration, on-ground works, education, investigation, and monitoring.

6.3.1 Planning Options

6.3.1.1 EMF-1: Prepare and adopt a formal Entrance Management Policy for Saltwater Creek and Lagoon

Rank: 1/22

Addressing Objectives: 2, 5, 8, 9, 10, 11, 12

This option involves the preparation and adoption of a formal Entrance Management Policy for Saltwater Creek, in accordance with Council's standard template for Environmental Planning Instruments. Interim Entrance Management Protocols are presented in Appendix C. These Protocols incorporate the following key principles:

- For the period from the end of the Easter school holidays to two weeks prior to the start of the September school holidays, the entrance will be opened artificially when the water level in the creek reaches 2.0m AHD. Essentially all existing wetland vegetation is located on land below RL 2.0m AHD, so there is no significant benefit to allow waters to exceed this level. Given that the typical entrance breakout level is between RL 1.5 and 1.8m AHD, it is considered to be exceptional circumstances only that would result in levels approaching RL 2.0m AHD.
- For the remainder of the year, the entrance will be opened artificially when the water level is the creek reaches 1.8m AHD. This level is at the upper bound of normal entrance breakout conditions, thus giving the system ample opportunity to open naturally before intervention is permitted. The lower artificial breakout trigger level for this period recognises the economic interests of the Trial Bay Tourist Park and the potential impact on patrons at higher water levels.
- The entrance will be opened artificially when water quality at the creek mouth behind the entrance berm fails to meet specified criteria. Saltwater Creek, particularly the area behind the entrance berm, is utilised for primary contact recreation. Once water quality fails to meet primary contact recreation guidelines, or fails to meet basic ecosystem health guidelines, the entrance will be artificially opened to release poor quality water to the ocean and allow ingress of 'clean' oceanic water into the estuary.
- In exceptional circumstances, the entrance may be artificially closed to allow access between Front Beach and the Surf Life Saving Club, providing that the open entrance condition is restored immediately following completion of the need for access along the beach.

The policy should outline responsibility for implementation, including the nomination of authorised personnel to undertake physical removal of the entrance sand berm (when necessary, in accordance with the principles of the Policy), and the preferred timing and methodology for entrance works. The policy should also apply for a fixed period only (say 5 years, coinciding with review of this Estuary

Management Plan). At the end of this period, the principles of the Entrance Management Policy, along with specified trigger levels and water quality criteria, should be reviewed prior to continuance of the Policy.

6.3.1.2 Dev-5: Review status of existing 1(d) urban investigation lands and rezone to more appropriate landuse zonings

Rank: 3/22

Addressing Objectives: 6, 13, 14

The lands within the Saltwater Creek catchment that are zoned for urban investigation (i.e. zone 1(d)) are shown in Figure 6-2. Much of the 1(d) land to the west of Saltwater Lagoon is currently the subject of an LES (Connell Wagner, draft 2004).

In consideration of the environmental sensitivity of the existing 1(d) lands around Saltwater Creek and Lagoon, this option recommends rezoning those sections that are clearly not suitable for urban development in the future. This would be achieved through adoption of appropriate provisions in the LES, prior to any changes to the LEP.

The environmental sensitivity of the lands surrounding Saltwater Creek and Lagoon has been considered as part of this Estuary Management Plan, and takes into account the natural vertical variation of water levels in the estuary and how that transposes to a spatial change in inundation extents and vegetation community structure. A 'vertical' buffer to a level of approximately RL 3.0m AHD has been recommended by Kendall and Kendall (2003) (refer Section 2.2). Consideration has also been given to a additional 'horizontal' buffer / offset of 50 metres from the RL 3.0m AHD contour to ensure continued ecological function of riparian zone, terrestrial fauna passage around the lagoon, and separation of development from the waters edge in the future when water levels are higher than at present (refer Haines, 2005). Figure 6-2 shows areas within existing 1(d) zone that are recommended for rezoning to a more appropriate zone, such as 'environmental protection'. The boundary of the suggested zoning change is defined as a 50 metre offset from the RL 3.0m AHD contour, or the RL 3.1m AHD contour, whichever is the further landward. A level of RL 3.1m AHD represents the adopted 1 in 100 year flood level around Saltwater Lagoon, based on recent flood modelling results (WBM, 2005).

Detailed ground survey data is required to confirm the actual extents of the recommended zoning change.

Where necessary, the buffer area to be rezoned should be revegetated with appropriate indigenous species to maximise its ecological value (see Strategy Bio-2, refer Section 6.3.3.4). The land should then be dedicated to Council and/or DEC, as appropriate, to form a new Regional Park or similar.

The buffers should be protected from the impacts of adjacent future urban development. Masterplans for development should incorporate provisions for perimeter roads separating the buffers from adjacent urban areas. Further, the buffers within the environmental protection zone should not be used as a means to treat stormwater runoff, nor should it be used as an Asset Protection Zone (APZ) and cleared to reduce bushfire risk. Bush fire offsets should be located on the landward side of the environmental protection zone boundary. The bush fire offsets could incorporate perimeter roads

and/or stormwater treatment measures. Based on advice from DEC (NPWS), asset protection offsets from the buffers to address bushfire hazards should be based on Class 3 buildings in accordance with the *Planning for Bushfire Protection 2001* document.

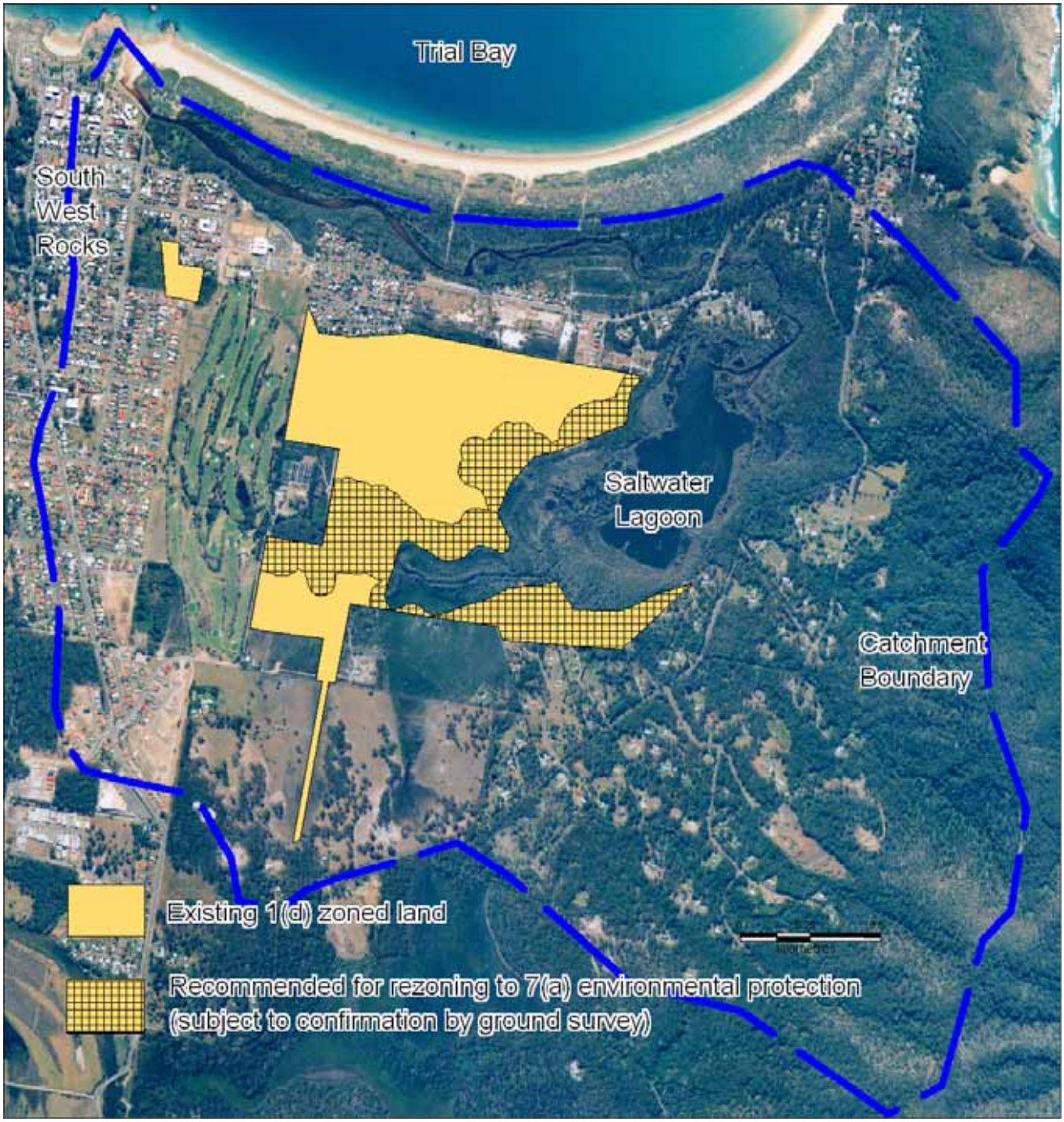


Figure 6-2 Existing Urban Investigation [1(d)] lands within the Saltwater Creek catchment and recommendations for rezoning based on environmental sensitivity and conservation of estuarine habitats

6.3.1.3 Dev-1a: Prepare a stormwater management strategy for the Saltwater Creek and Lagoon catchment to specify stormwater requirements to achieve a net reduction of pollutants entering the estuary

Rank: 5/22

Addressing Objectives: 6, 8, 13, 14

This strategy is an amalgamation of previously presented strategies associated with establishing new development control to i) have net positive benefits to the wetlands (Dev-1) and ii) impose 'best practice' stormwater management requirements on all new development (Dev-2).

Existing urban development discharges stormwater into Saltwater Creek and Lagoon, and is contributing to the currently degraded condition of the estuary. Additional urban development within the Saltwater Creek catchment is expected in the future.

Rather than simply conforming to BASIX requirements, future development can provide an opportunity for *improving* the condition of the estuary by treating existing and future runoff to a level whereby pollutant loads entering the waterway are lower in the future than under existing conditions. This can be achieved by 'best practice' urban stormwater and water cycle management for all future developments, combined with treatment of stormwater from existing urban areas.

This strategy involves the preparation of a holistic, catchment-wide urban stormwater strategy for Saltwater Lagoon. The stormwater strategy would describe what stormwater treatment measures are required for all new developments within the catchment, combined with required treatment measures for runoff from existing urban areas, in order to achieve a net reduction of pollutants entering the estuary (thus achieving a net positive outcome for the estuary) for events up to the 1 in 2 year ARI, as a minimum. Treatment to this flow level would correspond to treatment of approximately 99.5% of total runoff volume from the catchment.

It is expected that the stormwater strategy would include a range of lot-scale and end of line treatment measures in order to achieve pollutant load objectives, including:

- Dual reticulation water supply (using treated effluent from nearby sewage treatment works);
- Rainwater tanks (in addition to proposed dual reticulation system);
- Stormwater harvesting;
- Filter strips;
- Vegetated swales;
- Infiltration basins;
- Bioretention basins;
- Raingardens;
- Detention ponds; and
- Artificial wetlands.

Examples of 'best practice' water cycle and stormwater management are available at www.wsud.org and www.clearwater.asn.au.

6.3.1.4 Dev-8: Investigate opportunities to establish wildlife corridors between SEPP-14 wetlands

Rank: 6/22

Addressing Objectives: 6, 13, 14

Long term planning of the urban environment should consider opportunities for re-establishing wildlife migration between similar habitats in relatively close proximity. It is considered that an opportunity exists to re-establish a wildlife corridor between the wetland habitats of Saltwater Lagoon (SEPP-14 No. 439) and the wetland to the south (SEPP-14 No. 446) (refer Figure 6-3).

Wildlife corridor provisions should be incorporated into a broad landscape-based planning strategy, to ensure that individual developments cannot compromise opportunities for, and integrity of, the corridors. Therefore, the potential for establishing corridors should be investigated at the Local Environmental Study (LES) stage (or preceding an LES), so that appropriate provisions can be included in any LEP amendments. Investigations of wildlife corridors should not only focus on existing wildlife migration, but rather, should also seek to address potential migration once the corridors are fully regenerated to natural vegetation conditions. Land associated with the corridors would need to the zoned for environmental protection and dedicated to Council and/or National Parks, as appropriate.

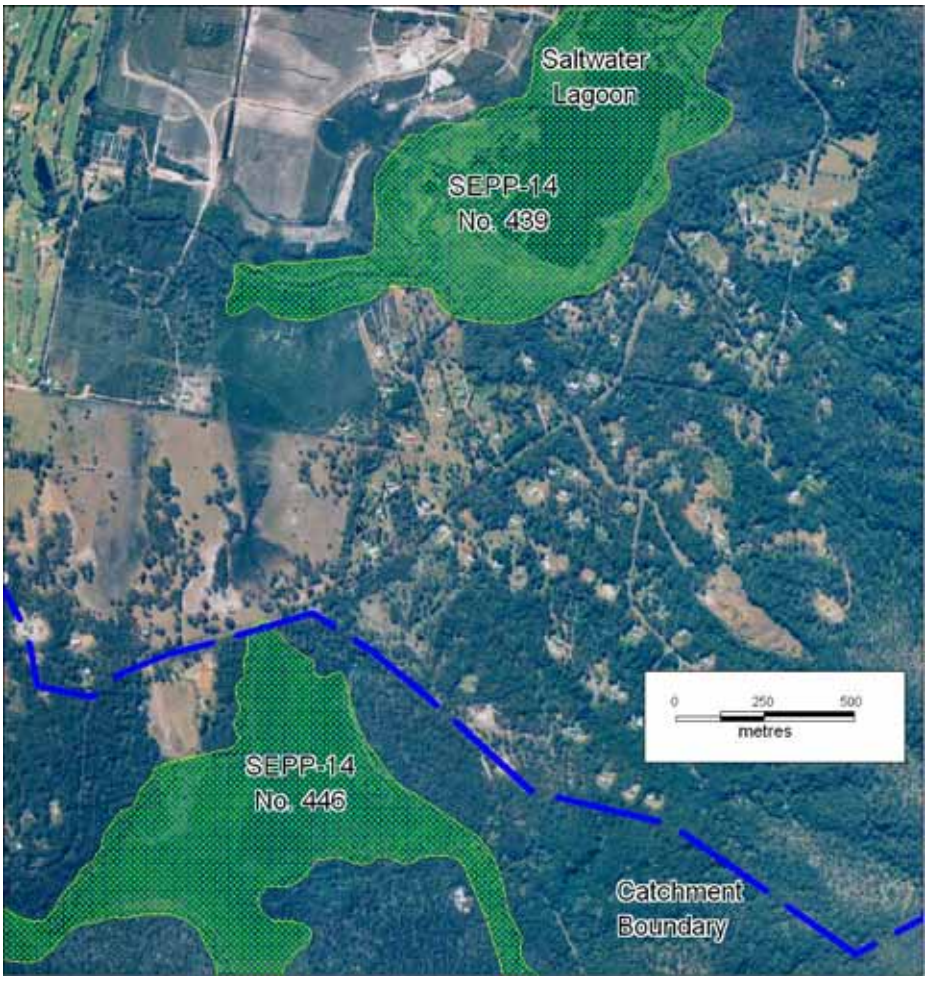


Figure 6-3 SEPP-14 wetlands to be linked by wildlife corridor

6.3.1.5 Dev-6: Rezone important habitats around Saltwater Lagoon to 'environmental protection'

Rank: 11/22

Addressing Objectives: 13, 14

Strategy Dev-5 (see Section 6.3.1.2) recommends rezoning of important habitats around Saltwater Lagoon within the current 1(d) land to an appropriate 'environmental protection' zoning. This option / strategy involves the rezoning of other sensitive lands around the lagoon to an environmental protection zone. Lands that should be rezoned include portions of the 1(c) land that is located within a proximity of 50 metres from the RL 3.0m AHD contour, or within the RL 3.1m AHD contour, whichever is the further landward. Rationale for selecting this proposed rezoning boundary is discussed in Strategy Dev-5 (see Section 6.3.1.2).

Figure 6-4 shows the 1(c) lands that are recommended to be rezoned for environmental protection. Rezoning of the land should be accompanied with provisions for existing use rights – that is, landholders should be entitled to continue existing business on the land, without modification that would otherwise necessitate development consent. Where possible, areas rezoned for environmental protection should be actively revegetated, through private / public agreements or landholder incentives (refer Strategy Bio-2, see Section 6.3.3.4). As individual land parcels become developed, the environmental protection zoned land should be dedicated to Council and/or DEC, as appropriate.

6.3.1.6 Bio-1: Review existing environmental planning instruments regarding native vegetation removal

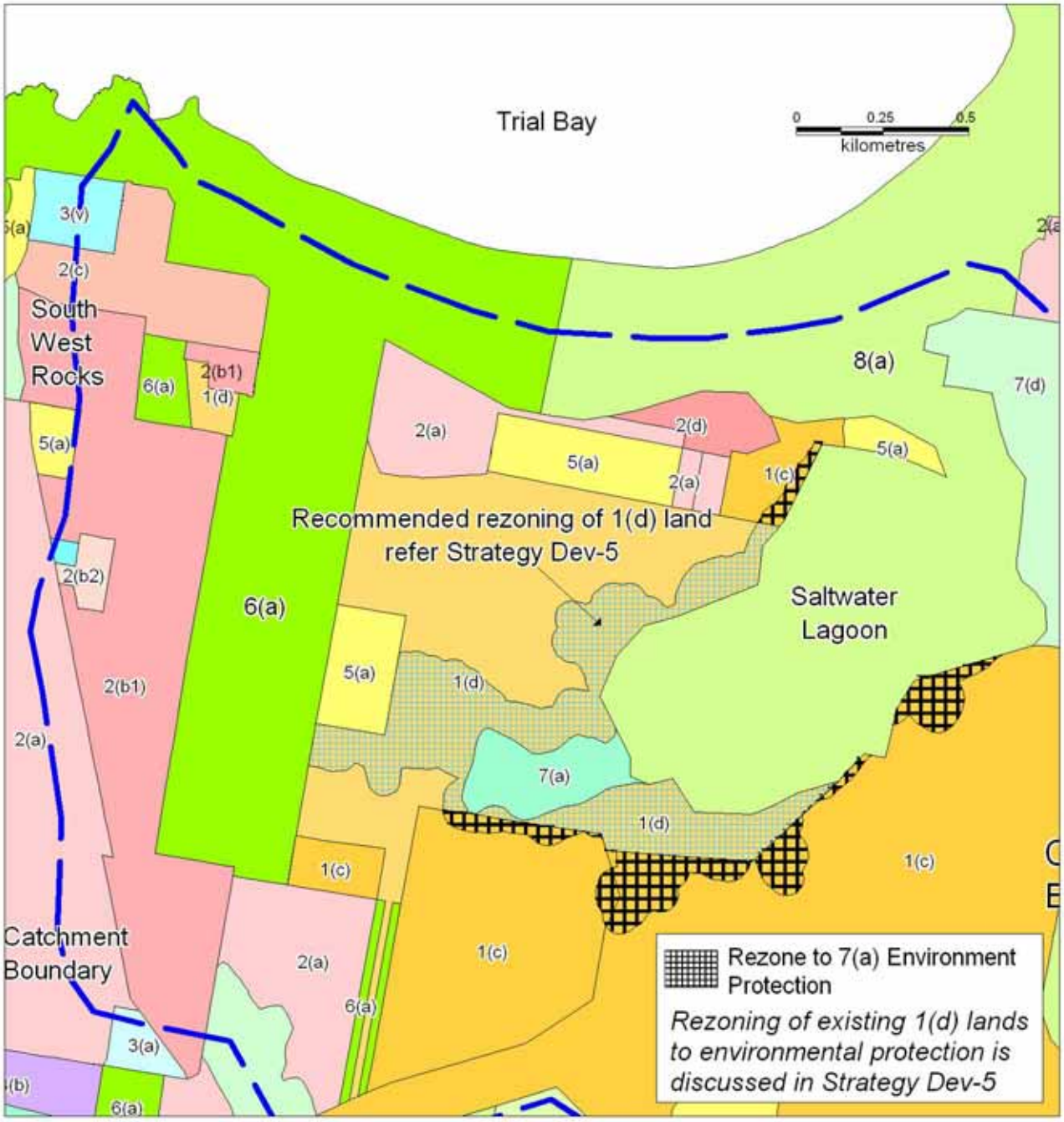
Rank: 17/22

Addressing Objective: 6

Protection of existing native vegetation is afforded by a number of environmental planning instruments. The *Native Vegetation Conservation Act 2003* applies primarily to non-urban lands, while Council Tree Preservation Orders (TPOs) apply to urban vegetation.

