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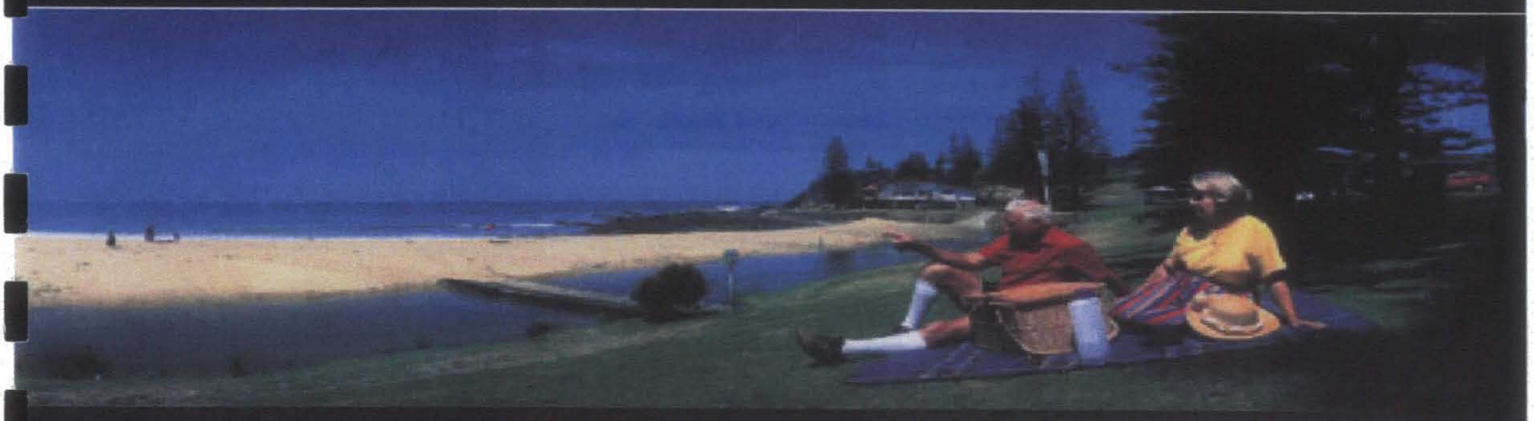

BLACK HEAD LAGOON ENTRANCE

MANAGEMENT PLAN

DRAFT

FEBRUARY 2006

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1. EXECUTIVE SUMMARY

In September 1998, the Greater Taree City Council developed a management plan for the Black Head Lagoon Estuary The plan identified the need for development of a specific management plan for the Entrance of Black Head Lagoon

The entire catchment of the Lagoon was invited to attend a community workshop People were invited to the workshop by mail and by ads in the local papers The community consultation identified two core issues with regard to the lagoons entrance

1 Water Quality
2 Flood risk of private property and assets

This management plan also outlines management actions for ecological, social and economic activities that will be influenced by the management of the entrance and water quality, including

- Recreation
- Ecology
- Sedimentation / Erosion
- Public Health
- Community Awareness
- Safety, and
- Aesthetics

Findings from the community workshop and investigation carried out by council officers have identified three possible entrance management options

1 Retain the lagoon in its natural state (no artificial opening)
2 Manage the lagoon as close to its natural state as possible (Provisions for opening during flood or poor water quality)
3 Artificial system (Engineered opening / maintained water levels)

After consideration of ecological, social and economic benefits of the three options, option 2 was considered the most appropriate This involves artificial opening of the lagoon entrance once critical point/guidelines are met with regard to flooding, and water quality Additionally the results recorded at the community workshop held on the 25th September 2005 (figure 1 0) indicated that a large majority showed preference to option 2

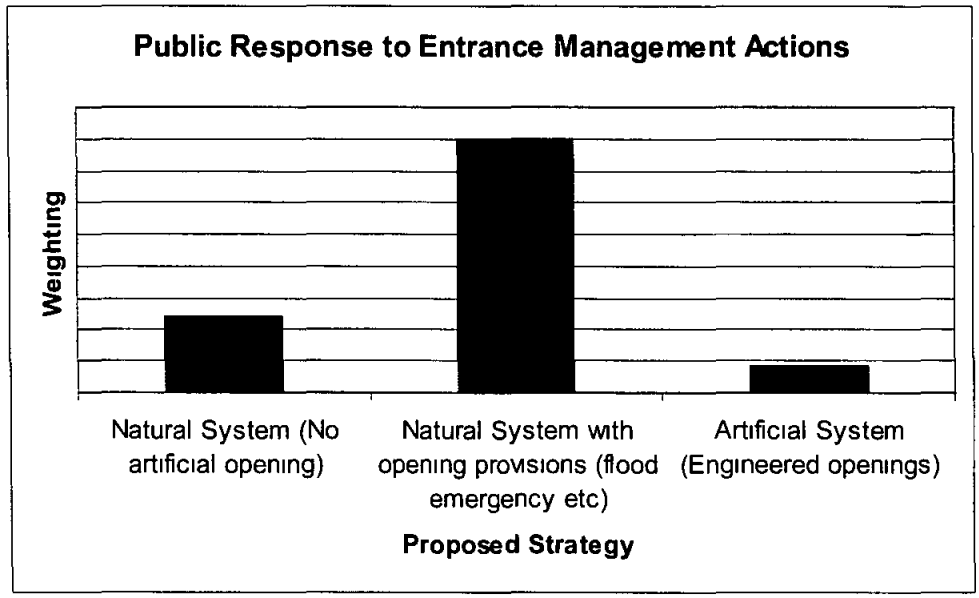


Figure 1.0 Public Responses to Entrance Management Actions

A preliminary critical flood level in the lagoon has been set at 2 4m AHD Council will further investigate the preliminary flood level and refine it over time Particular attention will be paid to minor flood events that will occur in the catchment in the future

The Environmental Health department of council has advised against the encouragement of primary and secondary water based activities in the lagoon due to extremely dynamic and poor water conditions Therefore critical water quality guidelines have not been set to secondary and primary contact levels (Australian Standards) This Plan recommends the expansion of monitoring parameters to be carried out in the lagoon (currently only Faecal coliform), and correlation of these results with natural events, and ecological status of the lagoon over a period of time in order to set lagoon specific critical water quality guidelines at which artificial opening of the lagoon should be considered

Other issues identified during the preparation of this plan were

- Identification of a monoculture of introduced fish species *Gambusia holbrook* in the lagoon
- Bad odours resulting from poor water quality
- Poor community and tourist education of lagoon processes
- Old broken footbridge near entrance
- Norfolk Island Pine replacement
- Beach access for emergency vehicles when lagoon water levels cut off existing access

- Surf club pool water quality when lagoon breaches
- Existing sediment in upper lagoon that occurred prior to installation of artificial wetlands

In addition to the main issues discussed above, further issues identified in the management actions of this plan are the basis for the following recommendations

- Erection of educational signage with regard to lagoon odours, water quality and ICOLL processes
- Source funding and the installation of 2 automated water-sampling devices
- Turn ocean bath pump off when natural or artificial breach of entrance occurs
- Upgrade storm water outlet located near surf club
- Development of lagoon specific education programs
- Further implementation of Water Sensitive Urban Design techniques in the upper catchment
- Investigation into the remediation of severely shoaled areas in the upper lagoon
- Encourage research from universities and similar via email and direct contact (Mosquito Fish / Water Quality opportunities)
- Once existing Norfolk Island Pines begin to die out, select appropriate species to replace trees (eg Wollemi or Norfolk Island Pines)
- Modification of existing footbridge for emergency vehicle access during times when water levels in the lagoon are high, cutting off normal access points
- Removal of old broken footbridge located near entrance of lagoon

The Black Head Lagoon Entrance Management Plan itself must be regularly reviewed and adapted It should be treated as a living document, subject to fine-tuning and adjustment as needed

2. INTRODUCTION

1.1 BACKGROUND

In June 1998 GTCC completed the Black Head Lagoon Estuary Management Plan The Plan addressed and provided management actions for the following Water Quality, Erosion and Sedimentation, Aquatic Ecology, Terrestrial Ecology, Foreshore Management, and Recreation and Monitoring This plan will address the issue of opening the lagoon as identified in the Black Head Lagoon Estuary Management Plan 1998

Anecdotal evidence suggests Black Head Lagoon was a safe swimming place for children up until the 1960s The lagoon was also used for bait fishing and general recreation However as a result of recent development pressures, and its natural periodic openings to the sea 4 – 6 times per year (Love, 1985), the quality of the water has deteriorated

In 2003 the Black Head Lagoon Constructed Wetlands and Detention Basin were installed by GTCC as a part of the management actions outlined in the Black Head Lagoon Estuary Management Plan 1998 The wetlands were designed to catch the majority of water and sediments before entering the lagoon, acting as a natural filtering system Since the installation in 2003 there has been a marked increase in water quality that can be attributed to the construction of the wetlands and detention basin The constructed wetlands were seen as an environmentally friendly technology and less energy intensive

1 2 LOCATION AND DESCRIPTION

Black Head is situated within the locality of Hallidays Point Hallidays Point comprises of four main villages of Diamond Beach, Redhead, Black Head and Tallwoods, located 25km south of Taree

Black Head Lagoon is typical of many coastal lagoons of south eastern Australia

- Small, covering an area of about 1ha The lagoon is ephemeral meaning that it varies in size according to the environmental conditions Total length is approximately 850m while the width varies between 6m and 27m,
- Shallow, with depths normally no more than 2m,
- The lagoon drains a small catchment of 205 ha In this case it is also heavily developed,
- The lagoon is usually closed to the sea via a sand bar or berm, and classed as a saline coastal lake,
- In the past the lagoon had been occasionally opened mechanically to allow partial drainage flushing to occur,
- The lagoon is subject to event driven fluctuations relating to either catchment processes (flood flows) or coastal/ocean forces (tide, wind, ocean swell, weather),

- Experiences wide and rapid variations in such factors as salinity, pH, temperature, dissolved oxygen and nutrients in response to such events as floods, droughts and wash overs;
- The entrance to the lagoon is located at the southern end of the beach where the energy from the strong south easterly swell is much refracted, but also where constructive swell from the north east quadrant can induce a lateral shift in the entrance towards the rocky southern headland (Bird, 1984); and
- Urban development is dramatically increasing and covers a significant area of the catchment. A large proportion of the catchment consists of cleared and rural land. This cleared land will almost definitely be urbanised within the next decade.

1.3 Land Status and Tenure

Over recent years The Hallidays Point area has had a strong development interest that is ever increasing in the general locality. The geology of the area makes it very attractive for development as it is being characterised by a well-forested undulating coastline leading to significant rocky headlands adjacent to unspoilt beaches and Black Head Lagoon, which is the focus of this study. The Hallidays Point Development Strategy guides development in the Black Head locality, with an emphasis on Water Sensitive Urban Design.

According to the Greater Taree Demographic Profile 2004, the average annual change in population between 1996 and 2001 is a significant positive growth of 5.2%. With the implementation of the 2000 Hallidays Point Development Strategy the growth trend is expected to continue.

Figure 2.0 is an extract from the LGA Local Environmental Plan 1995 and shows the current zonings for the area.

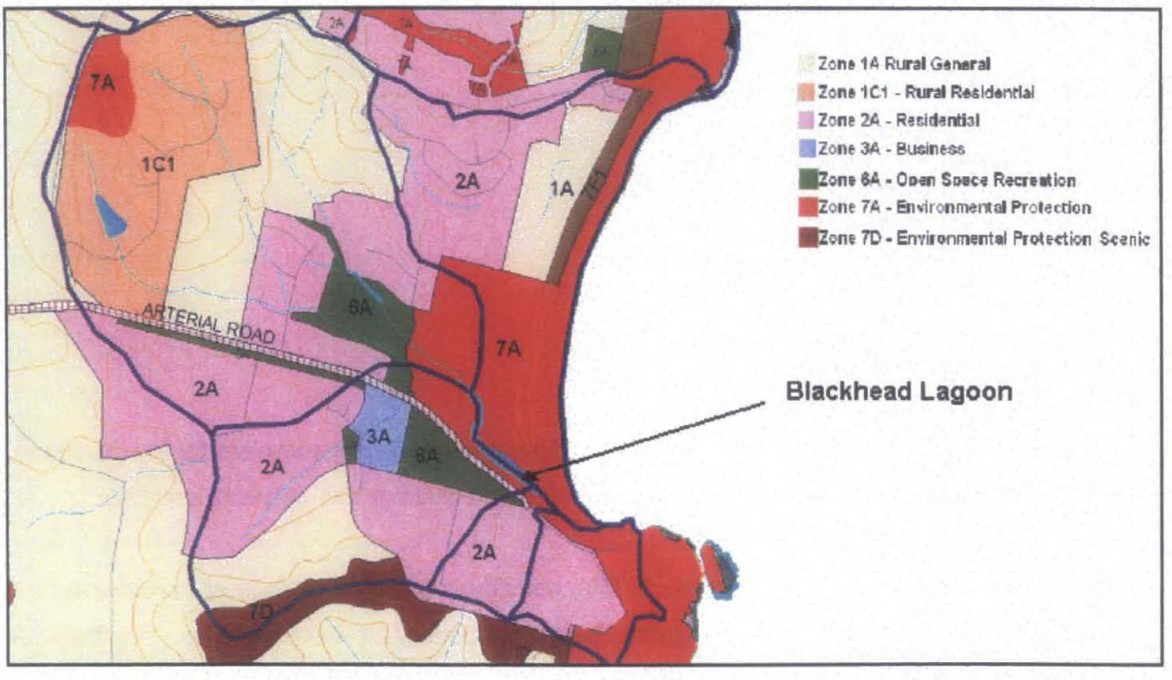


Figure 2.0 Black Head Lagoon Catchment LEP Zonings.