Provisions pursuant to these environmental planning instruments should be reviewed in the context of ensuring there are no 'loop holes', particularly in the cross-over regions, whereby significant stands of native vegetation can be cleared by landholders. In particular, the review should consider the value of native vegetation regrowth and minimum tree sizes covered by the existing instruments.

All future Masterplans for proposed developments within the catchment should document existing native vegetation stands, and should incorporate provisions for maintaining such stands, wherever possible (eg incorporation into public open space land etc), or should detail compensatory replacement of native vegetation if there is no feasible alternative to removal.



1(c) Rural (Small Holdings)
1(d) Rural (Investigation)
2(a) Residential A
2(b1) Residential B1
2(b2) Residential B2
2(c) Residential C
2(d) Residential (Tourist facility)
3(a) Business (General) A
3(b) Business (Neighbourhood) B
3(v) Business (Village) V
4(b) Light Industrial B
5(a) Special Uses A
6(a) Open Space A
7(a) Wetlands Protection
7(d) Scenic Protection
8(a) National Parks Nature Reserve
8(b) Proposed National Parks Extension

Figure 6-4 Areas to be rezoned for environmental protection, excluding the existing 1(d) land, which is addressed separately under Strategy Dev-5

6.3.2 Administration Options

6.3.2.1 Dev-4: Maintain & enforce existing policies regarding the sensitivity of lands surrounding Saltwater Creek and Lagoon

Rank: 4/22

Addressing Objectives: 6, 13, 14

This strategy involves Council continuing to consider the existing suite of development and planning controls that helps define the natural sensitivity of lands surrounding Saltwater Creek and Lagoon. Existing controls include SEPP-14, SEPP-71, DCPs 10, 27, 30, 32 and 34, and the South West Rocks Town Centre Masterplan.

6.3.2.2 Bio-3: Increase enforcement of recreational fishing regulations within Saltwater Creek and Lagoon

Rank: 7/22

Addressing Objective: 6

It was identified through the community consultation process that fishing regulations, particularly in respect of minimum size, were not being followed by some members of the community, especially during holiday periods. This strategy involves increasing the level of policing of these regulations to ensure that excessive and/or under-sized fish are not being taken from the estuary.

As the estuary is closed from the ocean for the majority of the time, there is no mechanism for constant recruitment of fish from the ocean. Therefore, inappropriate fishing practices in Saltwater Creek may potentially have serious consequences on the ecological structure of the estuarine environment.

6.3.3 On-Ground Works Options

6.3.3.1 WQ-4: Provide signage at key recreation areas regarding risks for swimmers and other waterway users

Rank: 8/22

Addressing Objective: 2

Following an assessment of the typical water quality within Saltwater Creek and Lagoon under a range of preceding rainfall and entrance conditions (refer Strategy WQ-1, Section 6.3.5.1), and determination of the levels of acceptable risk for primary contact within the waterway, appropriate signage should be installed at key recreation areas informing the public of water quality risks. Locations for signage should include, as a minimum, adjacent to public reserve beside the Surf Life Saving Club, adjacent to footbridges and road bridges across the waterway, and adjacent to the Lagoon View Tourist Park / Caravan Park.

Signage would typically relate expected water quality at individual sites with preceding rainfall and also the condition of the entrance, if determined to be important. For example, the sign beside the Surf Life Savings Club may say…

> "*Due to possible poor water quality, swimming in Saltwater Creek is not recommended for a period of 24 hours after rainfall if the entrance is open to the ocean, or 72 hours after rainfall if the entrance is blocked*"

Signage could also inform swimmers of fast flowing currents through the entrance channel, requesting swimmers take care when bathing or crossing the channel (particularly with children and infants).

6.3.3.2 WQ-5: Artificially open Saltwater Creek entrance to improve water quality and thus maintain recreational amenity

Rank: 9/22

Addressing Objective: 2

Provisions should be made within the Entrance Management Policy (refer Strategy EMF-1, Section 6.3.1.1) to allow artificially opening the entrance in order to improve water quality, particularly following rainfall and particularly during the peak summer holiday season when there is the greatest demand for primary contact recreation within the waterway.

Artificially opening the entrance to improve water quality should only be carried out if it is determined that conditions under an open entrance would be significantly improved than under closed entrance conditions, as determined through implementation of Strategy WQ-1 (refer Section 6.3.5.1).

Prior to entrance manipulation in accordance with the Entrance Management Policy, an environmental assessment of potential impacts would need to be carried out, and relevant licences and consent obtained from authorities (e.g. Department of Lands, DPI-Fisheries).

6.3.3.3 EMF-5: Periodically allow a full hydrological range in Saltwater Lagoon to inundate fringing wetlands

Rank: 10/22

Addressing Objectives: 6, 9

The wetlands surrounding Saltwater Creek and Lagoon are dependent on periodic inundation by water. If the entrance was continuously opened artificially at levels lower than the natural breakout levels, some sections of the wetlands may dry out, and may be subject to 'terrestrialisation' (i.e. invasion be non wetland species).

Provisions should be made within the Entrance Management Policy (refer Strategy EMF-1, Section 6.3.1.1) to allow for periods when the wetlands can be fully inundated. Floristic assessment of wetlands shows that inundation-dependent vegetation extends to a level of approximately RL 2.0m AHD. Therefore, water levels within the lagoon should be permitted to reach this level, under natural conditions, to prevent non-wetland species invasion. As there are a number of commercial interests

that would be disadvantaged by high water levels within the lagoon, it is recommended that the timeframe for allowing high levels of inundation should be limited to the non-holiday period (thus minimising direct and follow-on economic impacts to South West Rocks). Timing of the 'no intervention' period should also consider the seasonality of ecological processes and local rainfall conditions.

Given that fish recruit from late winter to early summer, nutrient rich upwelling occurs in the ocean in spring and summer, and prespawning migration to the ocean occurs in autumn and later winter (MHL, 2002), combined with peak tourism opportunity in summer and other holiday periods, the most ideal time for allowing more substantial inundation is likely to be the period from mid autumn to early spring (i.e. April to September). As April is also a popular time for tourism, it is recommended that the higher inundation period commences immediately following the Easter long weekend, and extends until two weeks prior to the beginning of the September school holidays.

MHL (2002) and Bureau of Meteorology monthly summaries (http://www.bom.gov.au/climate/averages/tables/cw_059030.shtml) indicate that the dries months of the year in South West Rocks (measured at Smoky Cape lighthouse) are July to October. Long-term rainfall averages for the 5 month period April – August suggests an average rainfall of 600mm. This would roughly correspond to an increase in water level of at least 1.5 metres, which should result in levels potentially reaching RL 2.0m AHD at least once during this period, depending on the starting lagoon level in April and the conditions at the berm that would dictate natural entrance breakout.

Local landholders that would suffer demonstrable economic loss should be encouraged to 'flood proof' assets and interests, thus minimising future potential losses associated with the adopted entrance management strategy.

6.3.3.4 Bio-2: Rehabilitate degraded habitats through revegetation, soil stabilisation, etc

Rank: 16/22

Addressing Objectives: 1, 6

Some areas around the foreshores of Saltwater Creek and Lagoon have been degraded through previous land clearing, weed invasion, fire, constructed drainage, inappropriate access and poor land management. These degraded areas should be rehabilitated in order to maximise the value of the estuary and its surrounding habitats.

Areas around the estuary to be rehabilitated include part of the buffer recommended to be rezoned (see Strategy Dev-5, refer Section 6.3.1.2). Degraded areas within the recommended buffer are shown in Figure 6-5, and should be rehabilitated as part of proposed land redevelopment.

Future rehabilitation works around the estuary and its feeder tributaries could be carried out using labour and/or funding from future development sites within the catchment, as part of the requirement to have a net positive impact on the Saltwater Creek and Lagoon environment.

Figure 6-5 Extent of rehabilitation required within proposed Environmental Protection rezoning

6.3.3.5 WQ-7: Retrofit stormwater filtration devices and wetlands to manage runoff from adjacent urban areas

Rank: 21/22

Addressing Objectives: 1, 6

Strategy Dev-1a (refer Section 6.3.1.3) recommends the development of a stormwater strategy that addresses existing urban runoff, in combination with future development works, to achieve a net reduction of pollutants entering the estuary. This strategy / option has been included to achieve minimum input of pollutants from existing urban areas, regardless of options associated with future development (that is, provisions for addressing runoff from existing urban areas do not need to be dependent on the approval and development of new urban areas in the future).

Stormwater treatment from existing urban areas is consistent with the Kempsey Shire Urban Stormwater Management Plan (refer Section 1.4.16). Stormwater filtration devices to be considered by this strategy should include gross pollutant traps, sediment ponds and artificial wetlands.

Filtration devices that primarily address litter, such as trash racks, proprietary GPTs and litter booms, would provide limited benefit to the system.

It is considered that opportunities exist for construction of stormwater treatment measures within the Golf Club / Country Club land. These opportunities would include construction of off-line stormwater storage and treatment ponds, permanent and ephemeral wetlands, and stormwater harvesting and reuse for irrigation purposes. Possible locations of stormwater treatment areas within the golf course are shown in Figure 6-6.

6.3.4 Education Options

6.3.4.1 Bio-6: Community education regarding weeds and pests

Rank: 13/22

Addressing Objectives: 6, 7

This strategy would involve community education regarding the natural values of the Saltwater Creek catchment, and how this can be degraded through poor land management practices, weeds and pests in surrounding rural-residential lands. Topics for education would include good environmental behaviour, bushland friendly plants, grey water management, garden maintenance and the 'bush beyond the backyard'.

Community based education would normally involve educational brochures, signage, media coverage and participatory on-site workshops. As the area is relatively small, direct contact with adjacent rural landholders would also be feasible. It is expected that DEC (NPWS) and/or DPI (Agriculture) could be involved in the consultation and discussions with the community.

6.3.4.2 WQ-8: Community education regarding the natural sensitivity of Saltwater Creek and Lagoon

Rank: 18/22

Addressing Objectives: 1, 2, 6

Similar to Strategy Bio-6, a community education program can be undertaken targeting to the urban and tourist communities around Saltwater Creek and Lagoon. The education program should focus on the uniqueness of Saltwater Creek and Lagoon, and the environmental sensitivity of the area, hence the need for careful landuse management and strict planning controls.

Education would involve brochures, media coverage and signage. Participation by local schools in environmental works associated with the estuary would also increase the community's appreciation of the natural values of the area. In this regard, local schools could participate in regular ecological and water quality monitoring of the system.

Figure 6-6 Possible location and configuration of wetlands and stormwater treatment devices within the South West Rocks Country Club

6.3.4.3 WQ-9: Encourage lot-based on-site stormwater management

Rank: 19/22

Addressing Objectives: 1, 2, 6

Water Sensitive Urban Design (WSUD) and Integrated Water Cycle Management (IWCM) are aimed at reducing stormwater runoff from urban areas by adopting a range of options including rainwater tanks (with reuse for garden and lawn watering, toilet flush, laundry, hot water services, etc), infiltration systems, grass swales (instead of kerb and guttering) and bio-retention basins.

Council could encourage the adoption of WSUD and other on-site stormwater controls through a range of financial incentives (including discounted rainwater tanks, rate reductions etc), or other market-based incentives. Other urban centres, such as Brisbane, have provided rebates to urban landholders who purchase and install rainwater tanks, in an effort to reduce volumetric runoff, which also corresponds to reduced demand on existing potable water resources. Rainwater tanks as small as 2,500 litres can have a significant impact on lot-based stormwater management.

Recycled effluent, treated to a very high standard, has also been identified as a possible measure for reducing potable water demand, by being used within households and for irrigation of municipal lands as part of a wider dual reticulation system (refer Section 1.4.17).

6.3.5 Investigation and Review Options

6.3.5.1 WQ-1: Assess water quality to determine risks associated with recreational usage of Saltwater Creek and Lagoon during different rainfall and entrance conditions

Rank: 2/22

Addressing Objective: 2

At present, Saltwater Creek and Lagoon are utilised by the public for a range of recreational activities without a good appreciation for the risks associated with the use. Many community members consider the waters to be polluted, particularly when it becomes tannin-stained by surrounding Melaleucas.

A detailed assessment of water quality within Saltwater Creek and Lagoon is required to determine the risks of using the waterway for recreational purposes, including swimming. The assessment would need to cover the entire waterway, and especially those areas that are known to support recreational activities. The assessment would also need to cover a range of meteorological and entrance berm conditions. The results of the assessment would be incorporated into the Entrance Management Policy (refer Strategy EMF-1, Section 6.3.1.1) and would be used to help develop educational signage regarding water safety (refer Strategy WQ-4, Section 6.3.3.1).

Water quality assessment should include monitoring of coliforms and enterococci, as well as general environmental health parameters (such as nutrients, dissolved oxygen and chlorophyll) and hydrocarbons, during both dry weather and wet weather periods, and during periods when the entrance is both open and closed. For this reason, monitoring will be opportunistic and will need to

be undertaken over a period of about 12 months or so. Suggested water quality monitoring locations within Saltwater Creek and Lagoon are presented in Figure 6-7.

Figure 6-7 Suggested Water Quality Monitoring Locations for Usage Assessment

6.3.5.2 WQ-11: Assess capacity of South West Rocks sewerage system to determine frequency of overflows and risks to Saltwater Creek and Lagoon

Rank: 22/22

Addressing Objective: 2

The townships of South West Rocks and Arakoon are serviced by a reticulated sewerage system (refer Figure 6-8). The sewage treatment plant is located close to Saltwater Lagoon, adjacent to the golf course. Effluent from the plant is mostly discharged to beach dune between the Macleay River entrance and Back Creek, while some is also used for irrigation on the adjacent golf course. Sewage pumping stations are located around South West Rocks and near Saltwater Creek to help direct the sewage to the treatment plant.

This strategy involves closely assessing the existing sewerage system in light of current and future demands, to determine if there are any 'bottle necks' in the system that would result in sewage overflows into Saltwater Creek or Lagoon. The proximity of several sewage pumping stations adjacent to the waterway suggests that any lack of capacity in the system will result in direct sewage contamination of the estuary.

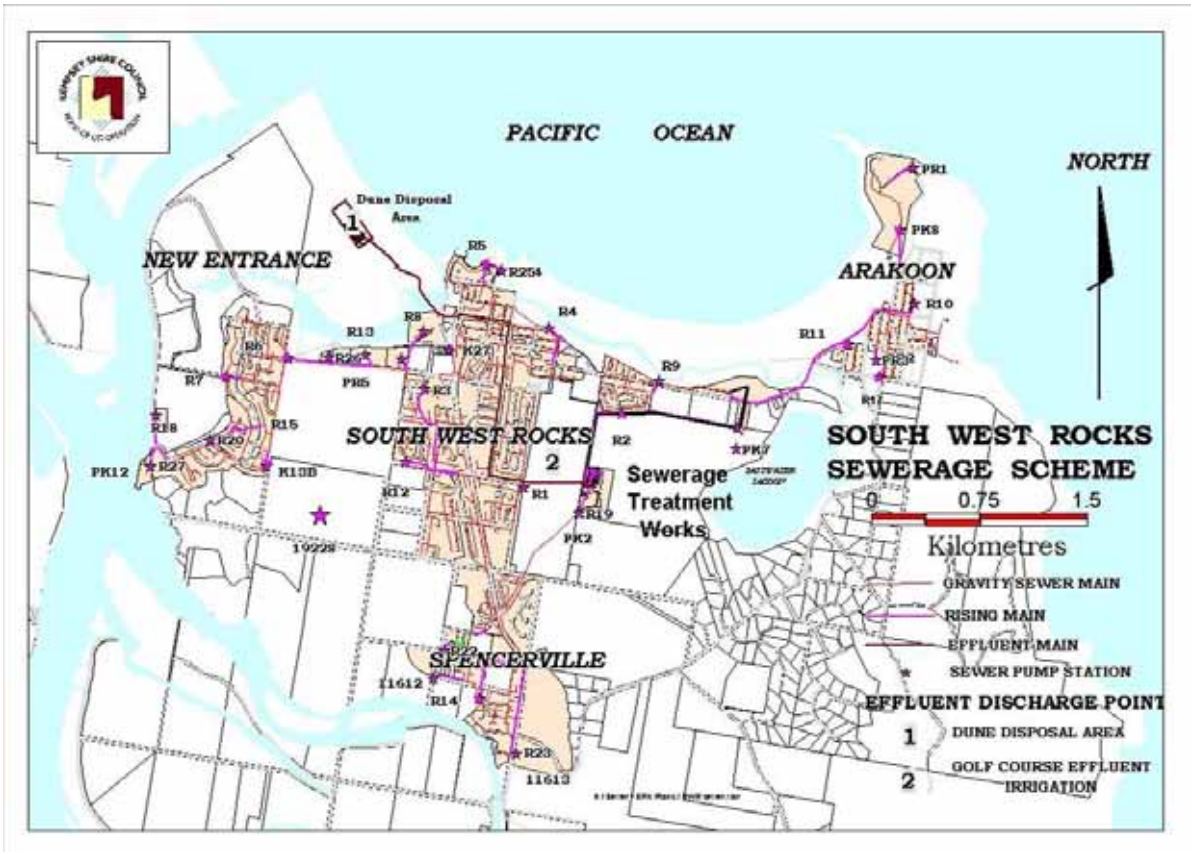


Figure 6-8 South West Rocks Sewerage Scheme (Courtesy of Kempsey Shire Council)

If it is determined that the sewerage system is lacking capacity, or will lack capacity in the future once development potential is realised, then this issue should be redressed before it results in unacceptable sewage discharge to the environment.

This strategy is consistent with recommendations of the Kempsey Shire Urban Stormwater Management Plan (refer Section 1.4.16).

6.3.5.3 WQ-10: Audit on-site sewage treatment systems

Rank: 15/22

Addressing Objectives: 2, 4

Rural-residential lands to the south of Saltwater Lagoon are not connected to the reticulated sewerage system (refer Figure 6-8), and as such, treat sewage via on-site sewage treatment systems (eg septic systems).

On-site sewage treatment systems have the capacity to pollute groundwater and surface water environments if they are inappropriately designed, constructed or maintained. Therefore, it is recommended that every on-site sewage treatment system is assessed / audited, along with the surrounding soil conditions (eg permeability), to determine the likely potential of the system to pollute the environment.

Systems that are found to be inappropriate should be repaired or replaced by landholders. Alternatives may include aerated holding tanks and regular pump-out, or surface disposal and evaporation, or a combination of treatments. Recent inspections of registered on-site systems around Saltwater Lagoon by Council have yielded 21 non-compliances (out of 58 systems inspected). Un-registered systems were not identified or inspected by Council.

This strategy is also consistent with recommendations of the Kempsey Shire Urban Stormwater Management Plan (refer Section 1.4.16).

6.3.6 Monitoring Options

6.3.6.1 Bio-5: Monitor biological indicators within Saltwater Lagoon and the catchment to assess environmental health

Rank: 12/22

Addressing Objectives: 6, 9

This strategy involves periodic assessment of biological indicators to provide a measure of the ecological health of Saltwater Creek and Lagoon. It is expected that different biological indicators could be monitored on different timescales and by different organisations. At one extreme, frequent monitoring of basic biological parameters could be undertaken by local schools or community groups (using the waterwatch kits for example). At the other extreme, detailed surveys of flora and fauna could be repeated every 3 – 5 years or so utilising permanent vegetation monitoring plots in the areas that were surveyed by Kendall and Kendall (2003) to provide information on population, diversity, density and viability.

In between these two extremes, there may be some simple and easy methods for periodically monitoring ecological parameters, such as seagrass depth limits.

The biological monitoring program is also to assess weeds and pest species, to provide a gauge of the degree of anthropogenic disturbance of the environment.

6.3.6.2 WQ-2: On-going monitoring of water quality at key recreation areas to determine public health risks

Rank: 14/22

Addressing Objectives: 2, 5

Following on from the initial assessment of water quality to determine the appropriateness of recreation activities within Saltwater Creek and Lagoon, it is recommended that water quality continues to be monitored at key locations within the waterway during peak usage periods (with appropriate usage locations determined following implementation of Strategy WQ-1). As a minimum, water quality should be measured every 5 days or so during peak recreational periods, i.e. summer (in accordance with ANZECC, 2000 guidelines) behind the entrance sand berm and adjacent to the Tourist / Caravan Park.

When water quality results indicate that the system is unfit for primary contact recreation activities, appropriate signage should be erected and/or the provisions outlined within the Entrance Management Policy (refer Strategy EMF-1, Section 6.3.1.1) enacted (eg open the entrance artificially).

Regular water quality monitoring should also include targeted environmental health parameters, such as dissolved oxygen, pH and chlorophyll, to determine if the aquatic ecosystems also require immediate management (eg open the entrance to introduce aerated saline waters to the estuary), and thus potentially prevent future fish kills.

6.3.6.3 WQ-3: Periodically monitor for hydrocarbon leachate contamination in surface and ground waters

Rank: 20/22

Addressing Objective: 3

Formal site remediation of the former oil terminals adjacent to Saltwater Creek and Lagoon have largely been completed, however, it is possible that some hydrocarbon contamination will continue in the future. This strategy involves carrying out additional investigations of hydrocarbon contamination through periodically monitoring for hydrocarbons within the surface waters of Saltwater Creek, as well as corresponding monitoring of groundwater quality, to determine if continued groundwater contamination is accumulating within the aquatic environment.

An initial water quality assessment should also be supplemented by a geochemical assessment to determine if hydrocarbons have accumulated within the bed sediments of the estuary (and thus potentially affect the benthos of the estuary). Only the area immediately down-gradient of the previous contamination area would need to be assessed for surface water and groundwater quality and

sediment quality, which covers the section of Saltwater Creek between the entrance and Phillip Drive (German) bridge (refer Figure 6-9).

Difficulties with access have previously prevented monitoring bores from being located immediately adjacent to Saltwater Creek. It is proposed that shallow monitoring bores are established using a small auger (possibly hand held) to provide information regarding the transport of contaminated groundwater into the estuarine receiving water. Any new bores are required to be licenced by the Department of Natural Resources in accordance with Part 5 of the Water Act 1912 (to be replaced by the Water Management Act 2000 in the future).

Following the initial water quality and sediment quality assessment, periodic water quality monitoring would only be required every 6 – 12 months, with monitoring carried out when water levels are low (thus maximising the flow of water from groundwater table into the waterway).

Figure 6-9 Area of Saltwater Creek to be monitored for hydrocarbon contamination

7 ESTUARY MANAGEMENT PLAN

7.1 The Purpose and Context of This Plan

This Estuary Management Plan for Saltwater Creek and Lagoon at South West Rocks represents the long-term strategy for environmental sustainability of the estuary. The Plan has been designed taking into consideration the ecological and social demands on the estuary. It has recognised its unique environmental setting, while acknowledging its values for local tourism and recreation, as well as the impacts of high water inundation on surrounding private lands.

The Plan has been developed in accordance with the NSW Government's Estuary Management Program, and in accordance with the Estuary Management Policy 1992 and the Coastal Policy 1997. The Plan has also been developed adopting the principles of Ecologically Sustainable Development. In particular, the Precautionary Principle has been applied in developing strategies, where results from detailed scientific investigations are presently unavailable.

It is proposed that the Saltwater Creek and Lagoon Estuary Management Plan be reviewed annually, and completed revised within an approximate timeframe of 5 years, to ensure that i) the Plan is being implemented in accordance with the proposed schedule, and ii) the Plan remains up-to-date regarding pertinent environmental management issues and best practice approaches to address issues.

7.2 Overview of Community Consultation Undertaken

This Estuary Management Plan has been prepared following consultation with the community of South West Rocks and the general stakeholders of Saltwater Creek and Lagoon. Community consultation was considered a critical step in identifying the issues that require management in the future, and in formulating options for addressing these issues. Consultation commenced as part of the Estuary Processes Study (MHL, 2002), and continued to public exhibition of the draft Estuary Management Plan. For the Plan to be successful, the local community and relevant stakeholders of the estuary will need to embrace the roles and responsibilities detailed herein, and continue to pressure Council and Governments to implement works and actions leading to the long-term sustainability of environmental and social values afforded by the Saltwater Creek and Lagoon estuarine system.

Community consultation undertaken during development of the Plan included:

- A questionnaire survey of local residents and community groups, with the questionnaire distributed directly to key stakeholders and community groups, and also presented to the general public via the local newspaper;
- Telephone discussions and several on-site (face to face) meetings with community members and concerned stakeholders;
- Workshops with the Estuary Management Committee and with the wider community regarding the issues requiring management and potential options to address them; and

- Public exhibition of the draft Saltwater Creek and Lagoon Estuary Management Study and Plan document, coinciding with a public meeting to present the draft report to the wider community, and a follow-up meeting with key landholders around the estuary.

7.3 Overview of Goals and Objectives of the Estuary Management Plan

The overall goal of the Saltwater Creek and Lagoon Estuary Management Plan is to *ensure that the ecological and social values of the intermittently open estuary remain sustainable in the future*. To achieve this overall goal, a series of specific issues that threaten long-term sustainability were identified based on detailed scientific assessments as well as consultation with stakeholders and the wider community. Issues were broadly classified into water quality, ecology / biodiversity, entrance management (and flooding), and future catchment development.

A total of 14 individual management objectives were defined, which aim to address all key issues of concern, and conserve all existing environmental and socio-economic values. The management objectives of this Plan are:

(1) Reduce the urban stormwater pollutant loads entering Saltwater Creek and Lagoon;
(2) Ensure that the water quality of Saltwater Creek and Lagoon is compatible with the recreational uses of the estuary;
(3) Ensure that the contamination of the former oil terminal site does not degrade the existing or future estuarine environment of Saltwater Creek and Lagoon;
(4) Reduce the impact of on-site sewage treatment systems on the surface water quality of Saltwater Creek and Lagoon;
(5) Prevent the generation of acidic runoff resulting from activities carried out on potentially acid sulfate soils surrounding Saltwater Creek and Lagoon;
(6) Prevent any further loss or damage to the habitats around the lagoon that are valued by the local ecological communities, including the vegetation that provides an important buffer between the estuary and existing development, and enhance existing habitats through targeted restoration and rehabilitation;
(7) Ensure fire and weeds are managed appropriately on private properties surrounding Saltwater Creek and Lagoon;
(8) Ensure that water levels in Saltwater Creek and Lagoon do not compromise the functioning of existing assets around the estuary;
(9) Ensure that any artificial manipulation of the Saltwater Creek entrance does not adversely affect the value or health of the estuarine environment of Saltwater Creek and Lagoon;
(10) Ensure that water levels in the estuary do not unduly compromise the recreational opportunities offered by the Saltwater Creek / South West Rocks area;
(11) Ensure that all entrance works are carried out by authorized persons or their representatives only;
(12) Allow for selective temporary access across creek entrance during particular circumstances when the creek is open;
(13) Ensure that all future development does not place any additional stress on the existing natural environment of Saltwater Creek and Lagoon; and
(14) Ensure that all future development controls consider the environmental sensitivity of Saltwater Lagoon and Creek.

7.4 Existing Framework for Management of Saltwater Creek and Lagoon

As outlined in Sections 1.3 to 1.5, there are many Plans, Policies and Parliamentary Acts that have influenced the management of Saltwater Creek and Lagoon to date. This myriad of legislation has clouded the management process, resulting in a lack of clear responsibility and direction for land managers and urban planners. Management of the estuary has also been confused by the role of the Department of Environment and Conservation (National Parks), given that most of the eastern half of the catchment, as well as some sections of the waterway itself, are within Hat Head National Park, and is directed by the Hat Head National Park Plan of Management (NPWS, 1998).

A formal Estuary Management Plan for Saltwater Creek and Lagoon, consistent with existing statutory and non-statutory Plans and Policies, abbreviates the management framework for the estuary, and is applicable to all lands within the Saltwater Creek and Lagoon catchment outside the Hat Head National Park boundary. The Estuary Management Plan also fulfils Council's requirements for meeting the objectives of the NSW Coastal Policy and NSW Estuary Management Policy in respect to Saltwater Creek and Lagoon.

As Plans and Policies are revised and new instruments introduced in the future, it will be important that the Estuary Management Plan is also updated, to reflect changes in legislation and planning frameworks, as well as changes in environmental condition, community values and ecological function, as appropriate.

7.5 Proposed Management Strategies

Twenty two (22) individual management strategies have been developed for Saltwater Creek and Lagoon, which combined, address all of the 14 management objectives defined for the estuary. The strategies can be summarised into the following categories:

- Administration: involves actions that will assist with the resourcing and administration of estuary management actions for Saltwater Creek;
- Planning: involves modifying existing instruments or developing new plans and policies regarding conservation, and to guide rehabilitation and future management of the estuary
- Further Investigations: to gain a better appreciation of specific processes occurring within the estuary
- Community Education: which aims to improve the general communities awareness of the environmental issues associated with the estuary, and introduce ways that they can help protect and rehabilitate the valued environment
- On-Ground Works: involves physical works within the estuary, around its foreshores, or within the catchment, to minimise future degradation of the environment and restore currently degraded parts of the estuary
- Monitoring: to measure the condition of the estuary and to gain feedback on the success of the implementation of the Plan

Different timeframes for implementation have been assigned to the different strategies included in the Estuary Management Plan covering an overall Plan duration of approximately 5 years. After a period of 5 years, the Plan will undergo a comprehensive review and update (refer Section 7.12).

Immediate tasks are to commence within a timeframe of 12-18 months from adoption of the Plan (i.e. to commence before end 2007).

Short term tasks are to commence within a timeframe of 1-3 years (i.e. to commence before end 2009).

Medium term tasks are to commence within a timeframe of 3-5 years (i.e. to commence before end 2011). It is envisaged that there will be a number of reviews of this Plan prior to implementation of the medium term tasks (refer Section 7.12). Therefore, there will be opportunity for modification of these strategies, as necessary, as more information becomes available through monitoring and additional investigation of the estuary.

A summary of the strategies developed for Saltwater Creek and Lagoon are provided in Table 7-1, while detailed descriptions and guidance on their implementation are provided in Section 7.6.

7.6 Implementation Schedules

A program for implementation of the Saltwater Creek and Lagoon Estuary Management Plan has been developed with tasks spanning a five year horizon. The implementation details for each separate estuary management strategy are provided in the following schedules.

The implementation details are presented in the form of 'schedules', and provide information on specific actions required to implement each strategy, as well as costs, timeframes, maintenance requirements responsibilities for implementation, and 'measurables' to define the success of implementation. Comments are also provided for each strategy, which includes background information relevant to the implementation of the strategy and cross-references to other similar strategies.

The schedules are designed to provide the information in a 'quick reference' format to facilitate implementation and adoption by the responsible authorities.

Table 7-1 Prioritised Management Strategies for Saltwater Creek & Lagoon

Reference	Strategy Description	Option
	To commence implementation immediately (by end 2007)	
A	Prepare and adopt a formal Entrance Management Policy	EMF-1
B	Assess water quality to determine appropriate usage	WQ-1
C	Review status of existing 1(d) urban investigation lands	Dev-5
D	Maintain & enforce existing policies re: land sensitivity	Dev-4
E	Prepare stormwater strategy for new development	Dev-1a
F	Investigate opportunities for wildlife corridors between SEPPs	Dev-8
G	Increase enforcement of fishing regulations	Bio-3
H	Provide signage at recreation areas regarding risks	WQ-4
I*	Artificially open entrance to improve water quality	WQ-5
	To commence implementation in the short term (by end 2009)	
J*	Periodically allow full hydrological range in wetlands	EMF-5
K	Rezone important habitats to 'environmental protection'	Dev-6
L	Monitor biological indicators to assess environmental health	Bio-5
M	Education of community re: weeds and pests	Bio-6
N	Monitoring of water quality to determine health risks	WQ-2
O	Audit on-site sewage treatment systems	WQ-10
P	Rehabilitate degraded habitats via revegetation, soil stab., etc	Bio-2
Q	Review existing EPIs regarding native vegetation removal	Bio-1
R	Community education re: land and water sensitivity	WQ-8
S	Encourage lot-based on-site stormwater management	WQ-9
T	Periodically monitor for hydrocarbon leachate	WQ-3
	To commence implementation in the medium term (by end 2011)	
U	Retrofit stormwater filtration devices and wetlands	WQ-7
V	Assess capacity of sewerage to determine overflows	WQ-11

* *These strategies addressed primarily through implementation of Strategy A*

Strategy A	Prepare and adopt a formal Entrance Management Policy for Saltwater Creek and Lagoon				
Objectives addressed	2, 5, 8, 9, 10, 11, 12 (refer Section 5)			**Option Reference**	EMF-1
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Incorporate interim Entrance Management Protocols (presented in Appendix C) into a formal Entrance Management Policy that is consistent with other Council Policies and meets Council's requirements as an Environmental Planning Instrument (EPI).	2006	Staff time	Council, EMC	Policy adopted by Council	See Appendix C for Interim Entrance Management Protocols. Comments from DoP indicate that entrance works would not trigger SEPP-14 considerations as the entrance is outside the wetland boundary. This should be confirmed with DoP legal branch. Consents for entrance works need to be perpetual, due to the intermittent nature of entrance closure and quick response required when works are to be done. The new Coastal Zone Management Manual (not yet released) should provide additional guidance on entrance management practices for ICOLLs.
Prepare an Environmental Impact Assessment (e.g. SEE) and obtain necessary approvals and permits to undertake entrance management works	2006	$30,000	Council	Completed EIA and receipt of consents / permits	
Follow protocols presented in formal Policy with respect to actions when entrance closes	2006 and ongoing	~$10,000 p.a. + staff time (depending on survey)	Council	Reporting in accordance with Protocols	
Amend protocols within the Entrance Management Policy, as necessary, to cater for outcomes of other strategies presented in this Estuary Management Plan or a formal Saltwater Creek and Lagoon Floodplain Risk Management Plan	As necessary	Staff time	Council, EMC	Amended protocols, if considered necessary	

See also Section 6.3.1.1 for further details

Strategy B	Assess water quality to determine risks associated with recreational usage of Saltwater Creek and Lagoon during different rainfall and entrance conditions				
Objectives addressed	2 (refer Section 5)			**Option Reference**	WQ-1
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare a detailed water quality monitoring program targeting recreational uses of the system, and existing (and future) locations for recreational activities	2006	$5,000	Council	Detailed program of proposed monitoring	The program would include periodic sampling, as well as opportunistic and event-based sampling to cover a range of rainfall and entrance berm conditions. The extent of the monitoring program should match resourcing and funding availability and analytical limitations of lab, as well as environmental constraints. Figure 6-7 shows indicative locations for water quality monitoring Monitoring should include assessment for bacteria, general environmental health parameters and hydrocarbons.
Implement the program for a period of at least 12 months	2007	$50,000	Council	Results of monitoring for minimum of 12 month period, reported regularly to the EMC	
Assess the results of the program to determine risks associated with existing and future usage of the estuary	2008	$10,000	Council	Report on risks to recreational users of the estuary	
Modify the water quality criteria within the Entrance Management Policy (see Strategy A), as necessary, to better reflect risks associated with poor water quality during periods of entrance closure	2008	Staff time	Council, EMC	Change to the Entrance Management Policy, if considered necessary	
Use information from the assessment outcomes to prepare educational signage regarding environmental condition of the estuary and appropriateness for recreation activities (see Strategy H)	2008	Staff time	Council	Signage (as part of Strategy H) that incorporates outcomes of water quality assessment	

See also Section 6.3.5.1 for further details

Strategy C	Review status of existing 1(d) urban investigation lands and rezone to more appropriate landuse zonings				
Objectives addressed	6, 13, 14 (refer Section 5)			**Option Reference**	Dev-5
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Review opportunities and constraints for future landuse within existing 1(d) land, including *inter alia* environmental constraints determined as part of this Estuary Management Plan	2006	Staff time	Council	Documented outcomes of review and recommendations for rezoning, as part of LES	Environmental constraints on future landuse attributed to the natural function and behaviour of Saltwater Lagoon are defined by a 50 metre setback from the RL 3.0m AHD contour, or the 3.1m AHD contour, whichever is the further landward. Detailed ground survey of lands around Saltwater Creek and Lagoon are required to confirm the location of the RL 3.0m AHD and 3.1m AHD contours and associated buffer offset.
As part of the Kempsey LEP review, rezone existing 1(d) lands to more appropriate landuse zonings. For environmentally sensitive lands, this will be 'Environmental Protection Zone (Conservation)' under the draft LEP template	2006	Staff time	Council	Modified zones within new LEP	
Ensure all future development is consistent with new landuse zoning objectives	2007 and on-going	Staff time	Council	No development consents granted that are in conflict with new zonings	