1.4 Topography

Black Head Lagoon is located adjacent to the coast and extends inland approximately 400m Adjacent to and immediately to the west of the lagoon is a low-lying ephemeral wetland with an elevation of 2 to 4m AHD The wetland forms a relatively flat basin in the centre of the catchment Between the basin and the ridges that form the catchment boundary, the landform exhibits three small valleys or sub catchments that all drain to Black Head Lagoon

The topography of the catchment that surrounds the lagoon forms a horseshoe shaped valley that is bounded to the south, west and north by low ridges extending up to approximately 40 to 50m above sea level To the east, the catchment is bounded by Black Head Bay Adjacent to the Black Head beach escarpment of Black Head Bay is a low sand ridge that is located parallel to the coastline with it's crest approximately 100m inland from the water edge

1.5 Geology and Soils

The Black Head lagoon catchment lies on Late Devonian sedimentary rocks belonging to the Bundook Beds The Bundook Beds comprise of grey or brown lithic sandstone and siltstone, which is frequently cherty, and ribbon banded and is imbedded with massive grey whacks and minor conglomerate Pleistocene and more recent Holocene deposits are present in the area and from rear dune, fore dune and beach deposits The small Black Head Lagoon embayment has been in filled progressively during the Quartenary period with estuarine mud's and alluvium, which have consolidated to stiff clays during periods of low sea level (Umwelt, 1996a)

The Spoil Conservation Service has described four soil groups within the Black Head Lagoon catchment These are influenced by both geological and landform factors

1) Shallow Stoney Soils
2) Red-Brown Duplex Soils
3) Greyed Duplex Soils
4) Dunal Sands

(Umwelt, 1996a)

1.6 Previous Studies

The Black Head Lagoon has been the subject of debate and management strategies for many years Community debate has primarily been focused upon the issue of the Lagoons entrance

Documentation dates as far back as the 1970's, detailing a proposal for a 3 cell box culvert to be installed in the lower section of the Lagoon, designed to allow salt water intrusion, and therefore facilitating flushing, increasing water quality levels in the Lagoon However it was found that the work lacked analysis of coastal processes, with no account for possible blocking mechanisms or the ecological implications of providing a permanent connection to the sea

In 1989, the Coast and Rivers Branch of the New South Wales Public Works undertook photogrammetric analysis of past aerial photography The photography covered the years 1937, 1952, 1963, 1981 and 1986 From this work it is reasonable to assume that there is no net recession trend in the southern section of the beach within the vicinity of the Lagoon entrance

From March 1995 to March 1996 a photographic record of Black Head Beach and lower lagoon has been recorded These were taken at an opportunistic basis as significant changes of events occurred

In 1998 Greater Taree City Council prepared a Black Head Lagoon Estuary (BHL) Management Plan which recommended the preparation of this plan

Previous Studies

1 Greater Taree City Council (GTCC) (June 2002) *Hallidays Point OSARF Plan – Community Reaction Needs and Issues Paper*, GTCC, 20002

2 Greater Taree City Council (GTCC) (September 2002) *Hallidays Point OSARF Plan – Draft Final Report* GTCC 2002

3 Greater Taree City Council (GTCC) (August 2002), *Review of Environmental Factors for the Black Head Constructed Wetlands and Gross Pollutant Trap*, GTCC 2002

4 Coastcare/GTCC (1998) *Coastline Survey of Asparaceae and other Environmental Weeds –in the Manning Valley, northern New South Wales*, Geoff Williams & Daintry Gerrand, 1998

5 GTCC (December 1998) *Hallidays Point Habitat Study* GTCC 1998

6 Greater Taree City Council (GTCC) (June 1998), *Black Head Lagoon Estuary Plan of Management* ,GTCC 1998

7 Greater Taree City Council (August 1998), *Black Head Drain Maintenance - Revegetation Plan*, GTCC 1998

8 Greater Taree City Council (1998), *Hallidays Point – Black Head – Vegetation Restoration Action Plan*

9 GTCC (October 1997) *Black Head Reserve Drain Maintenance Eight Point Test* GTCC, 1997

10 GTCC (September 1997) *Black Head Reserve – Review of Environmental Factors for Drain Maintenance* GTCC, 1997

11 Greater Taree City Council (July 1996), *Part A – Draft Management Options Report – Black Head Lagoon Estuary Process Study*, Umwelt (Australia) Pty Ltd

12 Greater Taree City Council (July 1996), *Part B – Draft Management Options Report – Black Head Lagoon Estuary Process Study*, Umwelt (Australia) Pty Ltd 1996

13 Coastcare (April 1997) *Hallidays Pt Flora & Fauna Management Study – Coastcare Project 95/13 – Part A Fauna*, EcoPro Australia, 1997

14 GTCC (September 1995) *Hallidays Point Development Strategy* GTCC, 1995

15 GTCC (Spetember 1995) *Hallidays Point Development Strategy – Volume 2, Appendices*, GTCC 1995

1.7 Need For a Management Plan

The Black Head Lagoon Entrance Management Plan is needed to specifically manage the entrance at Black Head Lagoon The Black Head Lagoon Estuary Management Plan 1996 specified that further investigation into the entrance is required and a strategy developed This need is largely driven by past, existing and future human activities, which have had, or potentially have, an adverse impact on the lagoon The majority of adverse activities are not confined to the lagoon itself, but originate within the Lagoons catchment and are closely linked with the ever-increasing levels of human population in the catchment

Many activities have already degraded the Lagoons environmental values Such degradation has wide spreading ramifications on recreation, tourism, local economy, community attitudes, commercial activities, etc

A Black Head Lagoon Entrance Management Plan is needed to

- Maintain and improve the estuarine environmental values of the Lagoon
- Define, prioritise, costs, and management actions for the entrance
- Provide recommendations for the establishment of a management structure, which facilitates implementation of management activities

1 8 Objectives

The objectives of this Plan are to

- Define management strategies and select actions, which will help with the management of Black Head Lagoon entrance
- Describe and justify selected actions, and
- Prioritise selected actions in terms of their need and the practical limitations of their implementation

1 9 Plan Development

This Plan has been developed in accordance with a range of policies, plans and strategies and the recommendations of the NSW Government's Estuary Management Policy The policies, which were considered included

- State Rivers & Estuaries Policy
- NSW Coast Government Policy
- Crown Land Foreshore Tenures Policy (non commercial occupations) (1991)
- Coastal Policy for NSW
- State Environment Protection Policies (SEPP), including
    - SEPP 14 - Coastal Wetlands
    - SEPP 71 - Coastal Development
    - SEPP 35 - Maintenance Dredging

- SEPP 44 Koala Habitat Protection
- Greater Taree City Council Local Environment Plan
- Development Control Plan No 95

1.10 Plan Implementation

Some of the recommended management actions in this Plan will require alterations to existing Council planning documents and also other planning tools, such as development approval conditions, permits and/or licences for works and other measures to prevent future environmental damage Provision of any capital works will have to comply with relevant State and Federal legislation This should include consideration of

- Water Management Act 2000
- Coastal Protection Act 1979
- Crown Lands Act 1989
- Environmental Protection and Biodiversity Act 2000
- Environmental Offences & Penalties Act 1979
- Environmental Planning & Assessment Act 1979
- Fisheries Management Act 1994
- NSW Heritage Act 1977
- Local Government Act 1993
- National Parks & Wildlife Act 1974
- Native Vegetation Conservation Act 1997
- Maritime Services Act 1935
- Rivers and Foreshores Improvement Act 1948
- Soil Conservation Act 1938, and
- Threatened Species Conservation Amendment Act 2005

3. KEY VALUES

Although small, Black Head Lagoon provides an extremely valuable habitat and recreational resource While the lagoon is not utilised on a commercial scale, the environment provides an important niche area for a significant range of flora, fauna and marine biota Recreational uses of the lagoon in the past have included swimming, canoeing, and the occasional fishing and prawning

Black Head Lagoon supports an extremely variable habitat system, ranging from saline to freshwater conditions in the space of 24 hours

The dominant vegetation types are the She Oak and the Grey Mangrove Mangroves provide vital habitat for avifauna, crustaceans, macrofauna, and meiobenthos Meiobenthos are of particular importance as they are a major food-source for many fish species, and are therefore critical for the recovery of the Lagoons biological diversity Mangroves and She Oaks also proved a link for avifauna, including sea birds

A search of the NPWS Atlas of NSW wildlife was conducted over a 10 km x 10 km square radius over Black Head Lagoon The following threatened species were identified as being recorded within the area A site inspection was conducted to address the suitability of the site to fulfil the habitat requirements of the species

- Square Tailed Kite *(Lophoictinia isura)*
- Glossy Black Cockatoo (*Calyptorhynchus lathami*)
- Sooty Oystercatcher (*Haematopus fuliginosus*)
- Little Tern (*Strena albifrons*)
- Grass Owl (*Tyto capensis*)
- Masked Owl (*Tyto novaehollandiae*)
- Pied Oystercatcher (*Haematopus longirostris*)
- Black Necked Stork (*Ephippiorhynchus asiaticus)*
- Osprey (*Pandion haliaetus)*
- White Tern (*Gygis alba)*
- Powerful Owl (*Ninox strenua)*
- Masked Owl (*Tyto novaehollandiae)*
- Koala (*Phascolarctos cinerus)*
- Brush-tailed Phascogale (*Phascogale tapoatafa*)
- Eastern Freetail – Bat (Eastern Freetail – bat)
- Squirrel Glider (*Petaurus norfolcensis*)
- Grey Headed Flying Fox (*Pteropus poliocephalus*)
- Common Blossom Bat (*Syconcyteris australis*)
- Little Bentwing – Bat (*Miniopeterus australis*)
- Eastern Bentwing – Bat (*Schreibersii oceanensis*)

Flora

- *Cynanchum elegans*
- *Senna acclinsis*

Anecdotal evidence suggests historically the lagoon has been used for bait fishing, however this has not occurred in recent years due to declining water quality and species diversity Any commercial activities occurring in the lagoon will be required to acquire the appropriate permits and licensing agreements from Local and State Governments

Various values were identified in the Black Head Lagoon Management Plan completed in 1996 Some of these values are related to the entrance and are relevant to this management plan These values are as follows

KEY COMMUNITY VALUES (BLACK HEAD LAGOON ESTUARY MANAGEMENT PLAN 1996)

Ecological: The lagoon and adjacent reserve are ecologically valuable and supports a rich diversity of flora and fauna species with several species having national or regional significance

Recreational Opportunity: The lagoon and adjacent reserve provides a wide range of casual recreation opportunities These range from water based recreation along the beach and in the estuary area to walking, picnicking and nature observation in the reserve

Scientific and Education: The lagoon and adjacent reserve has the potential to act as an area for scientific research and to provide nature conservation education to the local community

Visual/Aesthetic: The lagoon and adjacent reserve provides a quality visual landscape that contrasts with the urban development adjoining the reserve

Linkage: The lagoon and adjacent reserve provides an important link with other habitat areas along the coast It also provides a linkage between the coast, the estuary, and the developed areas of Hallidays Point

Social Opportunities: The lagoon and adjacent contributes to the social fabric of the community by providing opportunities for social interaction and community based projects

KEY COMMUNITY VALUES (BLACK HEAD LAGOON ENTRANCE MANAGEMENT PLAN 2005)

On the 25th October 2005, the Black Head Lagoon Entrance Management Plan community workshop was held at Black Head SLSC The workshop identified various values of the entrance and the lagoon itself, from recreational to environmental to safety

Community consultation through the form of workshops encourage active public involvement in the development of Councils land management objectives It provides council with a sound understanding of relevant local issues from people who are familiar with and use the area in question It also allows for management based on community values and considers alternative ideas and strategies identified by the community

This management plan was developed through a consultative process including Black Head Lagoon users, neighboring residents, community groups, relevant agencies and other interested stakeholders Consultation undertaken in the preparation of this plan has included a community workshop held at the Black Head SLSC and submissions during the exhibition and submission period of this plan The Workshop minutes are attached in Appendix A

The community workshop identified three main management options with respect to the entrance itself These are as follows and will be further discussed in this Management Plan

1 Retain the lagoon in its natural state (no artificial opening)
2 Manage the lagoon as close to its natural state as possible (provisions for opening)
3 Artificial system (Engineered opening / maintained water levels)

Values identified in the workshop are summarised in the following table

Table 1: Values	
Identified Value	Graphical representation
Water Quality	
Public Health & Safety	
Flooding Risk	
Recreation	
Ecology	
Aesthetic Value	
Tourism	
Education	

4. CURRENT USES AND CONFLICTS

Black Head Beach, located adjacent to Black Head Lagoon is a major recreational destination for the local community Recreational use of Black Head Lagoon varies between seasons and includes both active and passive recreation These include

- **Foreshore picnicking -** Picnics are a passive, land based activity, which have a very wide appeal Black Head Lagoon Reserve provides picnicking facilities to the community in the form of, barbeques, tables, toilets, playground, and parking These facilities are subject to flooding, when overtopping of the lagoon occurs during high rainfall events and the entrance does not or has not yet breached
- **Previous Recreational Fishing** – Historically fishing has occurred in Black Head Lagoon However due to poor water quality that can be attributed to increased urban development, water quality has decreased and diversity of species has dramatically fallen The sole species known to occur in the lagoon *Gambusia holbrooki* (Mosquito fish) is an introduced species and not suitable for fishing or human consumption A Threat Abatement Plan has been devised by the National Parks and Wildlife Service NSW, which identifies various techniques of managing *Gambusia* However the plan indicates, "There are presently no effective and specific methods to control *Gambusia* " (NPWS 2003)
- **Watercraft** – Paddleboats and small floating craft are used intermittently in the lagoon, mostly during the school holiday period Current water quality does not support these activities, thus they should be discouraged until water quality improves
- **Swimming** – Most swimming activity occurs at the entrance to the lagoon This area has a sandy bottom, which is largely free of rocks, snags and weed throughout most of the year The shallow depth and wave energy of the lagoon encourages family groups, typically with young children (2 – 12 years) learning to swim

  GTCC's Environmental Health department has advised that swimming should not be encouraged in the lagoon although it does occur due to those swimmers being unaware of the health risk it involves It is recommended that information signs warning the public of health risks when swimming in the lagoon should be erected permanently, particularly during holiday periods, and that swimming should be encouraged in the surf on Black Head beach

- **Walking/Jogging** – Walking and Jogging should be encouraged around the lagoon as it helps to develop appreciation for the lagoon's environment and ever changing nature A walking track exists so that foreshore vegetation is not damaged
- **Cycling** – Cycling is an active, land based activity which is non polluting, however it does require appropriate facilities for safe cycling in the area, which do not currently exist