See also Section 6.3.1.2 for further details

Strategy D	Maintain & enforce existing policies regarding the sensitivity of lands surrounding Saltwater Creek and Lagoon				
Objectives addressed	6, 13, 14 (refer Section 5)			**Option Reference**	Dev-4
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare an inventory (check-list) of all existing environmental planning instruments that are applicable to Saltwater Creek and Lagoon, and itemise the constraints that are placed on future development as a result	2006	Staff time	Council	Completed inventory of EPI's and associated relevance to Saltwater Creek and Lagoon	Existing policies and plans that document and describe the environmental sensitivity of lands around Saltwater Creek and Lagoon include: • SEPP-14 • SEPP-71 • DCP 10 • DCP 27 • DCP 30 • DCP 32 • DCP 34 • SWR Town Centre Masterplan Refer Sections1.4 and 1.5 for further details In time, and to be consistent with new environmental planning reforms, a single place-based DCP should be prepared covering Saltwater Lagoon and surrounding areas.
Ensure that the inventory (checklist) is referred to when considering future development applications in the vicinity of Saltwater Creek and Lagoon	2006 and ongoing	Staff time	Council	No development consents granted that are in conflict with existing EPIs	
Update EPI inventory (checklist) as new planning instruments are introduced at a local, state or federal level.	As necessary	Staff time	Council	Modifications to the EPI inventory, as necessary	

See also Section 6.3.2.1 for further details

Strategy E	Prepare a stormwater management strategy for the Saltwater Creek and Lagoon catchment to specify stormwater requirements to achieve a net reduction of pollutants entering the estuary				
Objectives addressed	6, 8, 13, 14 (refer Section 5)			**Option Reference**	Dev-1a
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Review requirements of BASIX and similar Urban Water Management DCPs for other LGAs, eg Lake Macquarie, Newcastle, various in Sydney	2006	Staff time	Council	Scope for new DCP, which would cover state government requirements and represent current best practice	The introduction of BASIX to Kempsey Shire on 1 July 2005 already requires water usage of new developments to be reduced by 40% and greenhouse emissions by 25%. Stormwater strategy is likely to incorporate a range of lot-based and regional treatment measures. Treatment of existing urban runoff should be considered in accordance with Strategy V (WQ-7, refer Section 6.3.3.5).
Prepare a formal stormwater strategy for all potential future development land that addresses site stormwater, as well as runoff from existing urban development to yield a net reduction in pollutant loads to the lagoon for events up to at least the 1 in 2 yr ARI.	2006	$30,000	Council	Final stormwater strategy that meets requirements for net reduction of pollutants to the lagoon	
Prepare a formal environmental planning instrument that requires all new development to conforms with the stormwater strategy and outlines a developer contributions scheme (in accordance with Section 94 of the EP&A Act) for construction of regional measures as well as measures to address runoff from existing development.	2007	Staff time	Council	Adoption of new EPI by Council	
Ensure that future development applications are in accordance with the new EPI	2008 and on-going	Staff time	Council	No development consents granted that are in conflict with the new EPI	

See also Section 6.3.1.3 for further details

Strategy F	Investigate opportunities to establish wildlife corridors between SEPP-14 wetlands				
Objectives addressed	6, 13, 14 (refer Section 5)			**Option Reference**	Dev-8
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Undertake flora and fauna studies of SEPP-14 wetlands and intermediate area to determine the suitability and viability of linking the wetlands via vegetated corridors. Determine specifications for desirable corridor requirements based on expected utilisation.	2006	$30,000	Council, DEC (National Parks)	Report on wildlife corridors between SEPP-14 wetlands	Investigations for wildlife corridors could be carried out as part of an LES for proposed rezoning of land between the SEPP-14 wetlands.
If considered viable, incorporate the corridor specifications into future strategy landuse planning policy, including Local Environmental Studies.	2007	Staff time	Council	Incorporation of corridors into LES or other strategic policy	Consideration should be given to the likely future utilisation of the corridor by wildlife and the hazards imposed on the wildlife associated with road crossings etc. Determining the need for wildlife corridors should consider existing linkages through Hat Head National Park.
Ensure that future development applications are in accordance with the requirements for wildlife corridors, as specified in the strategic policy / LES	2007 and on-going	Staff time	Council	No development consents granted that are in conflict with the requirements for wildlife corridors	
Encourage revegetation of wildlife corridors on private lands through landholder incentives (supported by NRCMA initiatives)	2008 - 2010	Dependent on the incentives offered. Allow $100,000	Private landholders and Council	Area of private land revegetated	

See also Section 6.3.1.4 for further details

Strategy G	Increase enforcement of recreational fishing regulations within Saltwater Creek and Lagoon				
Objectives addressed	6 (refer Section 5)			**Option Reference**	Bio-3
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Install signage at key recreational fishing locations regarding fishing regulations, eg minimum size, bag limits etc.	2006	$2,000 + $200 p.a. to maintain	DPI (Fisheries)	No. of new signs installed	Additional resources associated with increased patrolling and classes could be met by seasonal employment, and funded through Recreational Fishing Trust Grants Similar fishing classes for children are held by DPI throughout NSW (refer DPI web-site for details: http://www.fisheries.nsw.gov.au/recreational/shared/fishing-workshops)
Carry out additional patrols by Fisheries officers to check recreational fishing licences, fish catches and to have a more prominent presence during summer holiday periods	2006 and ongoing	Staff time	DPI (Fisheries)	No. of patrols by Fisheries officers	
Run educational fishing classes for children during summer holiday periods to teach them the ethical and conservation principles of recreational fishing	2006 and ongoing	Staff time	DPI (Fisheries)	No. of children attending the educational fishing classes	

See also Section 6.3.2.2 for further details

Strategy H	Provide signage at key recreation areas regarding risks for swimmers and other waterway users				
Objectives addressed	2 (refer Section 5)			**Option Reference**	WQ-4
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Using the outcomes of water quality assessment (Strategy B), determine appropriate wording and layout for signage at key entry points to Saltwater Creek and Lagoon advising of conditions that may be unsuitable for swimming and other recreational activities (e.g. following rainfall or when the entrance is closed – pending outcomes of water quality assessment)	2008	Staff time	Council, EMC	Agreement on wording and layout for signage	Wording on signage may be different depending on location within estuary (depending on outcomes of water quality assessment – Strategy B) Educational material regarding suitability of recreation within the lagoon and creek should also be provided to temporary residents of the Tourist Park and other key accommodation providers in SWR.
Install signage at key locations around the estuary.	2008	$3,000 + $300 p.a. to maintain	Council	No. of signs at key entry sites around the estuary	

See also Section 6.3.3.1 for further details

Strategy	Artificially open Saltwater Creek entrance to improve water quality and thus maintain recreational amenity				
Objectives addressed	2 (refer Section 5)			**Option Reference**	WQ-5
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Confirm and incorporate interim provisions contained within the interim Entrance Management Protocols (presented in Appendix C) into a formal Entrance Management Policy (Strategy A).	2006	Staff time	Council, EMC	Policy adopted by Council incorporating water quality provisions	Interim criteria for artificially opening the Saltwater Creek entrance due to water quality concerns are provided in Appendix C and have been adapted from ANZECC guidelines
Follow protocols presented in formal Policy with respect to actions when water quality fails to meet the specified criteria	2006 and ongoing	Costed within Strategy A	Council	Reporting in accordance with Protocols	
Amend water quality criteria within the Entrance Management Policy to reflect the outcomes of the detailed water quality assessment (see Strategy B)	2008	Staff time	Council, EMC	Amended protocols, if considered necessary	

See also Section 6.3.3.2 for further details

Note: This strategy is essentially addressed through the implementation of Strategy A

Strategy	Periodically allow full a hydrological range in Saltwater Lagoon to inundate fringing wetlands				
Objectives addressed	6, 9 (refer Section 5)			**Option Reference**	EMF-5
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Confirm and incorporate interim provisions contained within the interim Entrance Management Protocols (presented in Appendix C) into a formal Entrance Management Policy (Strategy A).	2006	Staff time	Council, EMC	Policy adopted by Council incorporating provisions to periodically allow potentially full wetland inundation	Interim provisions within the Entrance Management Protocols (Appendix C) incorporate the prohibition of any entrance management works for a period from mid April to the mid September.
Follow protocols presented in formal Policy with respect to preventing entrance management actions during pre-defined times of the year, regardless of economic or social consequences	2006 and ongoing	Costed within Strategy A	Council	Reporting in accordance with Protocols	

See also Section 6.3.3.3 for further details

Note: This strategy is essentially addressed through the implementation of Strategy A

Strategy K	Rezone important habitats around Saltwater Lagoon to 'environmental protection'				
Objectives addressed	13, 14 (refer Section 5)			**Option Reference**	Dev-6
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Review environmental constraints on 1(c) land close to the lagoon (particularly southern side of Phillip Drive), based on recommendations presented in this Estuary Management Plan and Kendall and Kendall (2003).	2008	Staff time	Council	Documented outcomes of review and recommendations for rezoning	Review of environmental sensitivity should be carried out at same time as review of 1(d) land to gain consistency in approach for LEP changes. Rezoning of private land should incorporate existing use rights, so landholders would not be burdened in carrying out existing usage of the land.
As part of the Kempsey LEP review, rezone existing environmentally sensitive lands within 1(c) zoning to 'Environmental Protection Zone (Conservation)' under the draft LEP template	2008	Staff time	Council	Modified zones within new LEP	
Ensure all future development is consistent with new landuse zoning objectives	2008 and on-going	Staff time	Council	No development consents granted that are in conflict with new zonings	

See also Section 6.3.1.5 for further details

Strategy L	Monitor biological indicators within Saltwater Lagoon and the catchment to assess environmental health				
Objectives addressed	6, 9 (refer Section 5)			**Option Reference**	Bio-5
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare a biological monitoring program targeting assessment of overall environmental / estuarine health. Biological monitoring program should build-on the outcomes of the water quality assessment (Strategy B).	2008	$5,000	Council	Documented monitoring program that corresponds with available resources and funding	Ecological communities targeted by the monitoring program may include (but not limited to) benthic fauna, mobile aquatic fauna, aquatic vegetation distribution and conditions and seagrass depth limits. Weeds and pest species should also be included as biological indicators of disturbance. Frequency of monitoring would depend on the community targeted and the resources available for undertaking works. Where possible, community groups and/or local schools could participate in the monitoring program. Opportunistic water quality monitoring could also be carried out at the same time as biological monitoring.
Implement biological monitoring program	2008 and on-going	$15,000 p.a.	Council	Results of monitoring, reported regularly to the EMC and the community (refer Strategy R)	
Modify program, if necessary, based on monitoring difficulties or environmental constraints	As required	Staff time	Council	Amendment to monitoring program, if necessary	

See also Section 6.3.6.1 for further details

Strategy M	Community education regarding weeds and pests				
Objectives addressed	6, 7 (refer Section 5)			**Option Reference**	Bio-6
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare education material (brochures etc.), consistent with other Council information, regarding good environmental behaviour by communities and residents near sensitive natural environments.	2007	Staff time	Council, DEC (National Parks)	Production of new educational materials	To gauge the effectiveness of the education program, a community survey could be carried out prior to distribution of material, and then afterwards. Periodic follow-up survey should also be carried out to determine if knowledge has been retained and if materials / strategies need to be updated.
Distribute education material as part of standard Council information packs for new residents, and/or with periodic rates notices, specifically targeting households near sensitive areas.	2007 and ongoing	Depends on avenue for delivery	Council	No. of community members in receipt of new educational material	
Conduct periodic workshops and field-days to provide demonstrations and exhibitions of environmentally-friendly backyard and rural-residential land management practice	2008	Staff time + expenses of say $1,000 p.a.	Council, DEC (National Parks)	No. of community members in attendance at workshops	

See also Section 6.3.4.1 for further details

Strategy N	On-going monitoring of water quality at key recreation areas to determine public health risks				
Objectives addressed	2, 5 (refer Section 5)			**Option Reference**	WQ-2
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Collect water quality samples for bacterial analysis (faecal coliforms, enterococci) on a weekly basis and every day for 3 days following significant rainfall, during the period December to Easter, and deliver to Council's microbiological laboratory.	2007 and ongoing	~$2,500 p.a. + staff time	Council	Weekly reports on bacteria levels in Saltwater Creek, and distribution of information to the community via weekly newspaper report	Water quality conditions are to be determined by combined sample using waters taken from a minimum of three sites, no less than 20 metres apart.
Obtain rainfall records for SWR for periods corresponding to bacterial monitoring and assess results to identify any correlations between rainfall and bacteria numbers	2008	Staff time	Council	Report on correlation between rainfall and bacteria levels	Monitoring to be carried out in accordance with existing Beachwatch program
Ensure signage at key entry points (Strategy H) provides correct information regarding public health risks and correlations to environmental conditions (eg rainfall in preceding days)	As necessary	~$500	Council	Modified signage, if necessary	Monitoring is consistent with the requirements for closed entrance conditions, as defined in the Entrance Management Protocols, see Appendix C

See also Section 6.3.6.2 for further details

Strategy O	Audit on-site sewage treatment systems				
Objectives addressed	2, 4 (refer Section 5)			**Option Reference**	WQ-10
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Conduct audit of all unsewered properties within the Saltwater Lagoon catchment to identify on-site systems that are significantly deficient	2008	Staff time	Council	List and details of deficient on-site sewage systems.	For selected sites close to existing sewerage infrastructure, it may be possible for existing on-site systems to be connected to the sewer. This option is preferable to installation of new on-site systems. No on-site systems should be permitted on land lower than RL 4m AHD. Where connection to the sewer is not possible, on-site systems should be serviced by periodic pump-out. 58 on-site systems around Saltwater Lagoon are registered with Council, of which 21 are non-compliant and require remediation. The number of unregistered systems is unknown.
Hold discussions with landholders of deficient systems to encourage them to upgrade on-site sewage services, or issue non-compliance notices	2008 and on-going	Staff time – costs for system upgrades met by landholders	Private landholders and Council	No. of deficient systems that have been upgraded and conform to Council requirements	

See also Section 6.3.5.3 for further details

Strategy P	Rehabilitate degraded habitats through revegetation, soil stabilisation, etc				
Objectives addressed	1, 6 (refer Section 5)			**Option Reference**	Bio-2
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare a Foreshore Rehabilitation Plan for Saltwater Creek and Lagoon, based on an existing conditions survey, outlining areas requiring rehabilitation, priorities for works, and appropriate species for use. The Plan should cover all private and public lands considered to be environmentally sensitive to the lagoon (ie within 50m of the RL 3.0m AHD contour, or within RL 3.1m AHD contour, to be confirmed by reviews as part of Strategies C and K)	2008	$5,000	Council	Plan of action for rehabilitation works	Rehabilitation Plan should recommend the use of endemic species and be prepared by a qualified botanist familiar with local species and environment, taking into consideration the diversity of habitats and ecological communities being rehabilitated. See also Strategy F – Wildlife corridors
Liaise with local Landcare or other community organisations (e.g. Friends of South West Rocks) regarding voluntary services for undertaking revegetation works	2008	Staff time	Council	Agreement with community groups regarding rehabilitation	
Provide all necessary plants and resources required for volunteers to carry out works within public lands	2009 and on-going	$10,000 p.a.	Council, community groups	Area of habitat rehabilitated	
Encourage private landholders to rehabilitate environmentally sensitive areas through catchment management incentives and provision of materials and/or labour	2009 and on-going	Costed as part of Strategy F	Council, private landholders	Area of private land rehabilitated	
Maintain revegetated areas, particularly during initial stages after planting	2009 and on-going	$2,000 p.a.	Council, community groups	Survival rate of revegetated plants / trees	

See also Section 6.3.3.4 for further details

Strategy Q	Review existing environmental planning instruments regarding native vegetation removal				
Objectives addressed	6 (refer Section 5)			**Option Reference**	Bio-1
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Review all current local, state and federal EPIs regarding vegetation removal and identify gaps that would result in possible illegal clearing of native vegetation (e.g. regrowth of shrubs and seedlings that still provide valuable habitat)	2009	Staff time	Council	Report on the outcomes of the environmental planning legislation review	Where removal of native vegetation cannot be avoided by future development, compensatory habitat shall be provided at a rate of 2:1 (ie compensatory habitat shall be twice the size of the area of native vegetation lost), or other environmental offsets provided.
If considered necessary, amend existing environmental planning instruments (e.g. TPOs) that regulate the removal of native vegetation associated with all future development around Saltwater Creek and Lagoon.	2009	Staff time	Council	Modification to environmental planning instruments	
Ensure that future development applications are in accordance with the revised planning instruments, if amended	2009 and on-going	Staff time	Council	No development consents granted that are in conflict with the new EPI	

See also Section 6.3.1.6 for further details

Strategy R	Community education regarding the natural sensitivity of Saltwater Creek and Lagoon				
Objectives addressed	1, 2, 6 (refer Section 5)			**Option Reference**	WQ-8
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Prepare and distribute new educational material (including brochures, media releases, fridge magnets etc) covering a range of topics on Saltwater Creek and Lagoon. Information could be released as a 'series' addressing different facets of the environment and associated human interactions	2009	Depends on media, method of delivery, etc – allow $20,000	Council	Production of new educational materials and the number of community members in receipt of new educational material	To gauge the effectiveness of the education program, a community survey could be carried out prior to distribution of material, and then afterwards. Periodic follow-up survey should also be carried out to determine if knowledge has been retained and if materials / strategies need to be updated. This strategy could be carried out contemporaneously with Strategy M
Prepare and install educational signs detailing key characteristics, functions and values of Saltwater Creek and Lagoon	2009	$10,000 + $500 p.a. to maintain	Council	Provision of signage	
Provide results of periodic water quality and biological monitoring surveys in local newspapers	2009 and on-going	Staff time	Council	Results and interpretations provided in newspaper	
Initiate a schools program, including regular visits to Saltwater Lagoon to show students the diversity of local habitats and species that depend on them	2010 and on-going	$5,000 p.a.	Council, DEC (National Parks), DPI (Fisheries) & local schools	No. of students that have participated in the Saltwater Lagoon schools program	

See also Section 6.3.4.2 for further details

Strategy S	Encourage lot-based on-site stormwater management				
Objectives addressed	1, 2, 6 (refer Section 5)			**Option Reference**	WQ-9
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Review on-site stormwater management options for existing development adopted elsewhere, eg Newcastle	2009	Staff time	Council	Statement of review and scope for options to be offered to residents	Incentives offered to residents could involve discounted purchase of on-site management techniques, rate reductions or rebates, and one-off grants for implementation. Levies for regional stormwater management may be imposed on those residents not adopting on-site water management. This option is consistent with the Killick Creek (Crescent Head) Estuary Management Plan and could be adopted across the whole LGA with commensurate cost efficiencies
Prepare and distribute educational material for existing residents of South West Rocks regarding retrofitting on-site stormwater management, such as rainwater tanks	2009	$30,000	Council	Material prepared, and No. of residents receiving material	
Encourage uptake of on-site stormwater management options by offering incentives	2010 + ongoing	$20,000 p.a., but depends on incentives	Council	No. of residents who take up on-site stormwater management.	

See also Section 6.3.4.3 for further details

Strategy T	Periodically monitor for hydrocarbon leachate contamination in surface and ground waters				
Objectives addressed	3 (refer Section 5)			**Option Reference**	WQ-3
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Following on from the hydrocarbon monitoring carried out as part of Strategy B, continue to monitor for hydrocarbons in Saltwater Creek and Lagoon.	2009 and on-going	$2,000 p.a.	Council	Water quality monitoring reports, provided to the EMC periodically	Location and frequency of monitoring should be based on the outcomes of the initial water quality assessment (Strategy B) as well as the likely contaminated groundwater discharge from former oil terminal sites on Phillip Drive. Shallow groundwater bores could be installed using hand-held augers. Opportunities for cost recovery should be sought from existing landholders, former landholders (Shell and Caltex) or DEC (EPA).
Install shallow groundwater monitoring bores along the shoreline of Saltwater Creek adjacent to the former oil terminal sites and undertake regular (3-monthly) groundwater monitoring for hydrocarbon content	2009 and ongoing	$5,000 + $2,000 p.a.	Council, DEC (EPA), DNR	Installation of bores and groundwater quality monitoring reports, provided to the EMC periodically	
Provide results of monitoring to DEC (EPA) and liaise with authorities regarding remediation if results indicate on-going contamination	2009 and on-going	Staff time	Council, DEC (EPA)	Reports received by DEC (EPA)	

See also Section 6.3.6.3 for further details

Strategy U	Retrofit stormwater filtration devices and wetlands to manage runoff from adjacent urban areas				
Objectives addressed	1, 6 (refer Section 5)			**Option Reference**	WQ-7
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Based on the outcomes of the initial water quality assessment (Strategy B), supplemented by urban runoff modelling undertaken for the stormwater strategy (Strategy E), determine sub-catchments and input locations that are contributing significantly to pollutant loading of Saltwater Creek and Lagoon.	2009	$10,000	Council	Identified locations for stormwater treatment	This strategy would be largely addressed by future development in accordance with Strategy E. Devices should be supplemented by education of residents within the catchment to address pollutants that cannot be easily removed by retrofitted devices (e.g. bacteria, nutrients). Priority should be given to areas that are used for primary contact recreation (eg, lower reaches of Saltwater Creek behind the entrance berm), to supplement existing devices. This strategy is consistent with the objectives of the Kempsey Shire Urban Stormwater Management Plan (see Section 1.4.16).
Identify, assess and design a range of options for reducing urban runoff pollutants, including GPTs, wetlands and proprietary devices, taking into consideration site and environmental constraints, available funding, maintenance, etc. Prepare a strategic plan for prioritised works	2009	$50,000	Council	Strategic plan outlining works and priorities	
Install stormwater management devices in accordance with the strategic plan, with highest priority areas targeted first.	2010	Depends on works – allow $500,000	Council, DEC (EPA)	No. of stormwater management devices installed in accordance with strategic plan	

See also Section 6.3.3.5 for further details

Strategy √	Assess capacity of SWR sewerage system to determine frequency of overflows and risks to Saltwater Creek and Lagoon				
Objectives addressed	2 (refer Section 5)			**Option Reference**	WQ-11
Actions	**Timing**	**Costs**	**Responsibilities**	**Measurables**	**Comments**
Carry out a detailed sewerage modelling study to assess the hydraulic capacity of the SWR sewerage system, incorporating both current day and fully developed scenarios (assuming maximum development in accordance with revised LEP)	2011	$50,000	Council, EMC	Amended protocols, if considered necessary	Funding for upgrading of the sewerage system would not be sourced from the Estuary Management Program This strategy is likely to be implemented by Council as a matter of standard practice. It has been identified in this Estuary Management Plan given the importance of these works to the long-term environmental sustainability of the estuary.
Based on outcomes of capacity assessment, prepared a sewerage upgrade plan, which prioritises future works upgrade works based on the most critical system 'bottlenecks' and greatest risk of pollution to Saltwater Creek and Lagoon	2011	$50,000	Council	Reporting in accordance with Protocols	
Implement the sewerage upgrade plan on an as-needed basis, taking into consideration potential lead-times in obtaining necessary funding (ie start planning for the works before the need becomes critical, to avoid increased risks to the environment due to difficulties obtaining funding and consents)	2011 and as-necessary	Depends on works required	Council, EMC	Amended protocols, if considered necessary	

See also Section 6.3.5.2 for further details

7.7 Program for Implementation

Table 7.2 presents an indicative program for implementation of all the suggested management strategies. The table also distinguishes between one-off and on-going components of each strategy (where appropriate). This table can be used as reference to identify which strategies should be being carried out at any point in time over the next six years or so. Note that the periodic review process for the Management Plan may change this table somewhat in the future.

As outlined in Section 7.8, significant funds will be required to implement all of the strategies identified in this Estuary Management Plan. Council considers it highly unlikely that all strategies will be able to be implemented given limitations associated with funding and grant conditions (e.g. 1 to 1 funding, based on matching Council contributions). Therefore, the strategies in this Plan, and the indicative implementation program shown in Table 7.2, have been provided mostly for reference. Strategies should be implemented if and when appropriate funding becomes available, approximately in the implementation order presented in Table 7.2 and discussed previously in Section 7.5. Opportunities for seeking external funding are discussed in Section 7.8.

Table 7.2 Implementation Program for All Strategies

Strategy		2006/7	2008	2009	2010	2011
A	Entr. Policy					
B	WQ assess					
C	1(d) review					
D	Exist. policies					
E	Stormwater					
F	Corridors					
G	Fish. regs.					
H	Recr. signage					
I	Open for WQ					
J	WL range					
K	Rezone env.					
L	Monitor biol.					
M	Educ. weeds					
N	Monitor WQ					
O	On-site audit					
P	Rehab. degrad.					
Q	Veg. removal					
R	Educ. sensit.					
S	Storm. mgt					
T	Monitor hydroc					
U	Retrofit stmwtr					
V	Sewerage cap.					

One-off task *On-going task*

7.8 Funding Requirements and Opportunities

While many strategies can be implemented primarily by Council and other stakeholders as part of normal day-to-day duties, most strategies require some financial contribution, particularly for on-ground works, monitoring and further investigations. A breakdown of expenditure across all strategies over the first 6 year period is provided in Table 7.3.

Table 7.3 Financial Requirements for Implementation of Strategies

Strategy		2006/7	2008	2009	2010	2011	*TOTAL*
A	Entr. Policy	$30,000 cap $10,000 maint	$10,000 maint	$10,000 maint	$10,000 maint	$10,000 maint	*$80,000*
B	WQ assess	$55,000 cap	$10,000 cap				*$65,000*
C	1(d) review						*$0*
D	Exist. policies						*$0*
E	Stormwater	$30,000 cap					*$30,000*
F	Corridors	$30,000 cap	$50,000 cap	$25,000 cap	$25,000 cap		*$130,000*
G	Fish. regs.	$2,000 cap $200 maint	$200 maint	$200 maint	$200 maint	$200 maint	*$3,200*
H	Recr. signage		$3,000 cap	$300 maint	$300 maint	$300 maint	*$4,200*
I	Open for WQ						*$0*
J	WL range						*$0*
K	Rezone env.						*$0*
L	Monitor biol.		$5,000 cap $15,000 maint	$15,000 maint	$15,000 maint	$15,000 maint	*$65,000*
M	Educ. weeds		$1,000 maint	$1,000 maint	$1,000 maint	$1,000 maint	*$4,000*
N	Monitor WQ	$2,500 maint	$2,500 maint	$2,500 maint	$2,500 maint	$2,500 maint	*$12,500*
O	On-site audit						*$0*
P	Rehab. degrad.		$5,000 cap	$12,000 maint	$12,000 maint	$12,000 maint	*$41,000*
Q	Veg. removal						*$0*
R	Educ. sensit.			$30,000 cap	$5,500 maint	$5,500 maint	*$41,000*
S	Storm. mgt			$30,000 cap	$20,000 cap	$20,000 cap	*$70,000*
T	Monitor hydroc			$5,000 cap $4,000 maint	$4,000 maint	$4,000 maint	*$17,000*
U	Retrofit stmwtr			$60,000 cap	$250,000 cap	$250,000 cap	*$560,000*
V	Sewerage cap.					$100,000 cap	*$100,000*
Capital Total		**$147,000**	**$73,000**	**$150,000**	**$295,000**	**$370,000**	***~ $1.22m***
Mainten. Total		**$12,700**	**$28,700**	**$45,000**	**$50,500**	**$50,500**	

Approximately $1.22 million will be required to implement the Saltwater Creek and Lagoon Estuary Management Plan up to 2011. The vast majority of this expense, however, is associated with only a

small number of strategies. In fact, 7 strategies require no external funding (with most of these to be implemented within the first couple of years of plan implementation), 5 strategies require funding of less than $20,000, and an additional 8 strategies have costs less than or equal to $100,000. Only 2 strategies have costs in excess of $100,000. The first involves the assessment and rehabilitation of wildlife corridors between the SEPP-14 wetlands (if considered warranted and viable), while the second (accounting for almost 50% of the budget) involves treatment of surface runoff from existing urban lands (the costs of which may be partially or wholly offset by contributions from future land development within the catchment).

Council is expected to fund some of the works detailed in the Estuary Management Plan through environmental budget allocations of general revenue (particularly as an environmental levy is applied to landowners within the LGA). Given the high costs for overall implementation, however, the Plan will be reliant upon receiving external grants and funding to be successful, some of which will require matching funding from Council.

The Northern Rivers Catchment Management Authority (NRCMA) has recently prepared a draft Catchment Action Plan, which specifically targets implementation of natural resource management (NRM) activities identified in Estuary Management Plans and Sustainability Management and Assessment Plans (refer Section 1.4.19.2). NRM activities identified by this Estuary Management Plan include:

- Strategy M: community education regarding weeds and pests;
- Strategy P: rehabilitation of existing degraded habitats;
- Strategy R: community education regarding land and water sensitivity; and
- Strategy U: retrofit stormwater filtration devices to reduce catchment loads to wetlands.

In addition to funding from the NRCMA, there are other state and federal government grant programs that should be explored for potential funding of various strategies outlined within this Estuary Management Plan. These grant programs include:

- Emergency Management Australia (Local Grants Scheme)
- Department of Natural Resources (DNR) Estuary Management grants (**note that <u>most</u> works outlined in this Estuary Management Plan are eligible for part funding under the State Government's Estuary Management Program**);
- DNR Coastline Management grants;
- DNR Floodplain Management grants;
- DEC's Environment Trust Grants for:
  - Restoration and Rehabilitation;
  - Research; and
  - Education.
- DPI (Fisheries) Saltwater Recreational Fishing Trust.

In-kind contributions for completion of some of the elements of this Estuary Management Plan could also come from various educational institutions (such as universities), who could use the estuary for

specific data collection or research projects. In-kind contributions could also come from volunteer community groups, such as Landcare, Creekcare, and schools.

Opportunities should also be explored to utilise environmentally-oriented volunteer teams, such as Greening Australia, Green Corps and Work for the Dole, to assist with physically demanding elements of the Plan, such as revegetation works.

7.9 Performance Measures, Targets and Contingencies

The success of the Estuary Management Plan should be gauged through its ability to achieve the designated targets. The overarching targets are the Management Objectives, as described in Section 5. However, the timeframe for achieving some of these objectives is long (given the slow rate of vegetation establishment and growth, for example). To gain a better appreciation for the relative success of the Plan, a series of performance measures can be assessed on a periodic basis. Different types of performance measures are discussed in more detail below.

7.9.1 Primary Performance Measures

The first set of performance measures should ascertain whether the strategies are being implemented within the timeframe designated in the Plan. As such, the primary performance measures are simply a *measure of implementation*. Assuming that the Plan can be adopted by Council by mid 2006, there are eleven (11) strategies that need to commence implementation within 2006/7, with a further five (5) strategies to commence in 2008, and another five (5) strategies in 2009 (refer Table 7.2).

The commencement of 21 management strategies (out of the 22 total) within 3 years means that many strategies will actually be carried out concurrently. Organisations responsible for implementation will need to review the Plan carefully and ensure that adequate resources are allocated to the various strategies to ensure that the timeframe for implementation is achieved.

Clearly, a high degree of co-ordination will be required to manage the successful implementation of all the strategies within the designated timeframe. This co-ordination should be facilitated by the Estuary Management Committee, who would be required to meet regularly to discuss and manage the implementation of the estuary management strategies.

If it is determined that the strategies are not being implemented to the nominated timeframe then one or both of the following *contingencies* should be adopted:

- Determine the cause for the delay in implementation. If delays are funding based, then seek alternative sources of funding, including a formal request to Council to increase contributions to the Plan. If delays are resource-based, seek additional assistance from stakeholder agencies and/or consider using an external consultancy to coordinate implementation of the Plan;
- Modify and update the Estuary Management Plan to reflect a timeframe for implementation that is more achievable. The revised Plan would need to be endorsed by all relevant stakeholders and agencies responsible for implementation.

7.9.2 Secondary Performance Measures

The second set of performance measures relate to *measuring specific outputs* from the individual strategies, as appropriate. The specific outputs from each action, or step, of each strategy, are provided within the Implementation Schedules (refer Section 7.6) under the 'measurables' column. These measurables define what the specific outcome from each action should be. If these outputs are delivered as defined, then the action (or strategy) is considered to have been successful.

In some cases, the nominated 'measurable' also identifies a specific tool for gauging the rate of implementation of specific actions. For example, the rate of implementation of rehabilitation works can be 'measured' by determining the "area of land rehabilitated" (refer Strategy P). In other cases, a one-off output is identified as the 'measurable', such as a specific report.

If specific outputs, as defined by the 'measurables', are not generated from implementation of the Plan then the following *contingencies* need to be adopted:

- Determine the reason for not producing the specified output. If the reason involves a lack of funding or resources, then similar contingency measures to those described for the primary performance measures (refer Section 7.9.1) should be adopted. If the reason is of a technical nature, then expertise in the area should be consulted to overcome the technical problem. DNR and other government agencies should have the necessary in-house expertise to assist in most cases.
- Review the appropriateness of the specific output of the management strategy, and if necessary, modify the output described in the Plan to define a more achievable product.

7.9.3 Tertiary Performance Measures

The third set of performance measures are aimed at *measuring the outcomes of the Plan*, and as such relate to the specific management objectives of the Plan (as described in Section 5), and how implementation of the Plan has made a difference to the biophysical and social environments of Saltwater Creek (eg reduction in pollutant loads, improvement in swimming conditions, increase in biodiversity etc). The main mechanism for gauging whether these objectives have been achieved, or not, is monitoring. Therefore, monitoring of various elements of the physical, biological and social environment is an essential component of assessing the overall success of the Estuary Management Plan.

If, after a reasonable period of time, the specific objectives of the Plan are not being achieved by the strategies being implemented, then the following contingencies should be adopted:

- Carry out a formal review of the implemented management strategies, identifying possible avenues for increasing the effectiveness of the strategy in meeting the Plan objectives;
- Commence implementation of additional management strategies that may assist in meeting Plan objectives (possibly 'fast-track' some longer term strategies as necessary);
- Reconsider the objectives of the Plan to determine if they set impossible targets for future estuary conditions, and adjust the Plan, as necessary. Any such changes to the Plan would need to be endorsed by the stakeholders and relevant government agencies, as well as the public.

7.10 Accommodating Future Climate Change

Climate change as a response to increased greenhouse gases in the Earth's atmosphere is now a widely accepted phenomenon. Impacts of a changing climate are already beginning to emerge (Steffen, 2006). For example, WMO (2005) state that, with the exception of 1996, the last 10 years (1996 – 2005) have been the hottest years on record (globally averaged). In Australia, 2005 was the hottest year on record, at a temperature of 1.09°C higher than the 1961-1990 average (BoM, 2006). The past four years in Australia have been consistently significantly hotter than the 1961-1990 average (refer Figure 7-1).

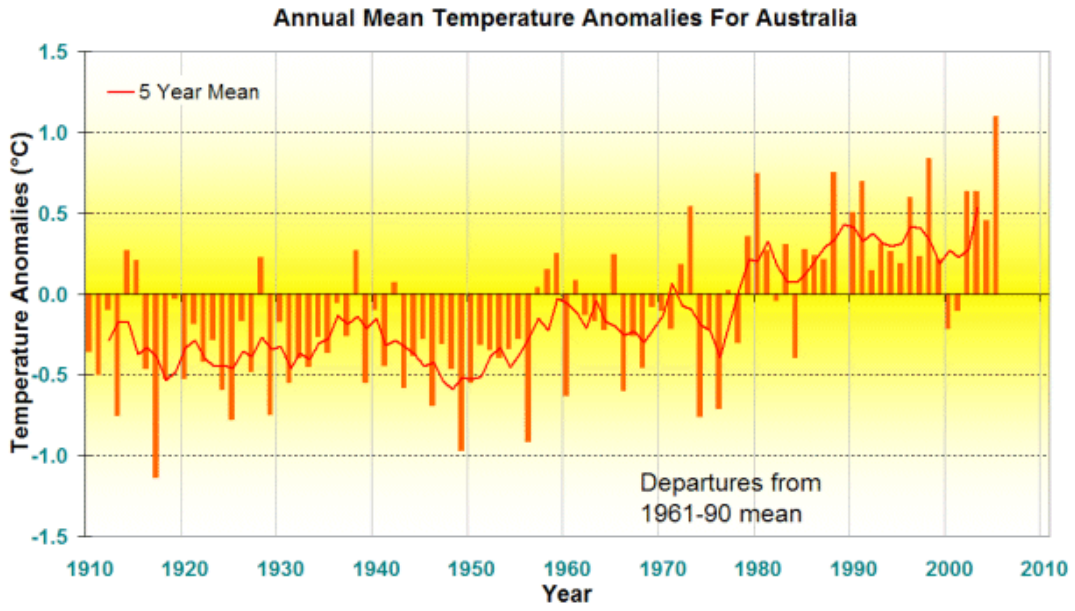


Figure 7-1 Australian average temperature variation, 1910 – 2005 compared to 1961-1990 average (Source: BoM, 2006)

Increasing air temperatures across the globe in the future will cause a variety of climatic effects, including sea level rise, increased atmospheric and ocean temperatures, and changes to rainfall and drought patterns. Changes to climate in the next 30 – 50 years are considered inevitable, regardless of possible reductions in global greenhouse gas emissions (Lord *et al.* 2005).

In compliance with the 'Precautionary Principle', as espoused by the NSW Coastal Policy (refer Section 1.3.3), management of Saltwater Creek and Lagoon over the next 50 to 100 years needs to accommodate the potential effects of climate change, despite the degree of uncertainty in many areas of climatic predictions. In particular, Objective 2.2 of the Coastal Policy requires the consideration of future climate change in the planning and management of coastal resources and development and promotes a 'risk averse' approach to decision making.

7.10.1 Predicted Changes Associated with the Enhanced Greenhouse Effect

Sea level rise is the most accepted of the predictions associated with climate change, however, predictions as to the extent of this rise vary greatly due to the uncertainty of greenhouse gas concentrations in the future and disagreement on the effect of various levels of such gases (Walsh 2004b).