5. BLACK HEAD LAGOON PROCESSES

Black Head Lagoon is typical of many small coastal lagoons characterised by an intermittently tidal waterbody, and a relatively small upper catchment Consequently, the sedimentation that has occurred since sea levels stabalised has not been sufficient to infill the initial back-barrier lake or lagoon

Black Head Lagoon has an intermittent entrance that is closed to the ocean for the majority of the calendar year Under natural conditions, the entrance opens only when a large build up of catchment runoff breaches the beach berm

Sediments are deposited to the lagoon by a variety of agents Bank erosion and general catchment runoff produce large quantities of sand, silt and clay Catchment runoff also delivers organic matter to the river/estuary Wind action on dunes and sand banks also carries fine sand into the estuary

The movement of water in and out of the lagoon is predominantly influenced by the tides Freshwater effects are generally small (but often of significance with respect to water quality), except during times of flood

5.1 Modes of movement

Sediment particles being moved by water can undergo three distinct modes of motion

- a rolling and/or sliding motion,
- a saltation or hopping motion,
- a suspended particle motion

Black Head Lagoon demonstrates all motions in correspondence to its immediate environment

During times of flood the flowing water entering and exiting Black Head Lagoon exerts a shear stress on the bed As the water flow increases it reaches a critical value required for initiation of motion of the sediments The sediment particles will begin to roll or slide whilst being in continuous contact with the bed As water velocity and shear stress increase, the particles then move along the bed in a series of more or less regular jumps called saltations At even higher levels of bed shear stress, upward turbulent forces can lift sediment particles from the bed and carry them into the water column If these forces are greater than the submerged weight of particles, the particles will remain in suspension

Soil samples collected from the lagoon bed show that sediments have an extremely high phosphorous concentration, which increased with sampling depth The samples also indicated low nitrate concentrations over the entire sampling depth

The Lagoon has high acid generation potential with oxidised sulphur content ranging from 0 8% to 1 75% This equates to an acid generating potential of approximately 25 kg H2SO4/tonne to 54 kg

H2SO4/tonne of dry sediment Therefore if exposure to the atmosphere of these sediments due to dredging or draining of the lagoon were to occur, extremely high levels of acid would be generated

5.2 Opened and Closed States

The closure of the entrance reduces the flushing of Black Head Lagoon, which can lead to poor water quality With increased anthropogenic impacts through urbanisation this process is intensified, with particular concern regarding increased nutrient levels As a result of increased nutrient levels the Lagoon can become eutrophic A thorough understanding of the circulation and mixing characteristics of the Lagoon is essential for the proper management of the system

Circulation and mixing characteristics of Black Head Lagoon are different to those of a normal estuary because of their location where tidal range and energetics are small Usually when the lagoon is connected to the ocean it is via a narrow, shallow inlet channel Hence, there is severe attenuation of the tide, as it propagates into the estuary, mainly due to frictional energy losses This causes tidal velocities in the estuary to be small when the inlet is open In general, tidal velocities in ICOLLs may be expected to be significantly less than those in a permanently open estuary and this will influence vertical mixing

Black Head Lagoon has two distinctive behavioral patterns during winter and summer which are largely unaffected by the tidal state as in permanently open estuaries The vertical stratification is governed mainly by the interaction of solar heating, wind stirring, estuarine circulation (driven by lateral advection of buoyancy) and convective cooling at night

In general the following hydrodynamic states all operate within Black Head Lagoon, depending on its immediate environment

1 **The closed state.** The main influences on the circulation and density structure during this time are wind mixing, river and groundwater flows, differential heating and cooling and evaporation Evaporation is the main mechanism for the increase in salinity when the stream flow is negligible
2 **The open state (freshwater regime):** During this period, fresh water is present throughout the estuary and there is no seawater penetration due to the high river runoff When the bar is opened (naturally) the estuary water is relatively fresh
3 **The open state (sea water regime)**· Seawater penetrates the estuary during the flooding state of the tide and forces a salt wedge into the estuary The degree of penetration of the salt wedge depends on the tidal range and the opposing stream flow

5.3 Biological processes

Filter feeders that are present in the lagoon remove clay particles and other suspended material from the water and eject them as larger agglomerates, which can settle from suspension under quiescent conditions Diatoms and benthic algae growing on settled sediment can impart a slimy, weakly bonded texture to the sediment, which inhibits erosion This is particularly evident near the footbridge at Black Head Lagoon

As a part of this plan Curlew Biological Services carried out a marine biological survey on 30 December 2004 Previously Curlew had carried out a similar study for the 1998 plan, which identified an expected variety of species indicating that the system was relatively healthy at that point in time The recent study used the same methods and techniques to compare diversity with that indicated in 1998 The results show that there has been a significant reduction in species diversity with the introduction of an exotic fish species, *Gambusia holibrook* This is further discussed in Section 11 - Ecology in this document

6. ESTUARY & CATCHMENT MANAGEMENT FRAMEWORK

6.1 GENERAL ESTUARY & CATCHMENT MANAGEMENT PROCESS IN NSW

It is well recognised that estuaries are of considerable environmental, social and economic value Because of their attractiveness and value, estuaries are used for a wide variety of purposes by different groups of people Often these uses are in conflict Additionally, inappropriate use and over-use of estuaries and surrounding catchments can, and do, degrade their natural values

There is growing recognition that to better protect the varied uses and attributes of an estuary a coordinated planning approach is required, particularly for land use in the catchment This approach needs to allow proposals for development, nature conservation and remedial works to be assessed and to proceed on an integrated and objective basis The preparation of a Management Plan provides such a coordinated planning base

For a Management Plan to be effective, it needs to

- reflect the considered and objective views of all regulatory authorities and interested parties,
- be formally adopted by local council(s) and all stakeholders,
- be incorporated into appropriate planning/policy frameworks, and
- be implemented by council(s), government authorities, interest groups and the community in general

In accordance with the above, the NSW Government has formulated an Estuary Management Policy to foster the better management of estuaries An Estuary Management Manual (NSW Government, 1992) has also been produced providing guidelines to help develop and implement soundly based Estuary Management Plans The Black Head Lagoon Entrance Management Plan has been formulated in accordance with these guidelines The components of the Estuary Management Framework, as documented in the Manual, are illustrated in Figure 3 0 and described briefly below

- Form Estuary Management Committee
- Assemble Existing Data
- Carry Out Estuary Process Study
- Carry Out Estuary Management Study
- Prepare Draft Estuary Management Plan
- Review Estuary Management Plan
  - Adopt and Implement Estuary Management Plan
  - Monitor and Review Management Process

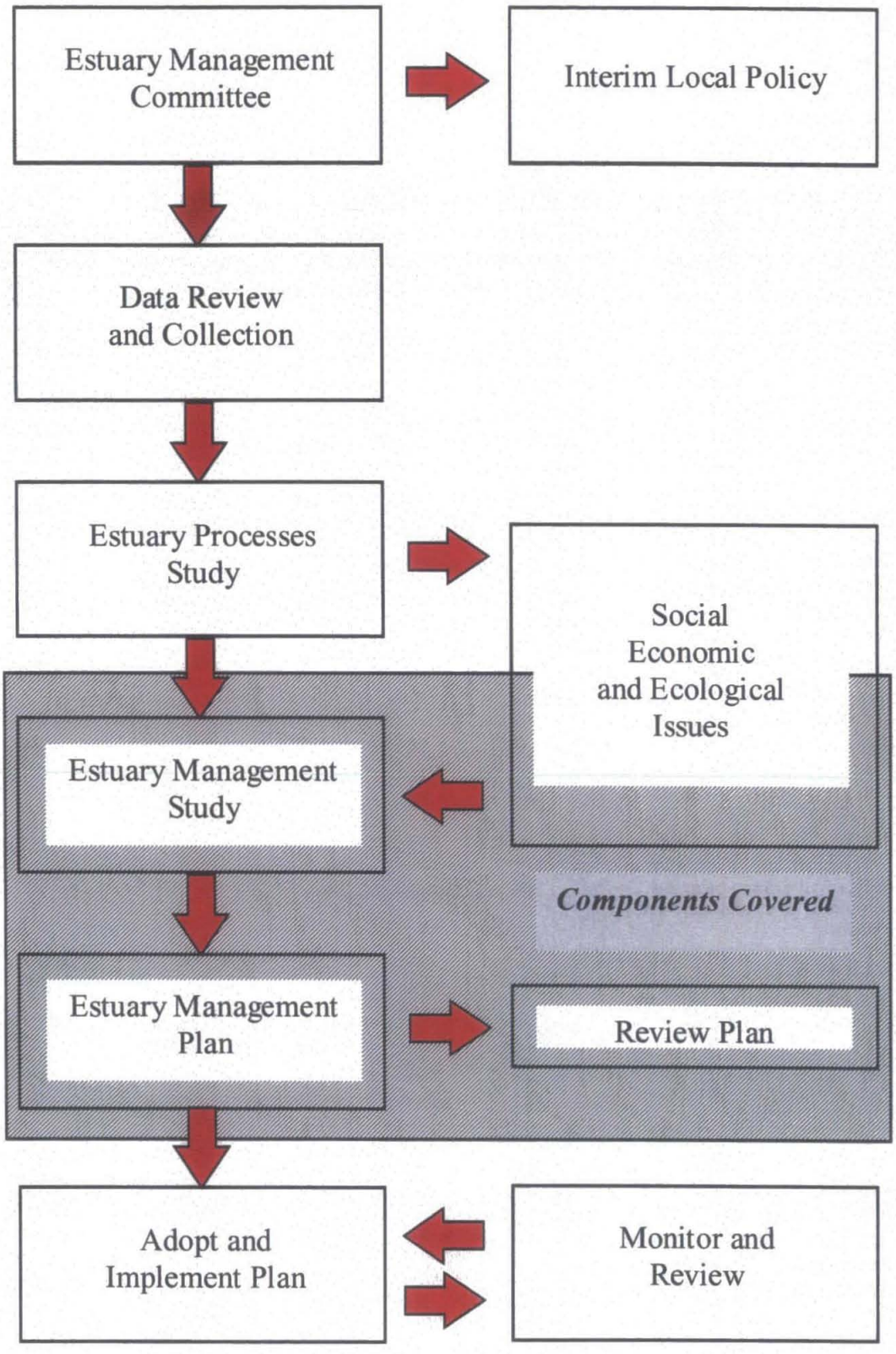


Figure 3.0 NSW Estuary Management Framework

6.2 Estuary And Coastline Management Committee

Estuary Management Plans are prepared under the guidance of an Estuary Management Committee, in this instance, the Estuary and Coastline Management Committee (ECMC). The Committee is made up of representatives from the local Council, relevant Government Departments, relevant authorities and

community groups as shown in Table 2. The table also indicates the roles and responsibilities of each organisation, as applied to the ECMC.

Table 2 Representations on ECMC

Organisation / Group	Roles and Responsibilities
Greater Taree City Council (3)	• Development approvals • Provision of services • Land management • Completion of this and previous studies according to the NSW Government's Estuary Management Policy • Implementation of this Plan in conjunction with other relevant organizations
Department of Infrastructure, Planning and Natural Resources (DIPNR) formerly Department of Land and Water Conservation (DLWC). (1)	• Promotion and administration of the NSW Government's Estuary Management Policy • Provision of funds to assist local government in implementing the guidelines • Administration of Total Catchment Management Policy in NSW • Provision of technical advice, expertise and reviews
Department of Lands (1)	• Land management responsibilities including foreshore development and crown lands (which includes the Lake bed) • Provision of technical advice, expertise and reviews
Department of Conservation (DEC) – National Parks and Wildlife Service (NPWS). (1)	• Environmental expertise
NSW Maritime Authority (1)	• Management of the Creeks boating activities
Hunter – Central Rivers Catchment Management Authority (1)	• Administration of Total Catchment Management Policy in NSW
General Public (2)	• Community Input
Manning Coastcare (1)	• Community environmental input
Manning Valley Channel Committee (1)	• Community channel issue input

Table 2 Representations on ECMC cont.	
Organisation / Group	**Roles and Responsibilities**
Manning Coastcare (1)	• Community environmental input
Manning Valley Channel Committee (1)	• Community channel issue input
Manning River Sustainable Recreational Fishing and Tourism Committee (1)	• Community tourism and recreation input
Taree Fisherman's Cooperative Society Ltd (1)	• Commercial fishing input
Manning River Oyster Farmers Association (1)	• Commercial oyster farming input
Manning Delta Landowners Protection Committee (1)	• Landholder input
Department of Primary Industries (NSW Fisheries) (1)	• Administration and management of NSW's fisheries resources including policing and education • Management of aquatic habitat and aquatic species • Management of commercial and recreational fishing activities and aquaculture • Responsible for marine reserves and aquatic species under the Threatened Species Conservation Act (excluding aquatic mammals)

7. BLACK HEAD LAGOON ENTRANCE MANAGEMENT PLAN - PART 1

7.1 WHAT THIS PLAN DELIVERS

This Plan is a management tool

It defines a series of actions, which if implemented, will manage the entrance of Black Head Lagoon This will in turn enhance recreational opportunities, community attitudes and the general wellbeing of the Lagoon

The recommended actions are based on available data, the findings of the Black Head Lagoon Estuary Management Plan 1998, Stormwater Management Plan, studies carried out for this management plan, Council research and community input / information Where there is unresolvable conflict between different interest groups, actions have been selected to achieve equitable access and distribution of the Lagoons resources to the community whilst preserving or enhancing the Lagoons environmental values

Actions are not set in concrete, but over time must be reviewed and fine-tuned based on feedback through monitoring and community opinions Community opinions can also be softened through awareness and education programs, which clearly explain why an action (or no action) is taken

This Plan does not provide the necessary information to obtain government approvals or to carry out designs for works, monitoring programs, community education programs, etc Most actions will require specific detailed investigations to address these requirements These studies should not be viewed as more studies "for the sake of having studies", but as one of the steps in implementing an action

This Lagoon Entrance Management Plan has been formulated as a series of actions and recommendations for each of the following categories

- Water Quality
- Artificial Opening/Flood Protection/Safety
- Ecology
- Foreshore Recreation/Aesthetics
- Erosion and Sedimentation

Each action has been selected on the basis that it is the best option, or group of options, to meet the objective of this Management Plan and the management aims as outlined in Table 3 The selection process takes into account a range of factors including the actual need (for action), the cost versus benefit and community opinions and needs

Table 3 Management Aims	
Category	Aim
Opening of the Entrance / Flood Protection / Health	To determine a balance between community/private assets, and the ecological integrity of the lagoon entrance
Water Quality	To improve water quality in Black Head Lagoon to a level with expected waterway uses
Erosion and Sedimentation	To identify the impact of past and present sedimentation and erosion impacts on the lagoon and recommend an appropriate strategy
Recreation / Aesthetics / Safety	To maintain and enhance the recreational and aesthetic value of Black Head Lagoon with consideration to the wider community
Ecology	To maintain and improve the ecological status of Black Head Lagoon

This Plan identifies the relevant organizations that should be actively involved in implementing and seeking / providing funds for an action Actions have not been prioritised according to available funds as these are to be determined and not necessarily guaranteed It is, however, not impractical to implement the majority of actions, provided, sufficient resources are allocated to actively seek and secure funds, and manage the implementation stages

7 2 Layout & Terminology

Estuary Management Plan actions are grouped according to the following categories

A. **Artificial Opening / Flood Protection / Public Health / Safety**
B. **Water Quality**
C. **Erosion and Sedimentation**
D **Ecology**
E **Foreshore Recreation / Aesthetics**

For each category the following is presented

- A general discussion providing the background to each issue
- A Management Aim
- An Overall strategy to achieve the Management Aim
- A table outlining the actions and their reason for selection Each table categorises an action according to
    - ***Priority*** where
        - **ASAP** is As Soon As Possible
        - **High** is within 1 year

- **Medium** is within 1 to 3 years
- **Low** is when resources become available eg funding
- **Ongoing** is on an indefinite basis Ongoing actions have also been assigned a priority (as above) to assist prioritisation of actions when implementing this Plan

- ***Agencies*** which are the authorities or groups identified as
  - having a significant interest in implementing the management action
  - providing and/or finding funds to implement the management action

- Indicative ***Cost*** which is a broad estimate for planning purposes that is subject to detailed design, etc The cost classifications are as follows
  - **Min** (minimal) = **$1,000 - $5,000**
  - **Low** = **$5,000 - $10,000**
  - **Mod** (moderate) = **$10,000 to $50,000**
  - **High** = $**50,000 to $100,000**
  - **Vhigh** (very high) = **greater than $100,000**

- All costs are only for the direct implementation for a particular action No estimate of costs has been made where an action may have "follow on" effects, such as recommendations for additional work, changes to land prices and employment

8. BLACK HEAD LAGOON ENTRANCE

BACKGROUND

The water level in Black Head Lagoon is controlled by the height of the beach berm, which closes the entrance of the lagoon to the sea An increase in height due to sand accretion and high water inflow to the lagoon from rain can compound to increase lagoon levels and flood properties

The lagoon entrance is a critical consideration in this plan and should be thoroughly understood

8.1 THE NATURAL STATE

The natural state of Black Head Lagoon is as an Intermittently Closed and Opened Lagoon or Lake (ICOLL) It has a shallow basin that has a very low (or negligible) freshwater input The catchment for the system is limited to the immediate hinterland Due to the lack of significant freshwater input (and associated terrigenous sediment) and strong tidal currents, the entrance to Black Head Lagoon is intermittently closed, resulting in isolation from marine influence for long periods (Ranasinghe et al 1999)

To preserve the natural state and characteristics of this unique system, alterations to natural processes should be minimised To do this the lagoon should not have a permanent connection to the sea Not only is this not the natural state of the system, a permanent connection would ultimately lead to concerns regarding water quality and visual amenity due to frequent complete drainage of the perched system (see figure 3 1 in section 8) Additionally near or complete drainage of the lagoon leads to the break down of aquatic flora and fauna trapped in the lagoons upper reaches resulting in an unpleasant strong odour

Although the lagoon should not have a permanent connection to the sea, there is potential for the entrance and water level in the lagoon to be managed Management options of entrance and water levels are discussed below

8 2 BREAKOUT

Council does not mechanically open Black Head Lagoon Additionally it is illegal for other bodies or people to open the lagoon

Lagoon opening procedures occur under State Government approval, which overrides any relevant State Government policy Such approval to mechanically open the lagoons has been in place since the commencement of the practice almost 35 years ago

Natural opening of the lagoon occurs when the water level difference is higher in the lagoon, i e high lagoon flood level and falling tide This increases the runout effect and removes the majority of the stored water and its soluble and suspended inclusions Also there is a significant scouring of sand from the beach berm as the opening is further widened under the force of water

Upon draining, the berm stays open until re-instated naturally by the sea. During this open period, tidal flushing of the lagoon occurs.

If the lagoon was to be artificially opened the breakout level should be controlled. One proposal is to regularly check the berm level, and when necessary create an overflow path on the lagoons beach berm. This overflow path would be set at a predetermined level and allows the overtopping to occur at a controlled place and level should Council machinery not be available. There is a high possibility that instances may occur where there is heavy rainfall at night or hazardous conditions have delayed the arrival of machinery.

The berm overflow path level should be identified if a breakout procedure was designed and implemented. The width and timing of this procedure would be set in response to development and ecological considerations.

8.3 Water Levels

Rainwater and catchment runoff are the main contributors to the lagoon water level. Long periods of closure to the ocean and relatively high bed levels in relation to mean sea level means that there is minimal tidal influence within the lagoon.

The bed of Black Head Lagoon at the entrance was measured at 0.596 AHD (27th September 2005). This means that the entrance of the Lagoon is perched 0.596 meters above average sea level. If the lagoon was to be opened there is a high potential that it will drain due to its perched nature, unless managed. One option for management of water levels is the installation of a water level control structure located near the existing footbridge. This device would be in the form of a weir, floodgates, or levee gate.

A structure such as this would keep the lagoon levels at an artificial height after berm openings, reducing the exposure of the lagoon bed and subsequent complaints about appearance and odour.

An alternative method is to not fully open the lagoon berm and therefore not completely draining it. To achieve this the opening strategy (if one was to be adopted) whereby the berm is opened when the water difference is the lowest and then mechanically closed after the flood level impact has been removed. Although difficult, this method is more acceptable from an ecological perspective in the short term, however there is high potential for long term problems such as, nutrient build up within the lagoon due to the highly urbanised catchment. Flushing is necessary on a regular basis however there will need to be a deliberate consideration of the ecological trade offs.

Any proposals for artificial structures will need to consider funding options for the initial capital cost and future maintenance.

Lagoon water depths may also be increased by undertaking lagoon deepening activities such as dredging. Any such activities would require a detailed environmental, economic and social impact assessment in order to justify, design and assess the merits of such work (as outlined in section 10 Erosion and Sedimentation).

Overall Strategy For Active Entrance and Water Level Management Options

Management Aim To determine a balance between community/private assets, and the ecological integrity of the lagoon entrance

Management Actions Identified in Community Workshop

On the 25th October 2005 the Black Head Entrance Management Plan Community Workshop was held at the Black Head Surf Life Saving Club to identify community values and views regarding the entrance of Black Head Lagoon Three possible management actions were identified and are as follows

1. Retain the current state of the lagoon entrance and allow it to function naturally
2. Retain natural entrance of the lagoon, and allow for mechanical opening when required (flooding/ public health risk)
3. Artificial management of the lagoon entrance, maintaining water levels and opening periodically

The workshop identified action 2 (above) as the option most preferred by the general Black Head community This option allows for the artificial opening of the lagoon in times where there is a flood risk, and poor water quality to support the lagoons environment This plan will therefore discuss and suggest the setting of parameters for the artificial opening of the lagoon when required in the following table and other management tables

COMMON ARTIFICIAL OPENING METHODS

Numerous local councils have various artificial opening methods. Of significant note is the Avoca lagoon located in the Gosford City Council.

Possible artificial opening methods are discussed below.

Option 1: Gauge the water level of the lagoon and set a critical water level height at which council should investigate the opening of the lagoon. Installation of a flood gauge similar to figure 3.0 and the use of a critical flood height would provide for a visible flood assessment method for artificial opening of the lagoon.

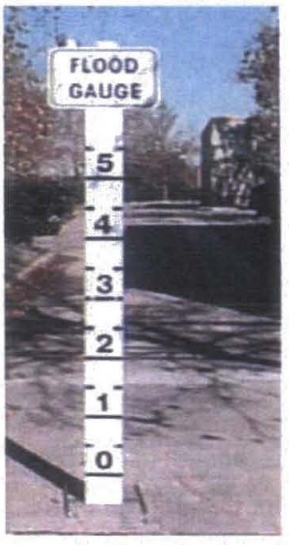


Figure 3.0 Example of flood gauge

When necessary create an overflow path on the lagoons beach berm. This overflow path would be set at a predetermined level and allow the overtopping to occur at a controlled place and level, should Council machinery not be available. There is a high possibility that instances may occur where there is heavy rainfall at night or hazardous conditions have delayed the arrival of machinery.

The berm overflow path level should be identified if a breakout procedure was designed and implemented. The width and timing of this procedure would be set in response to development and ecological considerations.

Option 2: Installation of a water level control structure located near the existing footbridge. This device would be in the form or a weir, floodgates, or levee gate. A structure such as this would keep the lagoon levels at an artificial height after berm openings, reducing the exposure of the lagoon bed and subsequent complaints about appearance and odour.

Option 3: Council not fully open the lagoon berm and therefore not completely draining the lagoon. To achieve this the opening strategy whereby the berm is opened when the water difference is the lowest and then mechanically closed after the flood level impact has been

removed This method has been attempted in other areas such as Terrigal lagoon and proven to be both difficult to achieve and expensive From an ecological perspective this method is more appropriate in the short term However there is high potential for long term problems such as nutrient build up within the lagoon due to the highly urbanised catchment Flushing is necessary on a regular basis, this will need deliberate consideration of the ecological trade offs

Any proposals for artificial structures will need to consider funding options for the initial capital cost and future maintenance

Lagoon water depths may also be increased by undertaking lagoon deepening activities such as dredging Any such activities would require a detailed environmental, economic and social impact assessment in order to justify, design and assess the merits of such work (as outlined in section 10 Erosion and Sedimentation)

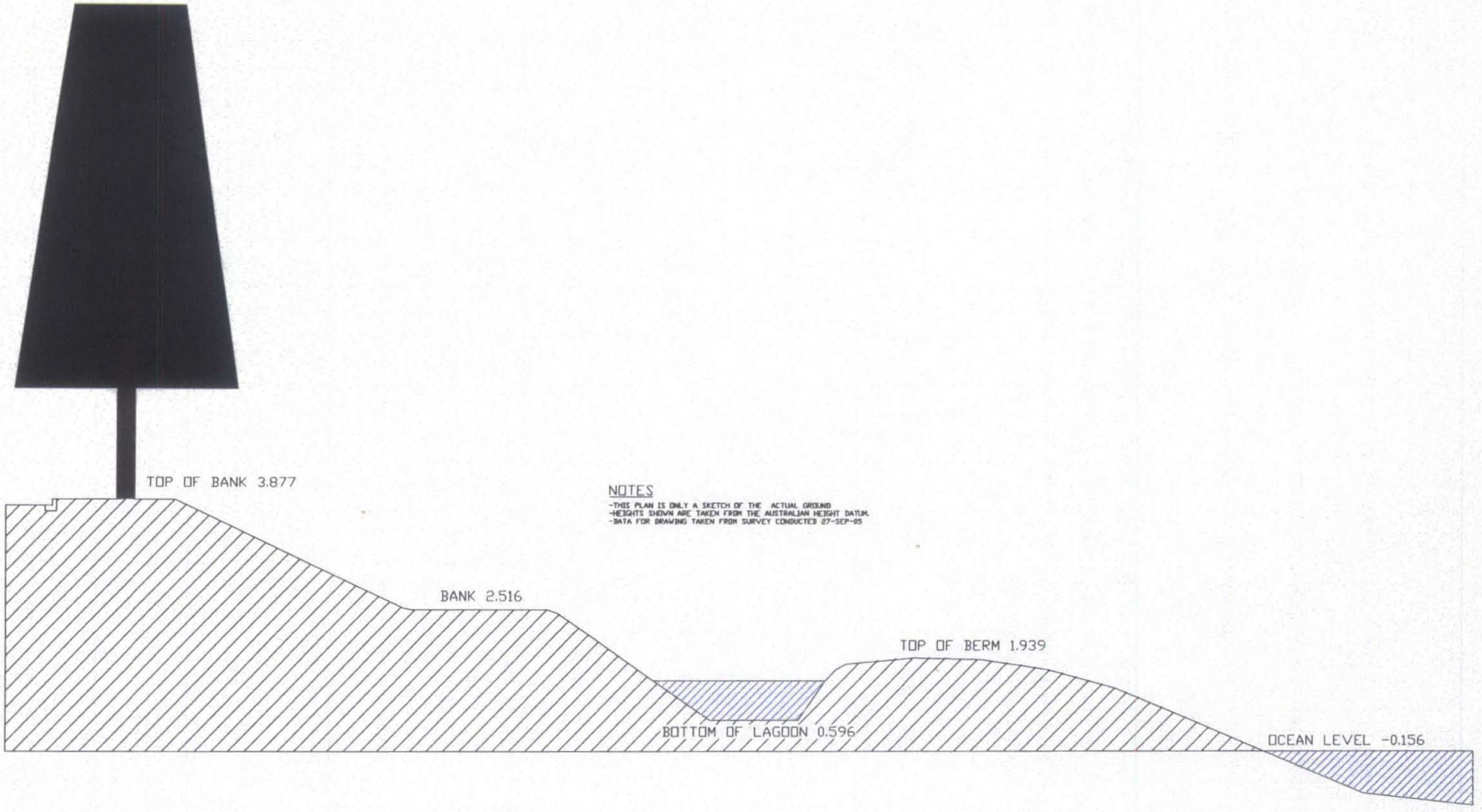


FIGURE 3.1 - HEIGHT OF LAGOON ABOVE AUSTRALIAN HEIGHT DATUM (AHD) 27 SEPTEMBER 2005

Table 4: Lagoon Entrance Management Actions							
Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	1 Water Quality	1 Expand monthly water quality testing parameters to include ❑ Faecal coliform ❑ Phosphates ❑ Nitrogen ❑ Dissolved oxygen ❑ PH ❑ Salinity ❑ Suspended Solids 2 Define specific environmental water quality guidelines for the opening of the Black Head Lagoon entrance Once one or more of these parameters are exceeded then investigate an artificial opening of the lagoon 3 Installation of automated water quality monitoring devices	Currently Faecal Coliform is the sole parameter measured within the lagoon on a monthly basis Due to the high use of the lagoon, especially at holiday peaks public health is a risk Parameters measured should be expanded and the information posted on Councils website The definition of environmental water quality guidelines set on an environmental basis will allow for more effective ecological management of the lagoon The use of primary or secondary contact guidelines are not appropriate as Councils Environmental Health department has advised that no swimming or paddling in the lagoon should be encouraged	Water quality testing parameters expanded Environmental water quality guidelines set Improved water quality	High	GTCC	Med