Greenhouse gases within the atmosphere, enhanced by past, current and future human activities across the globe, are expected to cause an increase in global atmospheric temperatures of between 1.4 and 5.8 ^{0}C between 1990 and 2100 (IPCC 2001), and will represent the most significant global temperature variation in the last 10,000 years. More recent assessments undertaken by IPCC in preparation for their next major report (due 2007) suggest that temperatures by the year 2100 are more likely to be at the higher end of the predicted range (Steffen, 2006). For coastal NSW, Hennessey *et al.* (2004b) predict increases in temperature of between 0.2 and 1.6 ^{0}C by 2030, and 0.7 and 4.8 ^{0}C by 2070.

Predictions for the amount of sea level rise for 35 different emission scenarios have been produced by the Intergovernmental Panel on Climate Change (IPCC) (2001). IPCC (2001) predict a 0.05 – 0.32 m rise in ocean water levels by 2050, and a 0.09 – 0.88m rise by 2100. The smaller increase in sea level rise up to 2050 is the result of thermal inertia in the oceans (Walsh *et al*., 2002) given that ocean surface layers take approximately three decades to absorb heat from the atmosphere (Flannery, 2005). The subsequent transfer of heat from surface layers to the deep oceans is likely to take several centuries due to weak diffusion and slow ocean circulation processes (IPCC, 2001). Thermal expansion of the deep oceans could result in a sea level rise of up to 4 metres (occurring over a period of several centuries). When combined with anticipated melting of polar ice sheets, the predicted ultimate sea level rise is in the order of 7 metres.

Sea level rise in Australia is also likely to be affected by the El Nino Southern Oscillation (ENSO), a decadal cycle characterised by periods of drought and dryer weather during the El Nino phase of the cycle, and relatively high rainfall and wetter weather during the La Nina phase. The likely effects of a warmer climate on the ENSO are not currently well understood.

On-going sea level rise beyond our immediate planning horizon prompts the recommendation for adoption of conservative sea level rise estimates, as well as the initiation of a program of adaptation and accommodation of continuously rising seas in the future.

An increase in mean sea level would result in an upward and landward translation of ocean beach profiles (Bruun 1962, Dean and Maurmeyer 1983, Hanslow *et al.* 2000), thus causing net shoreline recession (refer Figure 7-2). The changed beach processes will result in a net upward shift in typical berm heights of coastal lake entrances.

Changes to wave climates and the direction of wave impact are also predicted in association with the enhanced greenhouse effect. Specifically, east coast low pressure systems, which are currently responsible for the majority of storm surge water levels and coastal erosion on the NSW coast, may increase in frequency in the future (Walsh 2004a, Hennessey *et al*. 2004b). Hennessey *et al.* (2004b) suggest that in NSW, waves from the southeast will become more dominant, and waves from the northeast will become less so.

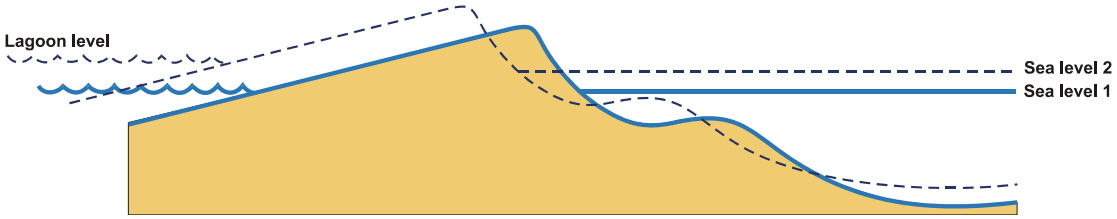


Figure 7-2 Shoreline response to increasing sea level (Hanslow *et al.*, 2000)

Hennessey *et al*. (2004b) also suggest climate change will cause a decrease in rainfall during winter and spring, and an increase in rainfall during summer for north coast areas of NSW. The intensity of summer storms is forecast to increase by nearly 22% by 2030 (Hennessey *et al.* 2004b) across NSW. Both Walsh (2004a) and Hennessey *et al.* (2004b) (in relation to NSW specifically) comment that, overall, annual rainfall is likely to decrease, but rainfall volume per storm could potentially increase.

In addition to rainfall changes, higher atmospheric temperatures are likely to increase evaporation rates (Hennessy *et al*., 2004a). As a consequence of reduced rainfall and increased evaporation, it is expected that average streamflow in Australia will decrease (Walsh, 2004a).

7.10.2 Impacts of Climate Change on Saltwater Lagoon

The impacts of sea level rise on Saltwater Lagoon would include an increase in the average height of the entrance berm. If left to natural processes, lagoon water levels would need to reach a higher level before inducing breakout across the berm. Typical water levels within the lagoon can therefore be considered to increase contemporaneously with increasing sea levels if the entrance is not artificially modified.

The predicted reduction in total rainfall, combined with an increase in evaporation due to the warmer atmospheric temperature, would reduce the capacity of catchment runoff to fill Saltwater Lagoon. With reduced catchment runoff and a larger storage potential associated with the higher entrance berm, the frequency of an open entrance will reduce, thus increasing the overall proportion of time that the entrance is closed. An increase in the proportion of time closed (ie the Entrance Closure Index) is considered to increase the natural sensitivity of the lagoon to external inputs (Haines *et al*., 2006).

Further, future increases in typical water temperature of the lagoon may degrade water quality, by reducing dissolved oxygen, and changing the solution of various salts and therefore dissolved nutrients, metals and pollutants in the water column. In turn, aquatic species may respond to changes in water chemistry, most notably, algal productivity may increase, causing flow on effects to higher trophic levels of ecology. The distribution of aquatic flora and fauna may also be expected to change in response to higher water temperatures.

7.10.3 Impacts of Climate Change on Flooding

The Saltwater Creek Flood Study (WBM, 2005) (refer Section 2.3) considered three entrance berm conditions corresponding to levels of RL 2.0, 2.5 and 3.0m AHD. While an entrance berm level of

RL 2.0m AHD is considered appropriate for present day conditions, higher berm levels should be adopted if the impacts of climate change, and sea level rise in particular, are to be accommodated (along with eventual phasing out of entrance management or modifying entrance breakout trigger levels in line with sea level rise).

Assuming a worst case sea level rise scenario (as recommended in the discussion above) and no entrance management, a berm level of RL 3.0m AHD would be the most appropriate design conditions for planning purposes for the year 2100. Under these conditions, 1% AEP flood levels of 3.4m AHD would be applicable around the lagoon, which is 0.3m higher than flood levels adopting a berm level of RL 2.0m AHD. Suitable freeboard to habitable floor levels should also be provided to account for variability in model predictions, rainfall intensities, local flooding issues, etc, as outlined in the Floodplain Development Manual (NSW Government, 2005).

If climate change is to be adequately accommodated by future development, then habitable floor levels need to be established based on current 1% AEP flood levels plus an allowance for impacts of future sea level rise plus a suitable freeboard (which, for Saltwater Lagoon is RL 3.1m AHD + 0.3m + 0.5m = RL 3.9m AHD).

7.10.4 Planning Considerations for Future Climate Change at Saltwater Lagoon

Management of climate change in the future will involve adaptation of systems to new environmental conditions. Momentum associated with the climate system will result in many more impacts over the next several decades (Steffen, 2006). It is considered that the ability of a system to adapt to these changes and impacts will determine its ability to survive in a future warmer world.

Many environmental systems, such as wetlands, will survive providing that their migration path is not inhibited and that the rate of migration / species adaptation can keep-up with rate of climate change (see DEH 2003).

For Saltwater Lagoon, consideration of future climate change is further complicated by proposed artificially opening of the entrance (refer Appendix C for details). Artificial management of the entrance should be considered as a necessary strategy to address issues associated with existing development only. Provisions associated with artificial entrance management should allow for upward sliding trigger levels, consistent with increases in sea level, and should be adopted as part of periodic reviews of relevant policies and planning instruments (and associated licensing of operations).

When planning for future development, consideration should be given to conditions at the end of (and beyond) a realistic planning horizon (say 100 years for residential development). As part of this consideration, provisions should assume that lagoon hydrodynamics are not controlled by artificial entrance works. Reliance on existing entrance policy and protocols as part of future landuse planning will set in concrete the need for entrance management for the duration of that development (likely to exceed 100 years). Imposing such conditions on future generations of landuse managers is considered inconsistent with the principles of Ecologically Sustainable Development (which this Estuary Management Plan is required to satisfy, in accordance with the central theme of the NSW Coastal Policy).

At present, the maximum natural breakout level of Saltwater Lagoon would be about RL 2.0m AHD (typically breakout range is 1.5 to 1.8m AHD). Worst case sea level rise predictions for the year 2100 suggest an increase in sea level (and thus an increase in natural entrance breakout level) of 0.88m (IPCC, 2001). This Estuary Management Plan recommends future development around the estuary is setback a minimum of 50 metres beyond the RL 3.0m AHD contour. The vertical buffer (Figure 7-3) applied to all future development will allow for the natural expansion of the lagoon and will allow existing vegetation communities to migrate upslope without being inhibited by new infrastructure. Meanwhile, the horizontal buffer (Figure 7-3), applied to the landward extent of the vertical buffer, will maintain sustainable functioning of fringing riparian ecosystems and protect the waterway environment from the many potential impacts associated with adjacent urban development (including impacts associated with increased demand on amenity) (Haines, 2005).

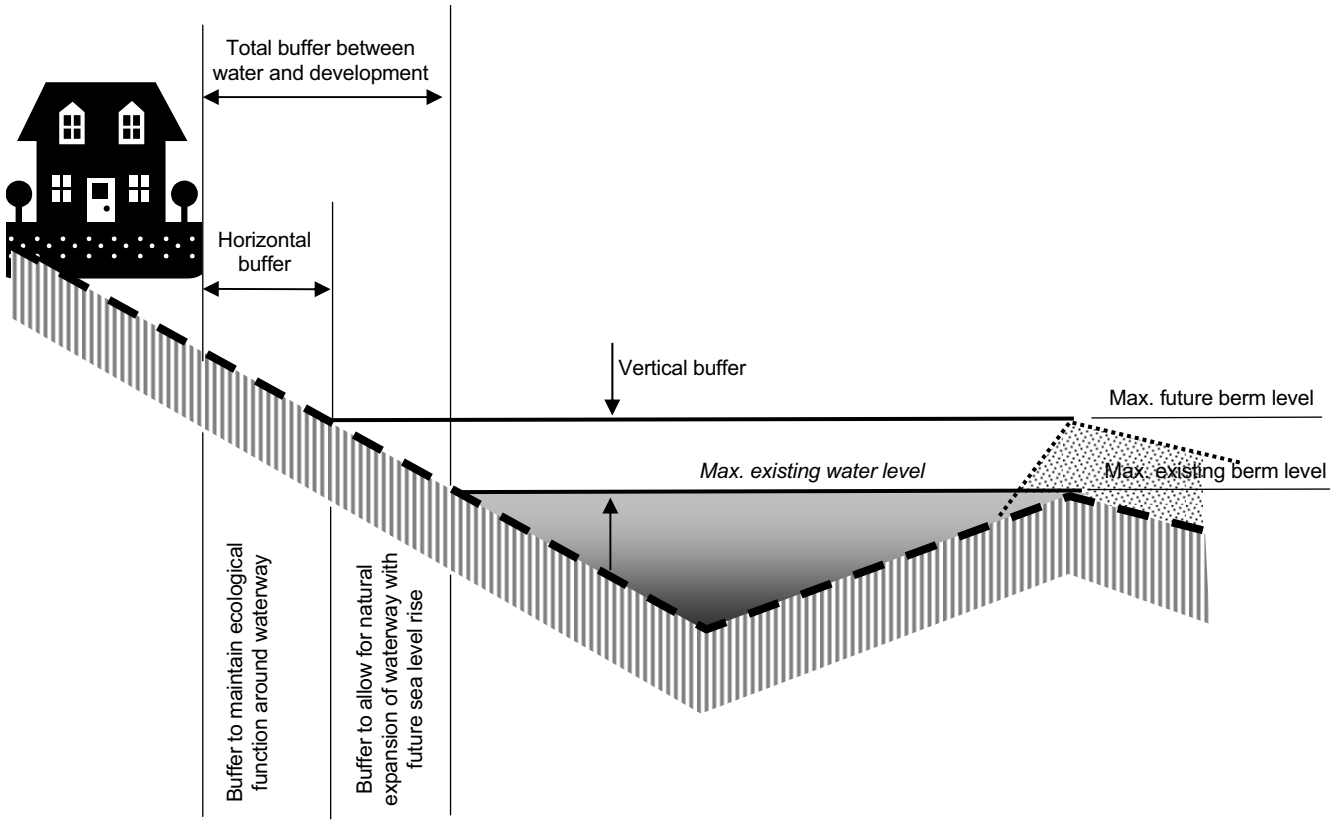


Figure 7-3 Vertical and horizontal buffers to accommodate future sea level rise (adapted from Haines, 2005)

Please note that this Estuary Management Plan has not made specific recommendations with respect to Floodplain Risk Management, and the need to manage flooding risk in the context of future climate change.

Management of existing development within the vertical and horizontal buffer provisions will need to be on a site by site basis. In the short-term, entrance management is recommended to achieve a balance between economic and environmental interests. In the long-term (50 yr +), however, such development will need to be considered on a merits basis, taking into account the need for on-going entrance management and the consequences of sea level rise. Periodic review of this Estuary

Management Plan and the entrance management protocols will provide a mechanism for slowly modifying the management of existing assets and infrastructure in the future.

It is considered that the strategies of this Plan address the need for system adaptation associated with future climate change, and sea level rise in particular.

7.11 Factors for Success

The success of the Saltwater Creek and Lagoon Estuary Management Plan is dependent on the following factors:

- Agreement on the objectives, strategies and implementation schedules by all state and local government agencies, stakeholders and the general community;
- Understanding and acceptance of responsibilities for the implementation of the various aspects of the Plan;
- Commitment by those involved to dedicate appropriate time and resources to achieve the objectives and timeframe of the Plan;
- Sourcing of appropriate funds, through grants, user contributions, and in-kind commitments from community.

Possibly the most important of these is acceptance and agreement by the local community. Without significant support by the local community, Council and the other agencies will not receive the pressure to ensure that the long-term sustainable management of Saltwater Creek and Lagoon remains a high priority.

7.12 Future Reviews and Modifications or Amendments to the Plan

It is proposed that the Saltwater Creek and Lagoon Estuary Management Plan is reviewed on a regular basis, and completely updated within a period of about 5 years (ie before end 2011). A regular review of the Plan (which may occur annually, for example) is necessary to allow modifications / alterations to the management of the estuaries, on an as-needed basis, within the context of an adaptive management framework.

The periodic Estuary Management Plan reviews should cover the topics described in Table 7.4. This table also outlines who is responsible for conducting the periodic reviews.

It is possible that the NSW Government's Estuary Management Program, under which this Plan has been prepared and will be implemented, may change in the future. A new Coastal Zone Management Manual is currently in preparation, and will combine and replace the existing Estuary Management Manual (1992) and the Coastline Management Manual (1990). Also, the role of the Northern Rivers Catchment Management Authority (NRCMA) in managing the coastal zone, including estuaries, is not yet clear. Therefore, on-going liaison between Council, NRCMA and DNR is necessary to ensure that the aims and objectives of the Saltwater Creek and Lagoon Estuary Management Plan continue to be achieved in the future.

Table 7.4 Framework for Future Estuary Management Plan Review

Review Period	Review tasks	Responsibility
Annual	• Assess primary, secondary and tertiary performance measures, and determine appropriate contingencies if performance measures do not meet targets • Review funding arrangements and allocations for current and future management strategies • Review resourcing and staffing allocations for current and future management strategies • Provide report on progress of Estuary Management Plan implementation, results of annual review, and any modifications required to the Plan coming out of the review	Estuary Management Committee or appointed external consultant* To be coordinated through Council and reported to Council, relevant stakeholders and government agencies
5 Yearly *(first review to be completed by end 2011)*	• Assess the overall effectiveness of each management strategy implemented to date • For strategies requiring on-going commitment, assess the value in maintaining implementation of those strategies • Reconsider the management options that were not short-listed and included in the original Plan (refer Section 6.1 for full list of previously identified options) • Provide implementation details of additional strategies that are to be included in the subsequent 5 year Plan • Update the Estuary Management Plan document to reflect proposed strategies for implementation over the next 5 year period, and seek endorsement by stakeholders, government agencies and the community.	Estuary Management Committee or appointed external consultant* To be coordinated through Council and reported to Council, relevant stakeholders government agencies and the general community

** It would be advantageous for the same consultant responsible for initially preparing the Estuary Management Plan to be involved in the annual review and 5-yearly update, given their appreciation of the study area and the details of the Plan and associated strategies.*

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APPENDIX A: CONSULTATION WITH STAKEHOLDERS

Consultation Letters to Stakeholder Groups

In order to gain input from a variety of stakeholders, WBM sent out a letter on 3/2/04 seeking comments relating to the issue and possible protection strategies. The results of this consultation are summarised in the following pages. The statements made in these sections are a reflection of communications between WBM Staff and the individuals concerned and are not presented here as fact or the opinion of WBM.

NSW Department of Infrastructure, Planning and Natural Resources (now DNR)

Contact: John Schmidt

The following information was gained from written correspondence with John Schmidt on 15/03/04.

John suggested that appropriate setback distances and development controls would need to be determined between future urban development and the Saltwater Creek-Lagoon System. He suggests the current policy of 50m setbacks from National Park Boundaries and High Conservation Areas appears inadequate particularly given the nature of the Lagoon to expand or contract dependent on the conditions.

Regarding Stormwater Management, clear strategies and controls for both existing and future developments should be required to focus on maintaining or improving the health and functioning of Saltwater Creek and Lagoon System.

John recommends implementation of a monitoring program for more effective management. In the Lagoon and areas of high public recreation in the Creek, he suggests water quality reporting. This program should include monitoring near the former oil terminal sites. Data produced from monitoring stations should be managed to ensure the data is reliable and routinely analysed.

NSW Fisheries

Contact: Max Enklaar

The following information was gained from written correspondence with Max Enklaar on 11/2/04.

Max agreed with the major issues identified in the consultation letter. With regards to Saltwater Lagoon, Max stated that minimum entrance manipulation was a high priority. Max mentions concerns over the detrimental effect on Saltwater Lagoon from unauthorised openings, development on low lands and poor quality storm water run off.

Max writes that NSW Fisheries would support strategies designed to mimic natural processes while maintaining the ecological health and biodiversity in the estuary and lagoon.

Environmental Protection Authority (EPA)

Contact: Lindsay Fulloon

Mr Lindsay Fulloon provided the following information via written correspondence on 09/03/04.

Lindsay wrote that many issues regarding water quality, flows and estuarine health should be reviewed. In particular, Lindsey mentioned the stormwater discharge into the Creek and whether this discharge was adequately treated. He suggested stormwater treatment and source controls mechanisms should be considered for the potential to improve water quality and alter runoff volume.

Lindsey also raised the issue of fish kills within the estuary and suggested investigation into the cause of such incidents. He comments that effects on the ecological integrity of artificially opening the mouth of Saltwater Creek should be examined.

With regards to the sewage system, Lindsey proposes that the adequacy of this system, particularly in the face of increasing development in the Saltwater Creek catchment, should be examined and modifications made if the system is deemed inadequate.

The possible contamination from former oil terminal site is also mentioned as a concern.

Coast and Estuary Committee

Contact: Terry Parkhouse

The following information was gained from written correspondence with Terry Parkhouse on 16/2/04.

Terry's main concerns are over maintenance of ecological processes and control of potentially threatening development. He feels that past planning and development has been ad hoc, often resulting in expensive remedial work or environmental degradation. Terry suggests using zoning to protect the local ecology.

Terry feels that development adjacent to Saltwater Creek will have detrimental deleterious impacts on the Creek, and asks is it better to ban all development, or to allow some development that can be demonstrated to have not adverse impacts on the creek. All on the Coast and Estuary Committee agree that planning first is better than dealing with consequences later, so strong recommendations based on science and experience are required for the Estuary Management Plan.

NPWS

The National Parks and Wildlife Service replied providing standard details to assist in the preparation of Estuary Management Plans.

The following information was also provided during follow-up consultation by Alexandra Wyatt, Mid North Coast Region – Parks and Wildlife Division, Department of Environment and Conservation.

- Weed infestation – prevention, management, funding and education.

- Fire management – where national park adjoins urban areas, it is common for the park to become a sacrificial area for hazard reduction activities. Fire management is required on a whole-of-landscape basis, so land management and property owners are responsible for fire prevention activities.
- Rubbish dumping in bushland areas and rubbish entering the catchment through stormwater system.
- Maintaining vegetation diversity, biodiversity, threatened species protection and overall conservation.

Community Questionnaire Responses (names withheld for privacy)

On the 13/02/04 a questionnaire was published in the local newspaper 'The Macleay Argus' regarding the preparation of this Management Plan. The questionnaire asked about the uses, values and issues relating to the Creek as well as inviting suggestions from community members about addressing the issues concerning the Creek. The responses received are summarised in the following sections. The statements made in these sections are a reflection of communications between WBM Staff and the individuals concerned and are not presented here as fact.

Contact: Respondent 1

Respondent 1 described the use of Saltwater Creek and surrounds as recreation based, including such activities as bushwalking and bird watching. Respondent 1 values the creek for passive recreational opportunities, wildlife, biodiversity, aesthetics and the natural process of runoff collection.

The respondent feels that urban development in the catchment is an issue as this results in an increase in impervious surfaces and thus an increase in the volume of runoff. The respondent links this issue with the decline in water quality over recent years. Vegetation clearing, often for the purpose of urban development, is an issue due to the fragmentation of wildlife habitat that results.

A further concern of the respondent's is that prior use of the area for oil terminals may have left the groundwater contaminated with lead and hydrocarbons.

Excessive fires around the foreshore have burnt large areas and the respondent is worried that the remaining unburnt areas are too small for sufficient recovery and regeneration.

Allowing the Creek to operate as a natural system is preferred over the artificial opening of the Creek entrance when water is regarded as too high or stagnant.

Contact: Respondent 2

The main uses of Saltwater Creek and Lagoon for Respondent 2 and family include recreational activities as well as sketching, photography, identification of bush tucker, and weed control activities with Dune Care.

Respondent 2 values the area as a water ecosystem for the large amount of species that thrive and breed in the coastal lagoon system. Respondent 2 also values the area for recreation, aesthetics and as a wildlife area forming part of a regional habitat corridor.

Flooding is an important issue to the respondent as the local vegetation relies on this natural process. The respondent feels that the Creek and Lagoon area have important ecological value due to the uniqueness of the area compared to other estuaries in the region. The respondent is concerned about water quality, particularly the effects on the natural ecological system and the possibility of contamination from the former oil terminal sites. Other issues including stormwater management,

developmental control, siltation and sedimentation were also of concern, as was some negative effects of recreation, such as the catching of under size fish and the inconsistency in signage with regards to allowing dogs in the vicinity of the National Park.

Management of the area should involve minimal interference except in areas requiring remediation for issues such as contamination, invasive weeds and predation by cats and dogs. Respondent 2 would like to see effective programs regarding fire management, contamination monitoring and vegetation assessment. Also, the respondent would like to see the entrance opened only due not natural events, not human interference and also feels that domestic dogs should be clearly prohibited from areas of high habitat value.

Contact: Respondent 3

Bushwalking and Kayaking are Respondent 3's primary uses of the Saltwater Creek and Lagoon area.

Respondent 3 values the natural attributes of the area as well as recreational and aesthetic values. In particular, the importance of the estuary and surrounds for bird breeding areas and as a fish hatchery is noted.

Respondent 3's suggestions as to how issues relating to the Creek and Lagoon could be addressed were similar to many respondents and included development control, replanting fire sensitive vegetation and allowing the entrance to open naturally without human intervention.

Contact: Respondent 4

Respondent 4 uses the Saltwater Creek and Lagoon area for canoeing about once a fortnight and for bird watching during Spring and Autumn months. The respondent's family members fish in the creek every 1-2 weeks.

Respondent 4 notes the value of the area as a natural open space, excellent for recreational activities such as bushwalking, fishing, bird watching and canoeing. The respondent also describes value of the estuary providing a variety of habitats and the importance as a wildlife corridor.

The issues of urban development, vegetation clearing and entrance management are most important. To address these issues the respondent suggests limiting developments in the catchment, particularly along drainage lines. Maintaining vegetation along drainage lines to act as a filter, maintain aesthetic values and provide a wildlife corridor are promoted.

In areas zoned for future development, the respondent would like to see 'best practice' stormwater systems adopted, while entrance management should be left up to nature, rather then artificially controlled.

Contact: Respondent 5

Respondent 5 and family have used the area for many recreational activities, particularly canoeing and walking. The peacefulness and enjoyment that locals derive from being so close to both the bushland and water body is emphasised, however the respondent also notes the degradation of the area.

The values of the Creek include the many passive recreational opportunities, aesthetic values and natural values. The respondent also mentions the importance of the area as a corridor for wildlife, aquatic and marine life.

Respondent 5 suggests better controls on development and protection of vegetation corridors, and feels protection of landscape that screens out urban development will aid the aesthetics. Fire sensitive vegetation should be replanted. Concerning urban development, future development us appropriate stormwater filtration is suggested.

Contact: Respondent 6

Respondent 6 values the estuary and surrounding area for recreational activities, including bird watching.

Respondent 6 values the heritage, both natural heritage and the historic use of the area to access Front Beach, and considers the recreational, aesthetic and ecological values of Saltwater Creek and Lagoon as important. The role of the estuary in collecting runoff from the local area is acknowledged.

Respondent 6 is concerned about the threat posed to the local ecology by fire and human impact, as well as water quality impacts, particularly around the new residential developments and the former oil terminal sites. The respondent feels that much of the area would be suitable for inclusion in Natural Park.

The respondent would like better development control and writes that wildflowers have disappeared from newly developed housing areas. Planting new vegetation would be appropriate to replace vegetation that is cleared and otherwise lost due to residential developments and roadways. Vegetation corridors on drainage lines and appropriate landscaping are suggested, along with appropriate stormwater filtration used in new developments so that cleaner water is discharged into the lagoon system.

Contact: Respondent 7

Although Respondent 7's use of Saltwater Creek was only by viewing, it is considered the Creek is very valuable aesthetically.

Respondent 7 emphasised how important the Creek was to South West Rocks and thus why such a water body should be protected against degradation.

Of most concerned is the role of the Creek in receiving runoff from much of South West Rocks and the need to ensure the runoff does not contaminate the Creek.

With regards to future development, Respondent 7 believes that no further rezoning of rural land to urban should occur as this will degrade the environment, and considers that the community would support a ban on all future urbanisation of the area.

Killick Creek and Saltwater Creek Management Plans Community Feedback Questionnaire

Attention residents of Crescent Head and South West Rocks.

Management Plans are currently being prepared to ensure that your local coastal creeks remain healthy in the future. The Plans will define works and controls aimed at protecting their current values, and remediating existing problems and issues.

Below are some questions we would like you to answer. Your responses will allow the consultants to gain an understanding of how the community values Killick Creek and Saltwater Creek and confirm the issues that need to be managed. The questionnaire also offers you an opportunity to suggest ways that Killick Creek and/or Saltwater Creek can be managed in the future.

Q1. What are your primary uses of the estuaries and surrounding lands, and how often do you use them? *For example swimming, camping, boating or fishing once a month, week etc.*

Q2: What are the important values of Killick and/or Saltwater Creek? *For example heritage values, native flora and fauna, recreational opportunities.*

Q3: Please confirm the most important issues related to Killick and/or Saltwater Creek. *Issues include flooding, biodiversity and ecology, water quality, entrance management, stormwater management, developmental control, siltation, land status, community involvement, sediments, recreation.*

Q4: What do you suggest could be done to address some of these issues in the future?

Thank you for your time. If you wish to be informed of future study findings please provide your contact details with your completed response.

Please send your submission by 27th February 2004 to Kempsey Shire Council at:

The Civic Centre
Cnr Elbow and Tozer Streets
West Kempsey NSW 2440
Attention: Ron Kemsley
Or email: Ron.Kemsley@kempsey.nsw.gov.au

PN3207429

The Macleay Argus Friday, February 13, 2004 3

APPENDIX B: MULTI-CRITERIA ASSESSMENT OF POSSIBLE MANAGEMENT OPTIONS

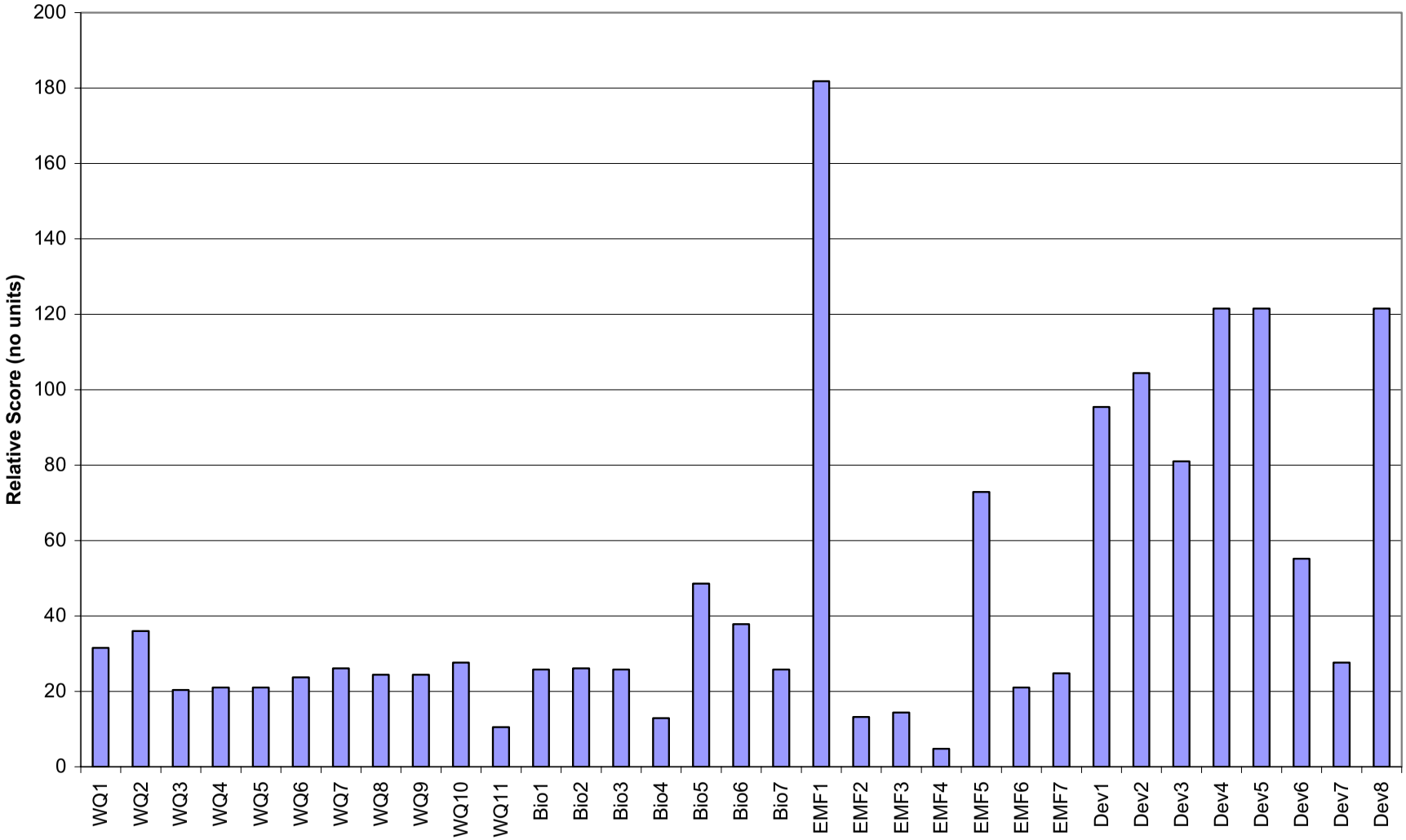
Refer Section 6.2 for discussion of options assessment.

Refer Section 5.6 for discussion of objectives prioritisation and relative scores.

Better options are those with higher overall scores, and represent options that address higher priority and/or multiple objectives, are low cost, and are likely to be effective when implemented (which includes consideration of community acceptance).

					Objectives																				
					1	2	3	4	5	6	7	8	9	10	11	12	13	14							
				rel. score	4.4	3.5	3.4	3.4	2.5	4.3	2	2.4	3.8	2	3.3	2.7	4.6	4.6		costs	cost factor	Obj*costfact	effect.	effect. Factor	Obj*costfact*effectfact	
		Type	timeframe																total	H-M-L			H-M-L		= overall score	
1	WQ1	Invest	**Imm**	Assess water quality to determine the appropriateness of primary and secondary contact recreation activities in the estua	0	1													3.5	L	3	10.5	H	3	31.5	
2	WQ2	Monitor	*ST*	On-going monitoring of water quality, particularly immediately following catchment runoff events, to determine risk to	0	1			1										6	M	2	12	H	3	36	
3	WQ3	Monitor	*ST*	Periodically monitor groundwater quality, surface water quality and estuarine sediment quality in the vicinity of the for	0		1												3.4	L	3	10.2	M	2	20.4	
4	WQ4	On-ground	**Imm**	Provide appropriate signage at popular recreation areas to inform public of water quality risks (especially following rain	0	1													3.5	L	3	10.5	M	2	21	
5	WQ5	On-ground	**Imm**	Artificially open the entrance, as necessary, to maintain water quality suitable for primary recreation in designated areas	0	1													3.5	L	3	10.5	M	2	21	
6	WQ6	On-ground	LT	Construct an ocean outfall for stormwater adjacent to the mouth of Saltwater Creek, instead of discharging stormwater c	1	1													7.9	H	1	7.9	H	3	23.7	
7	WQ7	On-ground	LT	Retrofit stormwater filtration devices and wetlands (incorporating sediment and nutrient removal) to major drains disch	1					1									8.7	H	1	8.7	H	3	26.1	
8	WQ8	Education	*ST*	Community education (including the temporary community during holiday seasons) regarding the sensitivity of Saltwat	1	1				1									12.2	M	2	24.4	L	1	24.4	
9	WQ9	Education	*ST*	Encourage on-site stormwater management (eg rainwater tanks, absorption trenches, grass swales) through education ar	1	1				1									12.2	M	2	24.4	L	1	24.4	
10	WQ10	Invest	*ST*	Conduct an audit of all on-site sewage systems to determine adequacy and enforce upgrading of unsatisfactory systems,	0	1		1											6.9	M	2	13.8	M	2	27.6	
11	WQ11	Invest	LT	Assess existing and future capacity of reticulated sewerage system to determine the frequency of sewage overflows to S	0	1													3.5	L	1	3.5	H	3	10.5	
13	Bio1	Planning	*ST*	Introduce new planning instrument(s), or modify existing instruments, to prohibit the removal or any existing native veg	0					1									4.3	L	3	12.9	M	2	25.8	
14	Bio2	On-ground	*ST*	Rehabilitate degraded habitats through revegetation (especially using fire-resistant species) and soil stabilisation, partic	1					1									8.7	H	1	8.7	H	3	26.1	
15	Bio3	Admin	**Imm**	Increase enforcement of existing fishing regulations (particularly with respect to size), especially during peak holiday pe	0					1									4.3	L	3	12.9	M	2	25.8	
16	Bio4	Admin	*ST*	Prevent unleashed dogs and other domestic animals from the natural environment around the estuary.	0					1									4.3	L	3	12.9	L	1	12.9	
17	Bio5	Monitor	*ST*	Monitor biological indicators to help assess environmental health of the estuary, including benthic fauna, seagrass distri	0					1			1						8.1	M	2	16.2	H	3	48.6	
18	Bio6	Education	*ST*	Education of community (particularly rural-residential landholders) and assistance where possible regarding fire manag	0					1	1								6.3	L	3	18.9	M	2	37.8	
19	Bio7	Planning	**Imm**	Adjust boundaries of Arakoon State Conservation Area / Hat Head National Park to include Saltwater Creek and Lagoo	0					1									4.3	L	3	12.9	M	2	25.8	
21	EMF1	Planning	**Imm**	Prepare a formal Entrance Management Policy that outlines if, when and how to artificially manipulate the entrance of S	0	1			1			1	1	1	1	1			20.2	L	3	60.6	H	3	181.8	
22	EMF2	On-ground	*ST*	Flood-proof or relocate low-lying assets around the estuary to minimise the need to artificially open the entrance due to	0							1		1					4.4	H	1	4.4	H	3	13.2	
23	EMF3	Invest	**Imm**	Review existing flood policy following outcomes of flood study and entrance management policy.	0							1							2.4	L	3	7.2	M	2	14.4	
24	EMF4	On-ground	LT	Increase capacity of Phillip Drive bridge to reduce peak flood levels upstream (as indicated by results of Flood Study).	0							1							2.4	H	1	2.4	M	2	4.8	
25	EMF5	On-ground	*ST*	Periodically allow the full hydrological range of Saltwater Creek and Lagoon to be met (ie achieving a maximum water	0					1			1						8.1	L	3	24.3	H	3	72.9	
26	EMF6	Admin	LT	Voluntary buy back of private lands within the vertical buffer limits of the lagoon and wetland.	0					1		1	1						10.5	H	1	10.5	M	2	21	
27	EMF7	Admin	LT	Purchase easements to inundate over private and public lands within the vertical buffer limit of the lagoon and wetland.	0							1	1						6.2	M	2	12.4	M	2	24.8	
29	Dev1	Planning	**Imm**	Prevent any further rezoning of urban land within the Saltwater Creek and Lagoon catchment unless it can be demonstra	0					1		1					1	1	15.9	L	3	47.7	M	2	95.4	
30	Dev2	Planning	*ST*	Prepare new planning instrument(s), or modify existing instruments, to enforce 'best practice' on-site stormwater treatm	0							1					1	1	11.6	L	3	34.8	H	3	104.4	
31	Dev3	Planning	*ST*	Prepare new planning instrument to specify an appropriate buffer between existing and future urban development and th	0					1							1	1	13.5	L	3	40.5	M	2	81	
32	Dev4	Admin	**Imm**	Maintain and enforce existing policies regarding the sensitivity of the area with respect to future development (eg visual	0					1							1	1	13.5	L	3	40.5	H	3	121.5	
33	Dev5	Planning	**Imm**	Review status of existing 1(d) urban investigation land taking into consideration the environmental sensitivity of the lan	0					1							1	1	13.5	L	3	40.5	H	3	121.5	
34	Dev6	Planning	*ST*	Rezone important habitats and estuarine fringes (as defined by scientific investigations) that are currently zoned urban i	0												1	1	9.2	L	3	27.6	M	2	55.2	
35	Dev7	Planning	*ST*	Place controls on pets within future developments that are located within close proximity to the wetlands and estuarine	0												1	1	9.2	L	3	27.6	L	1	27.6	
36	Dev8	Planning	*ST*	Ensure there is suitable provision for vegetated wildlife corridors between key habitats as part of future urban planning	0					1							1	1	13.5	L	3	40.5	H	3	121.5	

Overall scores for different options considered (refer Section 6.1 for description of all options assessed).