Table 4: Lagoon Entrance Management Actions							
Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	2 Flooding	1 Installation of a critical flood gauge measuring water level at Baywood Drive 2 Definition of a critical water level at which opening of the lagoon should be assessed by Council in order to minimise flood damage to neighbouring properties Preliminary investigations into the critical height suggest that a height of 2 40AHD be set at which Baywood Drive is likely to flood This level is strictly preliminary and subject to monitoring and changes over time	This gauge would identify a certain water height in the public eye, at which Council should consider and assess the possibility of opening the lagoon to a set opening procedure, therefore minimising flooding dangers to nearby properties	Installation of flood gauge Setting of a critical height in AHD Opening of the lagoon before flooding occurs	High	GTCC	Low
	3 Opening procedure	1 Devise opening method and procedure guidelines, only to be used as a last resort that will not allow the lagoon to open and alleviate flood or improve water quality (See discussion of options below)	A specific opening procedure will facilitate effective management of the entrance while protecting the surrounding community and the lagoons ecology	Adoption of specific opening strategy	High	GTCC	Med

Table 4: Lagoon Entrance Management Actions							
Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
+	4 Surf club pool	2 Turn pump off when natural or artificial opening event occurs	When a breakout occurs, water of poor water quality can be pumped into the pool, resulting in a public health risk Turning the pump off eliminates the health risk, as the poor water does not enter the pool	Pump turned off in event of breakout	High	GTCC	Low

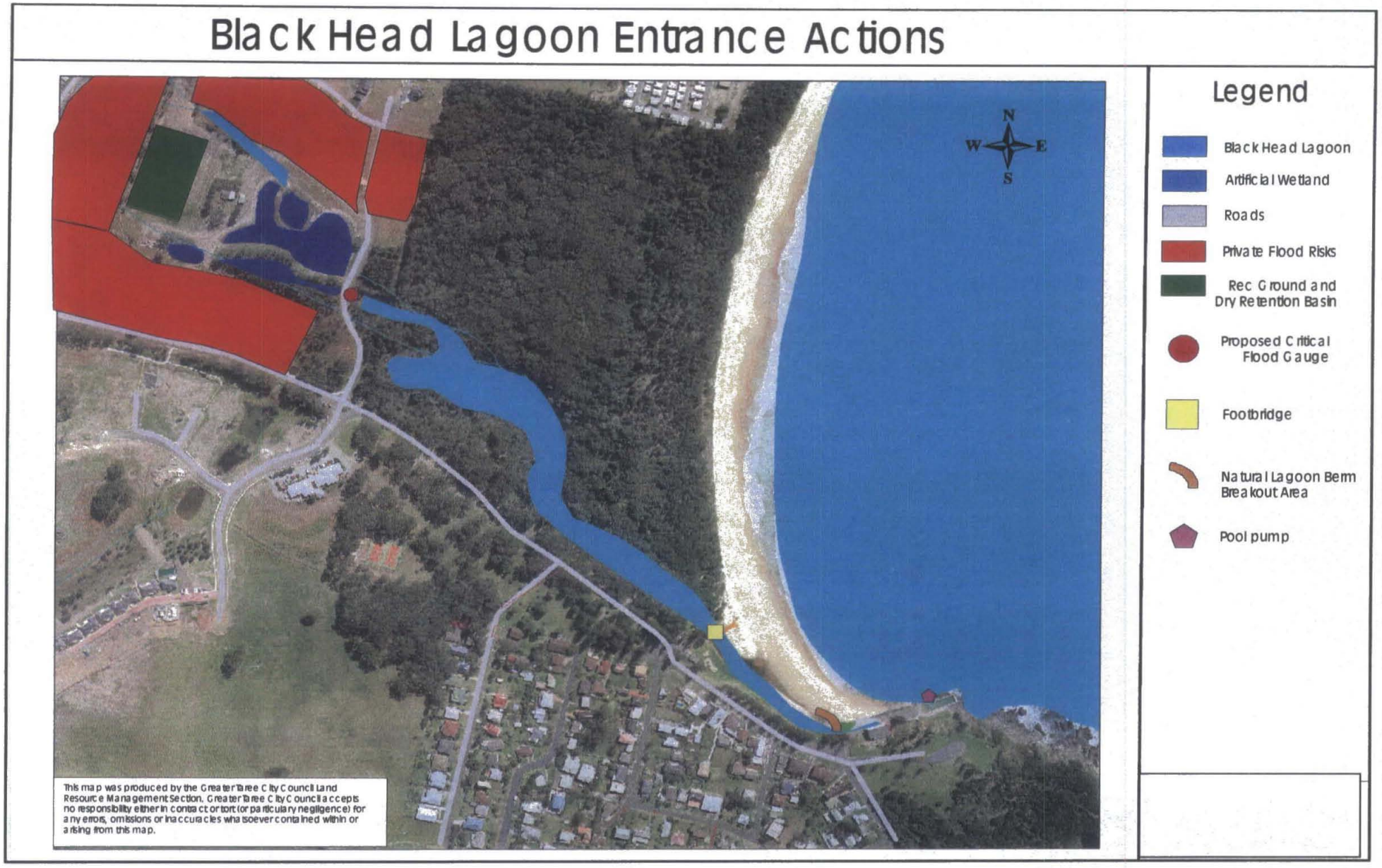


Figure 3.2 Entrance Management Actions, Flood Risk Areas

9. WATER QUALITY

BACKGROUND

The water quality of a lagoon is extremely variable and heavily influenced by the quality and quantity of water, which enters the lagoon from the small, heavily developed catchment These inflows include catchment runoff, tidal exchange and point source discharges into the lagoon Where the quality of inflows to the creek is poor, accumulation of pollutants in the lagoon may occur, resulting in water quality degradation This water quality degradation can in turn affected the lagoons ecology in addition to recreational and aesthetic values

Black Head Lagoon has been influenced from increasing urbanisation of its catchment since the 1960s Increasing the Lagoons catchment population results in

- Greater catchment modification leading to additional stormwater wash off (and associated pollutants) This increase in pollutant loads can result in a greater potential for water quality deterioration Deteriorating water quality can result in degraded conditions for aquatic flora/fauna Sediment carried by stormwater also has the potential to affect aquatic ecosystems (eg by smothering algae, and decreasing water clarity)

- Greater recreational use - increasing the potential for adverse ecological impacts (eg boat mooring damage to seagrass beds, litter inputs, etc) and conflict between users (eg between commercial and recreational fishers)

- Increased nutrient loads which can lead to algal blooms and ecosystem deterioration Black Head Lagoon has highly variable water quality, although signs of water quality improving since the introduction of the wetlands is increasingly apparent Decreases in nutrient and suspended solids concentrations have been observed in the Lagoon since the construction of the wetlands and improved monitoring of developers implementation of Water Sensitive Urban Design as defined in the Black Head Lagoon Estuary Management Plan

- Nutrient levels in Black Head Lagoon are approaching and sometimes exceeding the upper acceptable limits recommended by Australian water quality criteria (ANZECC Guideline criteria), and if exceeded increases in algal and aquatic weed populations in the Lagoon are likely to occur

Whilst water quality conforms to the Australian water quality criteria in most instances, there is an immediate need to implement management strategies to protect (and improve) water quality further A key part of this Plan is to mitigate the potential impacts resulting from future urban developments, so that population growth does not increase pollutant loads to the Lagoon and adversely affects the Lagoons water quality

OVERALL STRATEGY FOR WATER QUALITY

Management Aim: *To improve water quality in Black Head Lagoon to a level with expected waterway uses*

The key focus of management for improving Black Head Lagoon water quality is to manage the potential water quality impacts associated with catchment population growth, and point source discharges entering the Lagoon

The management options which will be most effective in improving water quality, include

- Assessment of known point source discharges such as the stormwater pipe adjacent to the Surf Club
- Treatment of urban stormwater directly entering the lagoon by pollution control devices or other methods as outlined in the GTCC Urban Stormwater Management Plan- improvement of existing Gross Pollutant Traps (GPT's), sedimentation basins and wetlands to remove nutrients and sediment before they enter the Creek
- Catchment management activities - encourage water sensitive urban design in future developments, street sweeping, restoration of creek vegetation etc (see discussion after Table 5)
- Improved control on construction by the installation and maintenance of sediment and erosion control measures
- Implementation of the Integrated Water Cycle Management Strategy (IWCM)
- Education of the catchment's community (rural and urban sectors) on how their activities can affect Lagoon water quality and what are good practices
- Monitoring of the Lagoons water quality - to measure the efficiency of the Management Plan actions

Improving the lagoons water quality will also ensure most of the ecological, fisheries, tourism and recreational values of the Creek are preserved and that, implementation of management actions for these values are not disadvantaged

Table 5: Water Quality Management of the Lagoon							
Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
	1 Pollutants entering the lagoon via overland flow and stormwater outlets	1 Upgrade of stormwater outlet located adjacent to surf club 2 Installation of end pipe gross pollutant trap on stormwater outlet pipe located adjacent to surf club 3 Development of an education program specific to Black Head Lagoon and its catchment	The upgrade and installation of GPT at the Surf Club stormwater pipe will reduce poor water quality entering the lagoon, reduce erosion occurring at the pipe itself, and catch gross pollutants entering the system The development of an educational program specific to Black Head Lagoon will aim to prevent pollutants entering the lagoon at their source It is essential that the public are aware of the unique catchment they live in and their specific impact the individual can have on the lagoon itself	Upgrade of pipe Education program developed GPT installed	Ongoing	GTCC	Med
	2 Eutrophication and deoxygenisation of water due to breakdown of plant material	1 Monitor water quality with the expanded parameters (Table 3) and devise critical environmental parameter levels at which point Council should consider the artificial opening of the lagoon to facilitate flushing and improve water quality	Black Head Lagoon is not suitable for swimming or any form of water based recreation Therefore primary and secondary contact guidelines for water quality are not suitable for the management of water quality in the lagoon Continued monitoring of water quality and health conditions in the lagoon will allow for the division of lagoon specific	Parameters expanded	High	GTCC Mid Coast Water	High

Table 5: Water Quality Management of the Lagoon

Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
		water quality	guidelines for water quality and future management of the lagoon entrance				
	3 Management of urban development	1 Ensure that Water Sensitive Urban Design (WSUD) is being utilised by developers, and educate the community and schools about their catchment 2 Enforce a limit on development in unsewered areas This may be achieved through limitations of lot sizes and/or development densities in areas with unsuitable soil types, inappropriate locations (eg high water table, close to waterways) etc	Water sensitive principles aim to reduce the quantity of stormwater and lower the load of pollutants exported from an urban catchment The principles utilise natural treatment mechanisms (such as filtration by vegetation) to store and treat stormwater close to the source, thus protecting receiving water bodies Construction sites can contribute massive loads of sediment, if unmanaged Sediment and erosion control measures need to be properly installed (before construction/earthworks begin) and maintained to be effective Therefore, rigorous enforcement of the sediment and erosion control measures required by Council should ensure lower	WSUD implemented Improved water quality	Med	GTCC	Low

Table 5: Water Quality Management of the Lagoon

Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
			sediment loads enter the Lagoon Some soils have a limited capacity to absorb and treat sewage wastes Many septic systems are not adequately maintained By imposing limits on unsewered developments, overloading of septic systems, and consequent high pollutant loadings to the Lagoon would be prevented				
	4 Under certain water quality conditions a bad odour occurs over the surrounding developed area	1 Installation of signage informing surrounding residents and tourists that the smell is a natural process that occurs in many small coastal lagoons or lakes 2 Possibility of the treatment of the lagoon on a needs basis with probiotic bacteria to eliminate the smell (Ecogreen Appendix A)	The installation of a sign explaining the cause of the smell would inform tourists and residents that it is a natural process, and does not need treatment for public health or environmental reasons The smell that occurs in the lagoon is not an environmental risk and does not pose any public health issues to the local community If Council were to implement a treatment program for when smells	Signage installed Removal of weed at needs basis	High Med	GTCC GTCC	High Med

Table 5: Water Quality Management of the Lagoon

Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
		3 Removal of seaweed once deposited near or in the lagoon entrance	do occur, a budget needs to be allocated At the present time it is not cost effective for this process to occur Often during rough seas large amounts of seaweed get deposited on Black Head Beach and in the Lagoon To minimise risk of the weed rotting and therefore stinking removal or burying of the weed should occur as soon as possible subject to resources				
 	5 Poor community attitudes and behaviours to lagoon water quality	1 Expand community education programs 2 Erection of tourist information sign	Individuals' actions can contribute excessive pollutants to the Lagoon Therefore, education of the community and community participation in reducing pollutant loads to the Lagoon can be effective in not only adopting modified behaviours but also their ability to educate/regulate other community members Many education programs are in place (eg Fletch the Fish), and these should be continued/expanded	Public perception of creek improved Increased public awareness School education program	Ongoing (High)	GTCC,	Mod

Table 5: Water Quality Management of the Lagoon

Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
			wherever possible				
	6 Sediments releasing nutrients (and/or other pollutants) to the Creeks water column and/or areas where sedimentation reduces flushing of the Lagoon	1 Identify and prioritise areas where sediment pollutant loads to the water column are adversely impacting water quality and/or sedimentation is resulting in decreased flushing Assessment may be able to be made from the nutrient and total organic carbon concentrations of sediment samples 2 Dredge nutrient and/or heavy metal laden sediments, which are contributing pollutants to the water column, where this has been identified as the appropriate management strategy for that particular area	Many points need to be considered before a dredging strategy can be developed Assessing each of the criteria outlined in Table 3 will allow an assessment of dredging impacts to water quality, ecology, and tidal hydraulics of the Lagoon to be made Appropriately managed dredging of nutrient laden sediments will have some localised water quality benefits	Dredging carried out Improved flushing of Lagoon when open Water Quality Improved	Low	GTCC,	Mod

Table 5: Water Quality Management of the Lagoon							
Value	Issue	Management Actions/Options	Reason for Selection/Comments	Performance Measures	Priority	Responsibility	Cost
	7 Water quality monitoring	1 See management action for water quality in Table 4	See Table 4	Table 4	High	GTCC,	Mod

Figure 4.0 Water Quality Management Actions, Flood Risk Areas

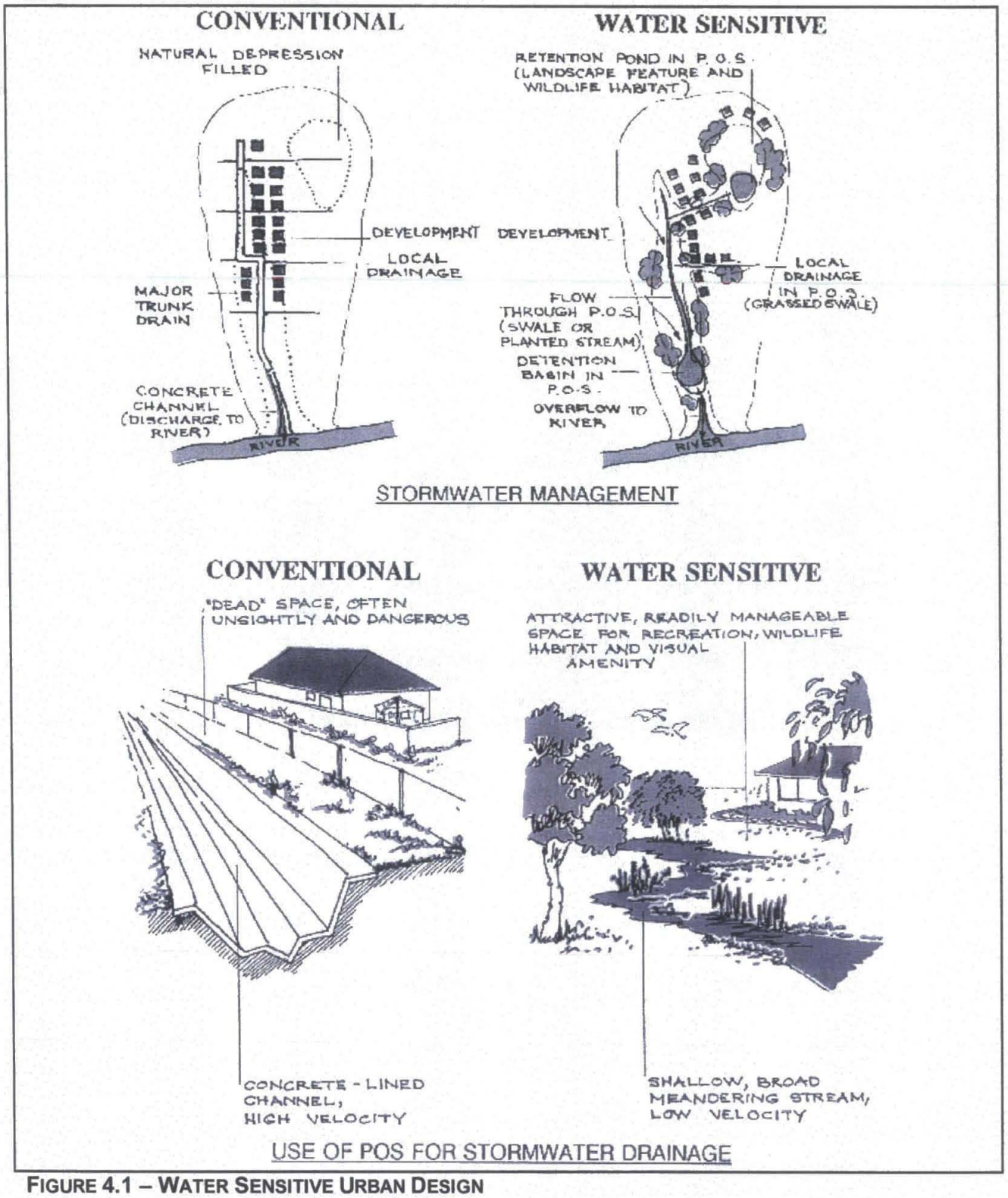


FIGURE 4.1 – WATER SENSITIVE URBAN DESIGN
Source: Whelans *et al*, 1994
Note: POS = Public Open Space

Urban development has many environmental consequences, including increased pollutant loads, loss of vegetation, modification of the catchment's hydrology, increases in runoff volumes and velocities, and adverse air quality impacts. Conventional urban design practices have been recognised for many years as causing significant environmental degradation, particularly to water quality and hydrology. An alternative, more sustainable approach to urban design has been recently emerging, known as Water Sensitive Urban Design (WSUD). The principles of WSUD attempt to mitigate the environmental degradation caused by urban development (both infill and new developments).

Water Sensitive Urban Design aims to retain stormwater, look for opportunities to utilise stormwater within the catchment, maximise infiltration in the catchment and use a sequence of smaller treatment devices throughout the catchment to improve stormwater quality and reduce the hydrological implications of catchment development The key objectives of Water Sensitive Urban Design include

- to manage the water balance of a catchment,
- to maintain and where possible enhance water quality,
- to encourage water conservation, and
- to maintain water related environmental and recreational values

Some of the management practices which are included in WSUD include

- preservation of vegetation,
- grassy swales, as opposed to kerb gutters,
- infiltration trenches,
- sequenced detention and retention basins,
- gross pollutant traps,
- artificial wetlands,
- non-potable re-use of stormwater,
- rainwater tanks, and
- reuse grey water

GTCC needs to embrace the principles of WSUD, in order to lessen the environmental degradation caused by urban growth (infill and new development areas) As the water quality on the lagoon is highly influenced by catchment runoff WSUD should be a high priority for Council GTCC have modified their visionary and planning strategies and plans (ie DCP's and LEP's) to incorporate WSUD principles, such as buffer zones along waterways (and the periphery of the Creek, where possible) to protect riparian/foreshore vegetation Council require all new developments to demonstrate "no net increase in pollutant loads" is caused by the proposed development, through the incorporation of WSUD principles and water quality treatment devices such as GPT's, wetlands and sedimentation basins However, even if the impact of all new urban growth areas are mitigated by adopting WSUD principles, the water quality of the lagoon will only be maintained at present levels Treatment of stormwater from existing urban areas is needed to lower pollutant loads and should result in water quality improvements, particularly in some localised areas

10. EROSION AND SEDIMENTATION

BACKGROUND

Black Head Lagoon is subject to various erosion and sedimentation issues In 2003 the Black Head constructed wetlands, a retention basin and a recreational area was established The project was designed to catch the majority of the catchment runoff prior to entering Black Head Lagoon Anecdotal evidence suggests that since the construction of the wetlands, sediment loads entering the lagoon have significantly decreased However during the biological survey conducted in December 2004 consultants noted the amount of loose sediment present in the upper reaches of the lagoon, were contributing to poor water quality

Sediment loads entering the wetlands system and the lagoon are derived from such sources as improperly managed construction sites, unsealed roads and road shoulders, vehicles, stream bank erosion, sheet/gully erosion, and particularly through stormwater outlets Existing urban areas in the catchment also contribute to the problem, as urban areas contain larger impervious areas This results in greater runoff volumes and faster velocities, which in turn causes greater scouring and erosion of waterways Sediment accumulated on roadways can contain high levels of toxicants, such as heavy metals and oil residues and these pollutants can also have adverse impacts on the lagoons water quality and ecology

Excessive sedimentation is not only a water quality issue, but also an issue for visual amenity, flood control and other public amenity concerns These issues are closely related as, excessive siltation is typically caused by high sediment loads in urban runoff

Overall Strategy

Management Aim: *To prevent excessive sedimentation and erosion Identify / remediate areas that currently or has previously experienced excessive sedimentation in Black Head Lagoon which may adversely impact on water quality, recreational and visual amenity*

Erosion and sedimentation in the Lagoon (including the wetlands system) can be minimised by

- Rigorous enforcement of sediment and erosion control requirements for construction sites
- Improvement of existing stormwater treatment devices, such as GPT's, sedimentation and wetland basins in key locations around the catchment
- Further implementation of catchment management strategies such as street sweeping, restoration of lagoon vegetation and other pollutant source reduction programs
- Education of the community (rural and urban sectors) on how their activities can result in high sediment export from the lagoons catchment (eg Dog faeces)
- Enforcement of water sensitive urban design principles for new developments
- Adoption of an Integrated Water Cycle Management Strategy

The upper reaches of Black Head Lagoon is severely shoaled, this area has potential for remedial actions, such as dredging The table of management actions outlines the criteria to be assessed before remedial works, such as dredging, can be undertaken

It should be noted that dredging is required in conjunction with sediment reduction strategies As sediment reduction strategies are implemented and take effect, the need for dredging will decrease

Table 6: Lagoon Sedimentation Management Actions

Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	1 High sediment loads entering the lagoon system (including the wetlands system)	1 Refer previous table on water quality management for appropriate management actions (Table 5)	Stormwater treatment/prevention actions will reduce both sediment and nutrient loads entering the system, thus preventing excessive sedimentation in the wetlands and the lagoon	Reduction of sediment loads entering the lagoon Improved water quality	High	GTCC	High
	2 Upgrading of stormwater pipe adjacent to Surf Club	1 See water quality Table 5	See Table 5	Table 5	High	GTCC	High
	3 Remediation of severely shoaled areas	1 Develop dredging strategy The strategy should address whether dredging to remove accumulated sediment is appropriate Each of the following points should be considered in selecting an appropriate dredging strategy and a suitable placement area for dredged material • consider alternative management options, • assess the potential for turbidity plumes to be generated during dredging and subsequent placement of dredged material (sampling and analysis of surface and subsurface material), • sample and analyse to establish contamination status and biological availability/toxicity of contaminants in sediments, where contamination status is	A dredging strategy should detail and prioritise dredging activities required in the lagoon Each of the points outlined need to be assessed before dredging can be performed Assessing each of these criteria will allow an assessment of dredging impacts to water quality, ecology, fisheries and tidal hydraulics of the lagoon Costs of implementing the dredging strategy have not been included in this management action, as the scope of recommended dredging is not known However, it would be likely that dredging costs would be moderate to high	Improved flushing Improved water quality	High	GTCC	High

Table 6: Lagoon Sedimentation Management Actions

Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
		not known, • evaluate acid generation potential of the sediments, if placement is to occur above tidal levels, • assess benthic invertebrate communities in the area to be dredged and their significance to the Lagoons ecology, • if seagrass is present on or near areas to be dredged, evaluate seagrass significance to the local and whole aquatic ecosystem, • assess impact of dredging to avifauna (particularly waders), • analyse implications of dredging to the Creek's hydrodynamic regime (tidal propagation, tidal range and areas of intertidal habitat not significantly changed), • will the dredging cause bank stability problems through increased wave attack and boat wash?, • are the profiles or velocities of any banks altered? (potential for scour and erosion if altered), • will the altered bathymetry (due to dredging activities) alter wave propagation characteristics? (potential for shore erosion from longshore currents or increased wave action), • what maintenance dredging will be required? (consider				

Table 6: Lagoon Sedimentation Management Actions							
Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
		costs, frequency, over dredging requirements and long term placement options), • assess the relative advantages and disadvantages (recreational, ecological, water quality, hydrodynamic etc) of proposed dredging works					

Figure 5.0 Erosion and Sedimentation Management Actions

11. ECOLOGY

BACKGROUND

Black Head Lagoon supports an extremely variable habitat system, ranging from saline to freshwater conditions over very small spaces of time

The dominant vegetation types surrounding the waterbody are the She Oak, Paperbark and the Grey Mangrove These species provide vital habitat for avifauna, crustaceans, macrofauna, and meiobenthos Meiobenthos are of particular importance as they are a major food-source for many fish species, and are therefore critical for the recovery of the Lagoons biological diversity if re-established Mangroves, Paperbark and She Oaks also proved a link for avifauna, including sea birds

A search of the NPWS Atlas of NSW wildlife was conducted over a 10 km x 10 km square, with the project site in the middle of the search area The following threatened species were identified as being recorded within that area A site inspection was conducted to address the suitability of the site to fulfil the habitat requirements of the species

- Square Tailed Kite *(Lophoictinia isura)*
- Glossy Black Cockatoo *(Calyptorhynchus lathami)*
- Sooty Oystercatcher *(Haematopus fuliginosus)*
- Little Tern *(Strena albifrons)*
- Grass Owl *(Tyto capensis)*
- Masked Owl *(Tyto novaehollandiae)*
- Pied Oystercatcher *(Haematopus longirostris)*
- Black Necked Stork (*Ephippiorhynchus asiaticus)*
- Osprey (*Pandion haliaetus)*
- White Tern (*Gygis alba)*
- Powerful Owl (*Ninox strenua)*
- Masked Owl (*Tyto novaehollandiae)*
- Koala (*Phascolarctos cinerus)*
- Brush-tailed Phascogale *(Phascogale tapoatafa)*
- Eastern Freetail – Bat *(Eastern Freetail – bat)*
- Squirrel Glider *(Petaurus norfolcensis)*
- Grey Headed Flying Fox *(Pteropus poliocephalus)*
- Common Blossom Bat *(Syconcyteris australis)*
- Little Bentwing – Bat *(Miniopeterus australis)*
- Eastern Bentwing – Bat *(Schreibersii oceanensis)*

Flora

- White Flowered Wax Plant *(Cynanchum elegans)*
- Rainforest Cassia *(Senna acclinis)*

As a part of this plan Curlew Biological Services carried out a Marine Biological Survey on 30th December 2004 Previously Curlew had carried out a similar study for the 1998 plan, which identified an expected variety of species indicating that the system was relatively healthy at that point in time The recent study used the same methods and techniques to compare diversity with that indicated in 1998 The results show that there has been a significant reduction in species diversity with the introduction of an exotic fish species *Gambusia holibrook*

Summary of Marine Survey

1. The introduced *G holbrooki* have become established as the dominant small species of fish in the lagoon, and are breeding prolifically
2. The diversity of fish and invertebrate species has declined markedly compared with the 1998 plan
3. Very high densities of zooplankton were measured in the lagoon The bloom provided an abundance of food for the large number of small *Gambusia Holbrooki* present, and continued to enable this species to multiply over a number of months

A large quantity of marine seaweed had entered the lower reach of the lagoon and had rotted to a deep sludge It is very likely that the breakdown of this weed caused eutrophication and oxygen depletion in the water causing a small fish kill in November 2004

Overall Strategy

Management Aim: *To maintain and improve the ecological status of Black Head Lagoon.*

The vegetation type immediately at Black Head Lagoon is not endangered and consists of species widespread throughout the region. A search of the NPWS Atlas of NSW wildlife has identified 22 threatened species as occurring within a 5km radius of the lagoon, none of which were aquatic. The 20 fauna species potentially utilising the site have been considered with regard to the entrance of the lagoon and would most likely benefit from the management actions suggested in the plan, particularly with regard to water quality.