APPENDIX C: INTERIM ENTRANCE MANAGEMENT PROTOCOLS

Saltwater Creek

REVISION/CHECKING HISTORY

REVISION NUMBER	REVISION DESCRIPTION	DATE	CHECKED BY		ISSUED BY	
0	Interim	February 2006				
1	Revised	June 2006				

OBJECTIVES

Saltwater Creek and Lagoon is an Intermittently Closed and Open Lake or Lagoon (ICOLL), and as such, its entrance is subject to periodic closure. When closed, water levels within the system can increase due to rainfall and catchment runoff, or decrease due to evaporation and seepage through the entrance berm. High water levels within the ICOLL can disrupt or inconvenience existing commercial enterprises (including the Tourist Park and the Golf Course). In the past, the entrance of Saltwater Creek has been subject to occasional, illegal opening by community members who have been concerned regarding the elevated height of water and/or perceived ailing condition of the water quality. A number of fish kills have occurred in Saltwater Creek that have both preceded and followed artificial entrance manipulation.

These Interim Entrance Management Protocols are designed to provide clear direction to Council with respect to any physical works within the entrance of Saltwater Creek. The objectives of the Protocols are to:

- Maintain acceptable water quality within the estuary for recreational purposes;
- Limit inconvenience to existing commercial enterprises resulting from extended periods of elevated water level within the lagoon;
- Minimise environmental impacts of artificially opening the entrance at levels lower than the expected natural maximum water level;
- Accommodate future sea level rise; and
- Meet all legislative requirements including SEPP-14 considerations.

Works associated with entrance management will be triggered by conditions relating to water level and/or water quality (with water level triggers a function of season).

A higher trigger level for entrance breakout is assigned for the period from approximately mid-April to mid-September. The level assigned during this period is only likely to be reached during exceptional conditions - natural breakouts would mostly occur before the trigger is reached. As such, the winter season represents a *de facto* 'no intervention' period, allowing natural wetting and drying of the Saltwater Lagoon wetlands. The winter period was chosen for the higher breakout trigger level because (MHL, 2002):

- fish recruit from late winter to early summer,
- nutrient rich upwelling occurs in the ocean in spring and summer,
- prespawning migration to the ocean occurs in autumn and later winter,
- lower rainfall occurs during the period July to October (refer Figure C-1); and
- peak tourism occurs in summer and other holiday periods.

Average monthly rainfall for South West Rocks (Smoky Cape lighthouse) indicates an average rainfall depth of approximately 600mm during the period mid April to mid September (Figure C-1). The water level in the lagoon would typically rise by about 1.5 metre (depending on the start level within the lagoon) during this 5 month period.

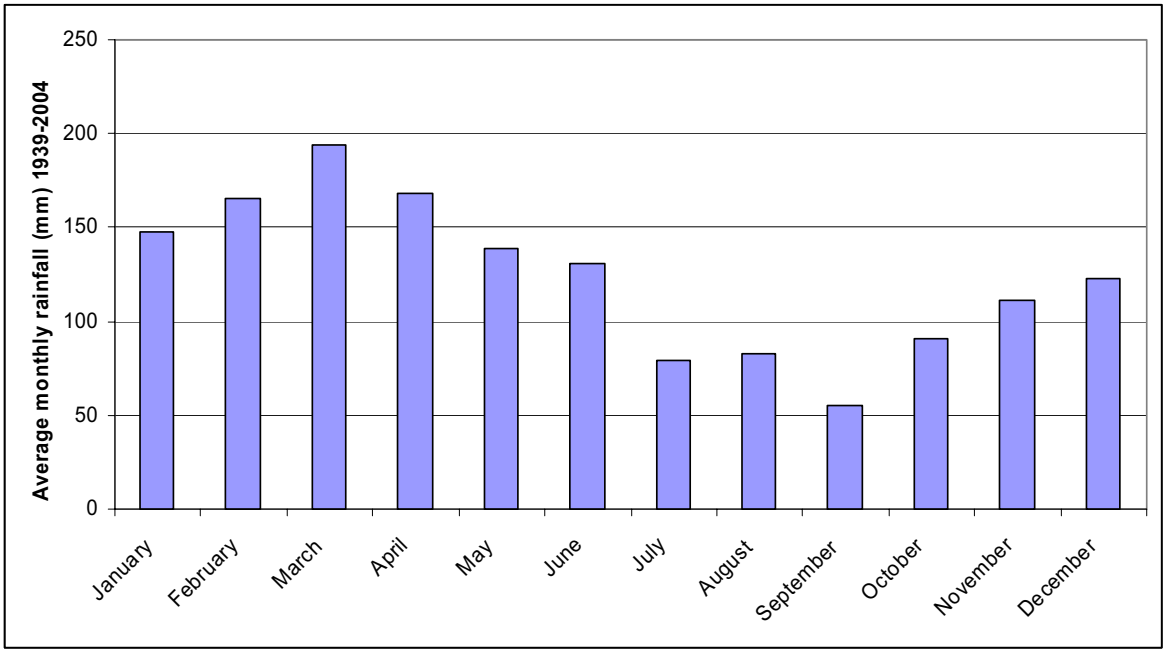


Figure C-1 Average Monthly Rainfall, Smoky Cape Lighthouse (1939 – 2004) (Source: Bureau of Meteorology)

WORKS REQUIRED

No permanent infrastructure is required to carry out entrance management works, however, earthmoving equipment suitable for deployment within the estuary entrance channel, such as an excavator with swamp tracks, is required to be mobilised at relatively short notice.

Flood-proofing and other structural works may be required in the future by Council and private landholders to abate any negative economic and amenity impacts of inundation by high water level.

Provisions should be included within local environmental planning instruments to permit minor filling of private low-lying land if it can be demonstrated that the adopted entrance management protocols are having an adverse economic impact on business.

WATER LEVEL CRITERIA

Water level conditions that trigger artificial entrance opening are as follows:

- End of Easter school holidays to 2 weeks prior to September school holidays: RL 2.0m AHD
- Remainder of year: RL 1.8m AHD

Modifications to the water level triggers may be considered following a suitable period of Plan implementation and associated monitoring, and agreement by relevant government authorities.

WATER QUALITY CRITERIA

Water quality conditions are to be used as a trigger for implementation of entrance management actions for the period from September school holidays to Easter school holidays. The conditions relate to waters behind the entrance berm when the estuary is closed, and represent the threshold for acceptable water quality for primary recreation activities within the waterway.

Interim water quality criteria are presented in Table C-1. The criteria have been based on ANZECC (2000) guidelines, but give local consideration to the unique nature of ICOLLs, and Saltwater Lagoon in particular.

Table C-1 Interim Water Quality Thresholds for Saltwater Entrance Works

Water quality constituent	Threshold (1)
Dissolved oxygen	4 mg/L (minimum)
pH	6.0 (minimum)
Temperature	35°C (maximum)
Secchi depth	1.0 metres
Faecal coliforms	600 counts/100mL (maximum) (2)
Enterococci	60 counts/100mL (maximum) (3)
Odour	Significant malodour generation (4)
Oils and grease	Presence of significant surface slicks (4)

(1) Refer Operational Procedures for monitoring frequency

(2) Alternative threshold is four (4) consecutive records greater than 150 counts/100mL

(3) Alternative threshold is four (4) consecutive records greater than 35 counts/100mL

(4) Although subjective, this threshold would be based, to some degree, on the potential impact that an odour or petro-chemical slick has on users of the estuary and its foreshores.

In addition to the above, the entrance to Saltwater Creek may be opened artificially for environmental management purposes, including for example fish kills or significant algal proliferation. Under these circumstances, entrance management works would be subject to agreement by DPI (Fisheries), and may be carried out at any time of the year. DPI may direct Council to undertake water quality monitoring within Saltwater Creek to support a judgement regarding artificial intervention.

A hand held water quality multi-probe is to be used to determine results for dissolved oxygen, pH and temperature, while secchi depth is to be determined using a secchi disc attached to the end of an incremented pole. Water samples are to be collected and provided to Council's microbiological laboratory for analysis in respect to faecal coliforms and enterococci. Sampling procedures shall be followed in accordance with laboratory requirements, with samples delivered to the lab not less than 24 hours after sampling. Samples are to be chilled during storage and transportation to the laboratory.

Water quality conditions are to be determined by averaging results from sampling at a minimum of three sites within the lower section of Saltwater Creek, behind the entrance berm, no less than 20

metres apart (refer Figure C-2). With respect to bacteria, a combined sample using waters taken from all sampling sites (minimum of 3 within lower section of creek) should be provided to the laboratory for analysis. Water quality within the main body of Saltwater Lagoon or the upper reaches of Saltwater Creek shall not be used as a trigger for entrance breakout given that these areas are most subject to natural variations, are least used for primary contact recreation activities, and would not benefit immediately from an entrance breakout event (as it would take some time for ocean water to flush into these upper estuarine regions).

Modifications to these criteria may be made in the future following further consideration of environmental impacts and associated implications for recreational users of the estuary.

Figure C-2 Suggested locations for minimum water quality monitoring to assess entrance breakout requirements

OPERATIONAL PROCEDURES

General operational procedures for management of the Saltwater Creek entrance are triggered once the entrance is closed.

Water levels are recorded within Saltwater Lagoon by Manly Hydraulics Laboratory every 15 minutes (http://www.mhl.nsw.gov.au/htbin/map_data_display.com?SITE=SALT). This gauge is to be maintained while ever entrance management is required in Saltwater Creek.

Water quality is to be monitored by Council on a weekly basis, as well as immediately after rainfall events (i.e. more than 5mm in 24hrs) throughout the period mid September to mid April, whenever the entrance is closed.

OPENING PROCEDURE

Once the need to open Saltwater Creek entrance has been confirmed by Council (and DPI if required), the following steps shall be followed.

1. Council officers will contact appropriate representatives of the Department Natural Resources (DNR), Department of Primary Industries (DPI – Fisheries), Department of Environment and Conservation (National Parks) and the Department of Lands (DoL) to notify them of the need for artificial entrance intervention.

2. Council officers will arrange for appropriate earth moving equipment to be mobilised to South West Rocks for excavation of the entrance channel. Mobilisation of equipment should be timed to coincide with the most appropriate tidal conditions for entrance breakout.

3. Optimum tidal conditions for entrance breakout would be spring tides with a strong diurnal variation in consecutive highs and lows. While waiting for appropriate tidal conditions, Council should conduct a ground survey of entrance conditions. Survey should cover the entire entrance berm area extending from the beach swash zone at low tide to the estuarine channel upstream of the berm (refer Figure C-3). Survey transects should be carried out at approximately 10 – 20 metre intervals.

4. A pilot channel shall be excavated between the ocean and the creek through the entrance berm. The channel should generally be positioned close to the western foreshore (refer Figure C-4). The channel shall grade towards the ocean and will have a width of approximately 2 metres. The invert of the channel shall be at a level of approximately -0.5m AHD. Break-though of estuary waters to the ocean should be timed to occur shortly after the ocean tide turns from high to low for the lowest tide predicted for that day. This will maximise the duration for water level difference between the creek and the ocean, thus maximising the potential for natural scour of the channel before the next high tide.

   If the entrance opening is triggered by poor water quality and water levels within the creek are low, then the width of the excavated channel should be increased to 5 metres due to the low hydrostatic head and limiting potential for the channel to self-scour once opened.

5. Appropriate actions should be carried out to ensure public health and safety during the breakout operations.

6. Following entrance breakout, ground surveys of entrance conditions should be carried out, particularly if pre-breakout surveys were undertaken. Surveys should be carried out immediately after breakout (i.e. within 1 day), and then repeated approximately 1 week later to determine the rate of initial marine infill within the new entrance channel. Subsequent surveys of the entrance, several weeks and months later could also be undertaken to help determine and quantify entrance dynamics and berm recovery processes.

Figure C-3 Extents of pre- and post-breakout entrance survey

Figure C-4 Approximate position of pilot channel for inducing artificial breakout

CLOSING PROCEDURE

In exception circumstances, an open creek entrance may be artificially closed (to provide surf boat access along front beach from the surf club during state tournaments, for example). Artificial closure of the creek entrance is conditional on the basis that the entrance will be re-opened to its former state, as soon as practical, after the passing of the exceptional circumstances.

The following steps will be followed in closing the creek entrance.

1. In close liaison with Council, applicants will contact appropriate representatives of the Department Natural Resources (DNR), Department of Primary Industries (DPI – Fisheries), Department of Environment and Conservation (National Parks) and the Department of Lands (DoL) to notify them of the need for artificial entrance intervention.

2. Applicants will arrange for appropriate earth moving equipment to be mobilised to South West Rocks for infilling of the entrance berm. Works will be conducted in accordance with all approval conditions, as imposed by Council or Government authorities.

3. Entrance closure should be timed to maximise water levels within the creek and lagoon once closed. This way, when the entrance is re-opened, maximum hydrostatic head can be used to self-scour the entrance channel. Final stages of berm infilling should therefore be timed to coincide with peak spring high tide conditions. Material used to infill the entrance berm should be sourced from the upstream edge of the active marine delta within the creek entrance and not from the adjacent dunal system.

4. Re-opening of the creek following artificial entrance closure entrance should be carried out in accordance with the Opening Procedures, as described previously. Ground surveys of entrance conditions (as specified in the Opening Procedure) are not required for re-opening works following artificial entrance closure.

CONSENTS AND APPROVALS

Excavation works within an entrance channel will require prior authorisation by a number of government agencies. First, however, the works will need to be permissible under Council's Local Environmental Plan (LEP). At present, the entrance of Saltwater Creek is zoned 6(a) – public recreation. Council is in the process of reviewing their LEP. It is recommended that Council makes provision within the new LEP for carrying out entrance works (with clear definition of the type of works and the purpose of the works) as a permissible activity with consent. The consent process should involve preparation of an Environmental Impact Assessment (such as a Statement of Environmental Effects), and assessed in accordance with heads of consideration under Part 79C of the *Environmental Planning and Assessment Act, 1979*. Concurrent consent from Department of Lands (under the provisions of the *Crown Lands Act 1989*) and/or Department of Primary Industries (under the provisions of the *Fisheries Management Act 1994*) may be required as part of an *integrated approval* process.

It will be important that consent for the works and approval by the relevant government agencies is on-going (for a duration of up to 5 years, say), so that works can be undertaken quickly without the need for written consent when entrance opening is required. Future extension of the consent and approvals would need to be supported by an updated environmental impact assessment, which would likely incorporate the outcomes of monitoring undertaken as part of previous entrance dredging works.

The entrance to Saltwater Creek is not located within gazetted SEPP-14 boundary (Figure C-5), which means that entrance opening works will not be undertaken on land subject to SEPP-14 provisions. Information provided to Kempsey Shire Council from the Department of Planning indicates that, in accordance with clause 7(1) of the Policy, only works carried out within the gazetted

boundary are affected by the Policy, even if external works modify water levels within the wetland, which then may have consequential effects on vegetation.

Provisions of SEPP-35 Maintenance of Tidal Waterways cannot be used to artificially open estuary entrance for the purposes of flood mitigation.

Figure C-5 Gazetted SEPP-14 wetland in relation to Saltwater Creek entrance

Approvals and/or authorisation of the works are required from:

Council: In accordance with requirements of the LEP (to be specified as part of the LEP review);

Department of Lands: Under the provisions of the *Crown Lands Act, 1989,* written consent is required as the works will be carried out on Crown Land; and

Department of Primary Industries: A dredging permit is required from DPI-Fisheries for any subaqueous excavation of bed material, under the provisions of the *Fisheries Management Act, 1994*, if a permit is not provided by another government authority (such as Department of Lands).

All government agencies would still be notified of the entrance management intention prior to undertaking of any works.

RESPONSIBILITIES

The primary responsibility for implementation of the Saltwater Creek entrance management protocols is with Kempsey Shire Council. These responsibilities include direction and supervision of all works on site to ensure that they are carried out in accordance with these protocols and relevant standards and codes of practice.

The nominated Council officer(s) for implementation of these protocols have not yet been confirmed.

Council is also to notify various government agencies prior to undertaking entrance works. Relevant contact officers from these government agencies have not yet been confirmed.

REPORTING

Results of water quality monitoring and entrance surveys shall be reported to key agencies (DEC, DPI, DNR, DoL) and the Coast and Estuary Management Committee on a regular basis during periods of entrance closure and following entrance management works.

An annual report shall be prepared by Council officers and presented to the Committee and Kempsey Shire Council regarding the effectiveness of these protocols and recommending modifications, as necessary.

PROTOCOL REVIEW

On an annual basis, Council will consider the need for changes to the protocols, specifically in relation to the criteria that define when actions are initiated. Any changes to the protocol thresholds or operational procedures will first need to be ratified by Council and the Coast and Estuary Management Committee prior to implementation.

It is recommended that these protocols are also reviewed on a more detailed basis during the environmental impact assessment required to gain consent for the works, and subsequent assessments that would be required to renew the consent (every 5 years or so, depending on Council and other agency requirements).

CURRENT CONTACTS

Agency	Contact	Phone and email details
Kempsey Shire Council	Ron Kemsley	6566 3248 ron.kemsley@kempsey.nsw.gov.au
DNR	John Schmidt	6562 0707 John.Schmidt@dipnr.nsw.gov.au
DPI-Fisheries	Marcus Riches	6626 1370 marcus.riches@dpi.nsw.gov.au
Department of Lands	Brian Semple	6552 2788 brian.semple@lands.nsw.gov.au
DEC – National Parks	Colin Campbell	6566 6621 colin.campbell@environment.nsw.gov.au

PROTOCOL AGREEMENT

Agency	Signatory (Regional directors)	Signed	Date
Kempsey Shire Council	(General Manager)	.....	
DNR		.....	
DPI-Fisheries		.....	
Department of Lands		.....	
DEC-National Parks		.....	
Kempsey Coast and Estuary Management Committee	(Chair)	.....	