The entrance itself does not provide sufficient habitat to suit the requirements of the threatened species recorded by the Atlas, however the surrounding environment described above does. It is likely that the species will benefit over the area if water quality in the lagoon was to increase, providing a food source for some fauna. Currently the marine species in the lagoon is severely limited, if biodiversity was to increase through management recommendations carried out in this plan, marine food sources will increase. The surrounding area also provides roosting sites and some suitable nesting sites. However no threatened species are solely dependent upon the Lagoon itself (and its environments).

MARINE SURVEY / BIODIVERSITY ASSESSMENT

The Curlew Biological Services consultants report, advised that the opening of Black Head Lagoon Entrance may have the potential to manage the population of *Gambusia holbrooki*, however further investigation by council and according to various scientific research and the National Parks and Wildlife Service indicates, "There are no effective specific methods to control *Gambusia holbrooki*. Once introduced it is almost impossible to eradicate from the environment" (NPWS 2003).

National Parks and Wildlife Service have completed a NSW Threat Abatement Plan for *G. holbrooki* which aims to research actions for the control of *G. holbrooki* in order to clarify aspects of the ecology of *G. holbrooki*, especially its impacts on frog species. It is hoped that outcomes from this research will assist in the future management of *G. holbrooki*.

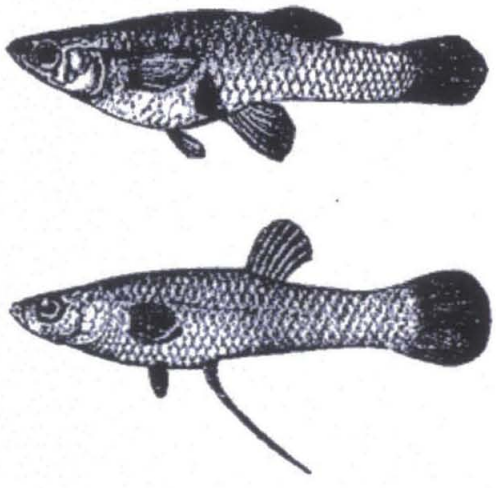


Figure 6.0: Gambusia holbrooki

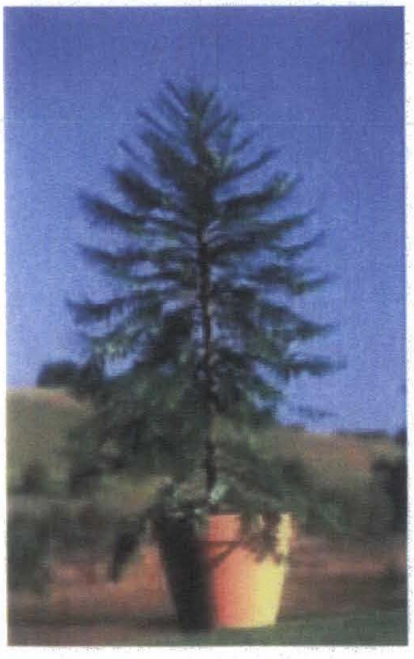
NORFOLK ISLAND PINES

The foreshore of Black Head Lagoon is a high profile area for the village. Norfolk Island Pines were introduced to the area and are approximately 100 years old, nearing the end of their life cycle.
The Norfolk Island Pine is not endemic to the Black Head Lagoon area. Consideration should be given to the replacement of the pines once they begin to die out in the near future. The Black Head community should be consulted regarding the type of species selected to replace the existing pines. The following options may be considered.

Option 1: Plantings of Norfolk Island Pine Seedlings.

Option 2: Plantings of the newly discovered Wollomi Pine.

Option 3: Plantings of known endemic species.



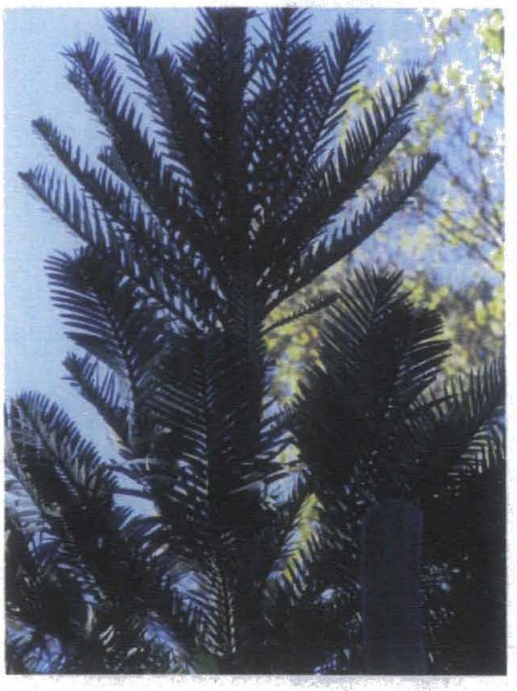


Figure 6.1: The newly discovered Wollomi Pine

Table 7: Lagoon Ecology Management Actions

Value	Issue	Management Actions	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	1 Monoculture of *Gambusia holbrook* in Black Head Lagoon	1 Encouragement of universities and research bodies to use Black Head Lagoon as a research project for students 2 Once a management technique has been identified it should be used to control the *Gambusia holbrooki* population in Black Head Lagoon	Currently there are no known management techniques for the control of *Gambusia holbrooki*	Research carried out on Black Head Lagoon New Management techniques used to control the population Reduction of *Gambusia holbrooki* numbers	High	GTCC	Med
	2 Norfolk Island Pines	1 Replacement of pines with one of three options identified above	The existing Norfolk Island Pines are maturing, nearing the end of their lifecycle and therefore will need replacement in the near future	Replacement of Norfolk Island Pines	Med	GTCC	Med
	3 Impact on threatened species in the Black Head Lagoon locality	1 The management options in this management plan will have a positive impact on the Threatened Species in the locality	N/A	No impact on threatened species	N/A	N/A	N/A

Figure 6.2: Ecological Management Action

12. RECREATION

BACKGROUND

Approximately 85% of Australia's population lives on the coast The pressures of extensive urbanization in coastal areas, and resulting increased recreational use of this extremely dynamic environment consequently has impacted on the coastal environment in a cumulative manner

The Black Head Lagoon Entrance management plan acknowledges the importance of balancing recreational/tourism use of the lagoon with the desire to sustain the natural environment

Currently Black Head Lagoon Entrance itself is not used extensively for recreation activities However the lagoon and adjacent reserve does provide a wide range of casual recreational opportunities, all of which have potential to be influenced by the management or behavior of the entrance Recreational activities range from picnicking, walking and jogging, to bird watching and nature observation in the area

It is important to encourage a better understanding of the dynamics and health of the lagoon, and to develop a better relationship between the community and the lagoon This can be achieved through encouragement of recreation and also activities within the area including bush regeneration activities, and educational opportunities

Water quality is critical to the water based recreational value of the Black Head Lagoon waterway Water quality management actions are defined in section 5 of this management plan The community has recommended that if lagoon water quality was improved sufficiently, an opportunity may exist in the future for water based recreational activities to become more prevalent in the waterway, such as swimming, kayaking etc

OVERALL STRATEGY

Management Aim: *To maintain and enhance the recreational and aesthetic value of Black Head Lagoon, with consideration to the wider community, tourism and the environment*

Currently recreation in the Black Head Lagoon area is limited to terrestrial activities Water based activities are not recommended by Council due to highly variable water quality conditions Water quality management actions recommended in section 5 of this management plan will facilitate in the improvement of water quality and therefore result in the increased recreational potential of Black Head Lagoon

The Black Head Lagoon Estuary Management Plan 1998 identified the potential community use of the lagoon for educational purposes This may be in the form of signage, educational activity days carried out by authorities such as Council and Mid Coast Water, or the provision of an educational facility to be utilized by district schools, and universities in teaching and research of the unique Black Head Lagoon system

Research activities should be encouraged at the lagoon to help facilitate better management practices directly related to the specifics of the Black Head Lagoon system Research opportunities can be encouraged via contacting potential universities and posting possible research projects on the Council website

Erection of educational signage will increase public awareness of total catchment and ICOLL processes Particular information desired by the public are those of the naturally occurring smell of the lagoon at certain times of year (Tourism), as well as the extremely dynamic behavior of the water body

Unauthorized structures have previously been installed above the pedestrian footbridge Council has not endorsed the installation of such structures and prohibits any such structures to be installed without Councils consent The structures have recently washed out to the beach during the latest natural breakout of the lagoon This poses a public health risk to beach goers and boaters, as well as an ecological threat to local marine species

The footbridge located near the entrance of the lagoon currently allows for pedestrian access to the beach As previously discussed in section 4 of this plan a possible management action providing year round access to the beach for life rescue would be the widening of the bridge and access path to allow vehicular access when the lagoon water level is too high for access near the surf club

A damaged footbridge exists near the entrance of the lagoon (Figure 7 0) The bridge is influencing the shape of the entrance of the lagoon, and also poses a safety risk to the general community and

tourists It is recommended that the broken footbridge be removed, as there is an adequate footbridge located near by

Table 8: Recreation and Aesthetic Management Actions							
Value	Issue	Management Action	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	1 Limited opportunity for water based recreational activities due to poor water quality	1 See water quality management actions outlined in Table 5	See water quality management actions outlined in Table 5	Improved water quality Increased water based recreational activities	High	GTCC	High
	2 Poor community and tourist awareness of catchment and ICOLL processes	1 Installation of signage 2 Encouragement of research by universities via websites and direct contact 3 Encouragement of school based learning of catchment and ICOLL processes through providing educational facilities and opportunities	Educational signage will increase public awareness of total catchment and ICOLL processes Particular information desired by the public are those of the naturally occurring smell of the lagoon at certain times of the year (Tourism), as well as the extremely dynamic behavior of the water body Research will facilitate better management practices directly related to the specifics of the Black Head Lagoon system Research opportunities can be encouraged via contacting potential universities and posting possible research projects on the council website	Signage installed Better community perception Research activities carried out by universities	Med	GTCC	Low

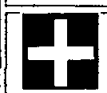
Table 8: Recreation and Aesthetic Management Actions							
Value	Issue	Management Action	Reason for Selection / Comment	Performance Measure	Priority	Responsibility	Cost
	3 Modification of beach access for emergency vehicles	1 Widening of pedestrian footbridge and path located near the entrance of the lagoon for vehicular access	Widening the footbridge and path will allow emergency vehicular access during certain times of the year when the lagoon water levels are too high for use of the regular access to the beach for emergency vehicles	Access to the beach for emergency vehicles	Low	GTCC	N/A
	4 Old derelict footbridge located at entrance of lagoon	1 Removal of old footbridge	The old footbridge poses a safety risk to the general public, and appropriate pedestrian access is available nearby	Removal of old bridge	High	GTCC	Med

Figure 7.0: Recreational Management Activities

13. MONITORING

Monitoring forms an integral part of the Management Plan to ensure that management actions and controls have the desired effects and to provide ongoing information to review and update the strategies as required

Numerous monitoring programs have been recommended in the Plan to monitor management actions Many of these monitoring programs will need to be designed and implemented by one or several regulatory authorities and/or GTCC Details of these programs can therefore not be given in this Plan and will need to be developed and implemented by the appropriate authority(s) However, a brief discussion of the requirements and components is presented below

BLACK HEAD LAGOON ENTRANCE MANAGEMENT PLAN

The Black Head Lagoon Entrance Management Plan itself must be regularly reviewed and adapted It should be treated as a living document, subject to fine-tuning and adjustment as needed

THE ENTRANCE

Management actions identified with particular regard to the entrance are to be further developed through monitoring of the lagoon with regard to flood and water quality as recommended in this plan

In order to identify and set critical flood levels a preliminary critical level of 2 4m has been set and is subject to change Monitoring of future flood events will allow for the refinement of the flood level

Critical water quality guidelines were not able to be set in this management plan Primary or secondary contact guidelines were deemed inappropriate for the lagoon due to its extremely dynamic nature Therefore an expansion of the monthly water quality sampling currently being carried out, and the correlation with visual effects and biological status of the lagoon will allow for a lagoon specific critical water quality level to be set

WATER QUALITY MONITORING

Council is currently monitoring Browns Creek This plan recommends expanding the program with the involvement of other local programs Automated water samplers would provide an accurate and time effective method See figure 4 3 for proposed monitoring sites (particularly upstream) and automated water sampler sites

This report and GTCC, environmental reports prepared for this region and other interested parties have all indicated that water quality and the ecological "health" are key issues for Black Head

lagoon Many other issues relate either directly or indirectly to the water quality and ecological health of the lagoon Therefore, monitoring of water quality and ecology in the lagoon is recognised to be an important component of lagoon management Monitoring of the lagoon will allow the status of the lagoon to be examined and the success of management strategies to be assessed

Overall health of the lagoon and catchment - routine and event monitoring throughout the lagoon and in the lagoons catchment for a range of standard parameters This data will provide baseline monitoring data,

Evaluation of Impacts/Management Options - locations, sampling frequency and parameters to be tested will depend on specific impacts/options being assessed,

Design monitoring - to determine if design techniques/methods are appropriate,

Incident Investigation - procedures need to be in place such that events/incidents can be monitored without delay, and

Environmental Promotion and Community Awareness - monitoring to address community concerns, may be performed by community groups or other organisations with the intention of publishing the data to the community regularly

Vertical profiling of some parameters would also be appropriate (eg dissolved oxygen) This monitoring will provide general condition data on the "health" of the lagoon, and information on any obvious long term trends in water quality with time

Additional biological sampling may also be undertaken in conjunction with the above water quality monitoring program

Automated sampling systems are an effective alternative that would provide daily water sampling results However this system requires a significant investment of funds for installation of the samplers

DESIGN MONITORING

This Plan strongly recommends that various management measures be instituted to protect the lagoon from the effects of urban development Management measures recommended include the extensive improvement and use of pollution control devices (GPT's, sedimentation basins etc) to treat urban stormwater runoff In many cases, the efficacy of the management measures that will be used to achieve the desired pollutant export/hydraulic outcomes is either poorly understood, or the management measures themselves have uncertain design characteristics In this regard, it would be advantageous to undertake specific performance monitoring at several locations in the catchment to gauge the effectiveness of the various proposed management measures

Monitoring may include (as a minimum) measuring changes in water quality upstream and downstream of a device or measuring amounts of debris/sediment removed by a device Should this effectiveness be less than, or greater than, the desired value, appropriate modifications could be made to future design techniques

PROMOTION OF PLAN IMPLEMENTATION / COMMUNITY INVOLVEMENT MONITORING

Existing programs are in place in the Black Head Lagoon Catchment to assist in regard to this exercise, eg Streamwatch programs throughout local schools Councils and relevant authorities (CMA, EPA, Mid Coast Water etc) should further encourage/expand such groups to implement monitoring activities to both provide continuing, albeit of limited scope, monitoring information and to facilitate community involvement and education

The works being undertaken as recommended by the Management Plan need to be carefully recorded, so that activities can be publicised to increase community awareness Activities which may be publicised include the following

- Setting of critical flood levels
- Setting of critical water quality level
- results of water quality testing,

This activity recording will enable the ready reporting of management actions, such as "*this month we have recorded x water quality and had a flood event that reached an x level and had no impact on private property* " This information will then facilitate publicity of the Estuary Management Plan implementation

FURTHER RESEARCH

This Plan recommends several areas for future research/study before appropriate management actions can be determined Some of these areas of research be able to be supported through various sources of funding

- Removal of past sediments that entered the lagoon prior to installation of the artificial wetlands
- Further ecological health study – aquatic flora and fauna
- Eradication of *Gambusia holibrook*
- Further water quality testing
- Individual Black Head lagoon processes

14. REFERENCE LIST

- GTCC 1998 Black Head Lagoon Estuary Management Plan, GTCC
- M V Jones & R J West, 2005, Spatial and temporal variability of seagrass fishes in intermittently closed and open coastal lakes in south eastern Australia Estuarine Coastal and Shelf Science, University of Woolongong, NSW, Australia
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- Paul D Vorwerk, Alan K Whitfield, Paul D Cowley & Angus W Paterson, 2002, The influence of selected variables on fish assemblage structure in a range of southeast African estuaries, Environmental Biology of Fishes, Kluwer Academic Publishes, Netherlands
- S P Griffiths, 2000, Recruitment and growth of juvenile yellowfin bream, Acanthopagrus australis Gunther (Sparidae), in an Australian intermittently open estuary, University of Woolongong, Blackwell Wissenchafts – Verlag, Berlin

APPENDIX A – WORKSHOP SUMMARY

Black Head Lagoon Entrance Management Plan

Community Workshop

Workshop Record
25th September 2005

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1. Particulars of Workshop

Held

6 00 pm to 8 30pm
25th September 2005
Black Head Surf Club

Attendees

NAME	ADDRESS
Les Beveridge	88 Vincent Street Cessnock
J Ritchie	35 Main Street, Blackhead
I Yaeger	1138 High Street, Blackhead
Ian Strathdee	43 High Street, Blackhead
Ann Bobin	43 High Street, Blackhead
Carol Cooney	35 High Street, Blackhead
Robert & Carol Baxter	13 James Forster Drive, Hallidays Point
Denise & Bony Greenaway	7 Lucas Court, Hallidays Point
Roy Single	21 William Street, Blackhead
J D Gregg	1 The Ridge, Hallidays Point
J Gils	9 James Foster Drive, Hallidays Point
Robyn & John Faint	6 Callemondah Lane, Hallidays Point
Keith Doyle	29 High Street, Hallidays Point
W McConnell	PO Box 54, Hallidays Point
J Edstein	10 Ocean Street, Hallidays Point
Alan Tickle	Greater Taree City Council
Dennis Jeffers	PO Box 60, Hallidays Point
David O'Hara	11 Coromont Drive, Hallidays Point
Tonia O'Hara	11 Coromont Drive, Hallidays Point
Kevin Stewart	17 High Street, Hallidays Point
Sandra Mansfield	5 Headland Drive, Hallidays Point
Michael Abight	44 High Street, Hallidays Point
Brian Lynch	10 William Street, Blackhead
Denise Elder	87A Peacock Avenue, Seaforth
Scott Crawford	6 Surfview Avenue, Blackhead
Alana Parkins	1 Coolna Street, Blackhead
Norman Shapro	1 Coolna Street, Blackhead

Peter Gollan	2 Callemondah Lane, Blackhead
Julie Coster	6 Headland Drive, Hallidays Point
Pat Roverts	25 High Street, Hallidays Point
B Allerton	"Bungay" Bungay Road, Wingham
S Bell	14 Gary Road, Diamond Beach

Attachments

1) Workshop Agenda
2) Slide Presentation

2. Opening

The Chairperson thanked participants for attending the workshop, which is intended to identify community values and issues of the Black Head Lagoon Entrance

3. Introduction/Background

The purpose of the meeting is to consult with the community before the development of the entrance management plan The entrance management plan is a document that will facilitate the on-going management of the Black Head Lagoon entrance, after identifying the values and issues associated with the area and consulting with the relevant stakeholders – neighbours, industry, community groups and government agencies

The Blackhead lagoon management process began in the 1990's with concern about water quality in the lagoon Studies were undertaken which lead to the development of the Blackhead Lagoon Estuary Management Plan (EMP) in 1998 Many of the actions identified in the EMP have been completed by Council and the Hallidays Point community However, one of the major issues remaining is the lagoon entrance The EMP identified that further investigations and consultation into the opening needed to be undertaken before any action is to be undertaken This has lead to the development of the Blackhead Lagoon Entrance Draft Management Plan and the subsequent community workshop held on the 25th October 2005

Blackhead Lagoon in classified as an ICOLL – Intermittently Closed and Open Lagoon or Lake
The lagoon has a natural intermittent entrance that is closed to the ocean for most of the time Under natural conditions, the entrance opens only when a large build up of catchment runoff breaches the beach berm
Lagoon characteristics

- Lagoon has an area of 1 ha
- 850m long and width between 6 – 27m
- Water depth is typically less than 1m
- Catchment area is 250ha
- Highly dynamic system – influenced by rainfall, tides, winds
- Highly variable water parameters – pH, temperature, dissolved oxygen & nutrients
- Natural entrance is at the southern end of the beach

The objectives of this plan are to

- Define management strategies and select actions which will help with the management of Black Head Lagoon entrance
- Describe and justify selected actions
- Prioritise selected actions in terms of their need and the practical limitations of their implementation

The plan will be developed using the guidelines of the NSW Estuary Management Framework
Many of the management actions identified in the Estuary Management Plan (1998) have been completed They include

- Installation of gross pollutant trap (GPT)
- Development of the constructed wetlands
- Bush regeneration / landcare activities targeting weed control & revegetation
- Introduction of water sensitive urban design principles into new developments
- Upgrade of sewage infrastructure near the lagoon (Mid Coast Water)
- Development of Blackhead Lagoon catchment urban stormwater management plan

The Draft Blackhead Lagoon Entrance Management Plan is focussing on five broad areas that have been identified in previous studies, as being influenced by the entrance They are

- Water quality
- Entrance Management and Flood Protection
- Recreation and Aesthetics
- Erosion and sedimentation

- Ecology

An ecological survey was conducted by Curlew Biological Services in 1995/96 to provide information for a report to Council on the status of the lagoon
In December 2004, Curlew were engaged by Council again to repeat the study to provide information for the draft management plan, and to determine the success of the management options implemented through the Blackhead lagoon estuary management plan
The key observations from the aquatic survey

- Mosquito Fish *(Gambusia holbrooki)* is an introduced fish that has entered the lagoon since the initial survey, and now dominates the fish fauna in the lagoon
- The diversity of the fish and invertebrate species has declined significantly since 1995 / 1996
- Very high densities of zooplankton were recorded in 2004 – providing food source for Mosquito fish
- A large quantity of marine seaweed entered the lagoon and rotted down into a deep sludge The breakdown of the seaweed caused eutrophication and oxygen depletion in the lagoon causing a bad smell and small fish kill in November 2004

The consultants recommended that future management strategies could include opening the lagoon at times to flush out large deposits of marine algae that can cause anoxic (low oxygen) conditions and fish kills However, care should be taken to not to drain the lagoon, which will exacerbate the situation

The community values of the lagoon as identified in the EMP (1998) were

- Ecological
- Recreational opportunity
- Scientific / education
- Visual / aesthetic
- Linkage
- Aboriginal heritage
- Social opportunities

The workshop broke into groups to determine values and issues of the entrance

4. Groups

The attendees were divided into smaller groups to address other issues of the entrance, to identify the values that the entrance has to the community, and the management options preferred by the majority of the community These have been recorded separately, and are attached to these minutes

Values Identified

- Water Quality
- Entrance dynamics
- Recreation
- Flooding
- Ecology
- Aesthetics
- Education
- Culture
- Future Development of the Catchment
- Access

WATERWAY VALUE	Issues	
	Current	**Future**
Water Quality	➢ Water unsuitable for swimming ➢ Safety / Health ➢ Signage ➢ Lack of frequent water testing ➢ Smell ➢ Planning ➢ Filtration ➢ Sea weed build up in Lagoon ➢ Impact on tourism ➢ Natural processes ➢ Runoff from roads	➢ Further degradation ➢ If opened due to poor water quality, warning should be given to beach goers ➢ Tourism ➢ Planning
Entrance dynamics	➢ Importance for existence of natural processes ➢ Balance between natural and artificial management ➢ Maintain high water levels ➢ Monitoring of sand levels ➢ Retain natural flow ➢ Openings on a needs basis ➢ Open only due to safety ➢ Installation of a weir ➢ Long term opening strategy ➢ Controlled opening	➢ Monitoring of water levels ➢ Monitoring of sand levels ➢ Monitoring of flood levels ➢ Long term opening strategy
Recreation	➢ Fishing ➢ Kids play area in water ➢ Boat launching ➢ Un-motorised water craft ➢ Swimming at entrance ➢	➢ Fishing
Flooding	➢ Functional flood control ➢ Flood levels monitored ➢ Establishment of critical flood level for opening lagoon ➢ Weir ➢ Flood markers	➢

WATERWAY VALUE	Issues	
	Current	Future
	➢ Flood gates	
Ecology	➢ Runoff from roads / acid sulfate areas ➢ Restore native fish populations ➢ Eliminate Gambusia holbrooki ➢ Restoration of flora and fauna ➢ Birds ➢ Support natural processes of the lagoon ➢ Support Landcare groups ➢ Revegetate surrounding dunes and lagoon edges	➢
Aesthetics	➢ Current toilet block ugly ➢ Preserve scenic area ➢ Fix gabion wall at Surf Club ➢ Removal of old derelict bridge ➢ Views of neighbouring property and from reserve ➢ Cleaning of beach (seaweed) ➢ Restore old bridge ➢ Colour of water	➢
Education	➢ Ecological education ➢ Water quality education ➢ Lagoon / ICOLL education ➢ Community catchment education	
Cultural	➢ Aboriginal community views on entrance strategy ➢ Aboriginal significant areas	
Future development management	➢ Service station location too close to lagoon ➢ Engage a coastal engineer ➢ Revise LEP to ensure new development adhere to 'footprint' requirements	➢
Access	➢ Beach access should be maintained or improved	

WATERWAY VALUE	Issues	
	Current	Future
	➢ More bridges ➢ Fix gabion wall at Surf Club ➢ Bridge for surf rescue ➢ Designated sight for horse access ➢ Widen bridge for vehicle access in emergencies ➢ Install retaining wall around lagoon ➢ Improve surf club access to the bridge ➢ Access needed to beach when lagoon is fully opened ➢ Repair old footbridge	

5. Conclusion of Workshop

The workshop session concluded, the smaller groups returned to the direction of Robert Baker, who briefly identified the next steps

- Values & issues identified would be directly used in the development of the management plan
- Draft management plan released for public comment & submissions received
- Submissions modify (if necessary) draft plan
- Draft plan adopted by Council
- Implementation of plan
- On-going review and evaluation of plan

A show of hands indicated that the majority of those present were in favour of the entrance to be left largely natural, but with the provision to open the lagoon when certain conditions warranted it

Natural system (no artificial opening) – 6 votes
Natural system with provisions for opening (eg smell, surf club access) – 20 votes
Artificial system (engineered opening / maintained water levels) – 2 votes

Note some attendees had left prior to the vote

Councillor Tickle suggested that a sign should be installed to advise visitors about the lagoon Explanation is required of smells / natural system / variable water quality / swimming not recommended Tourists have previously thought that sewage accounted for the bad smell

Meeting closed 8 15pm

APPENDIX B – CURLEW BIOLOGICAL SERVICE ECOLOGICAL ASSESSMENT