Department of
Infrastructure, Planning and Natural Resources

Brooklyn Estuary Management Study

HORNSBY SHIRE COUNCIL

GOSFORD CITY COUNCIL

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Synopsis:	This report provides information on future management strategies for the Brooklyn estuary. It details the objectives of long-term management and discusses some of the strategies that may be adopted to meet these objectives.

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EXECUTIVE SUMMARY

An Estuary Management Plan for the Brooklyn Estuary is currently being developed on behalf of Hornsby Council, Gosford City Council and the Department of Infrastructure, Planning and Natural Resources. The preparation of an Estuary Management Study is a critical step towards the development of this plan, as it outlines the requirements for management of the estuary, and provides a list of suggested options and strategies that can be employed to address problems, and foster improved management of the environment in the future.

What area is covered in this study?

The Brooklyn Estuary Management Study and future Estuary Management Plan covers the section of the Hawkesbury River between Croppy Point and the F3 road bridge. It also includes Mooney Mooney Creek, Mullet Creek, and the areas of Sandbrook Inlet, Brooklyn Harbour and Parsley Bay.

What are the problems?

The problems associated with the Brooklyn Estuary have been identified through a detailed community consultation program (carried out as a part of this study) and a scientific assessment of the environmental processes of the estuary (the Brooklyn Estuary Processes Study: WRL, 2003).

An exhaustive list of issues / problems was developed, which formed the basis for a set of long term management objectives for the estuary. The main issues affecting the Brooklyn Estuary are:

- Restricted tidal flushing in Sandbrook Inlet
- Increased marine influence of biota due to reduced freshwater flows
- QX oyster disease
- Decline in abundances and diversities of aquatic fauna
- Effluent release from the proposed Brooklyn Sewage Treatment Plant
- Sewage discharges from boats
- Upstream pollution sources
- Implementation of existing policies and regulations
- Illegal inhabitancy on moored boats
- Contaminated sediments
- Excessive sedimentation in navigation channels
- Derelict oyster leases
- Private developments encroaching into mangrove forests
- Dinghy Storage
- Car parking monopolising public open space
- Reclamation proposals
- Mooring arrangements
- Erosion and degradation of railway land including the causeway
- Littering
- Nature of development on Dangar Island
- Noise pollution from boats
- Derelict boats in Sandbrook Inlet
- Public access to foreshore areas
- Degradation of public wharves
- Jetty limits
- Visual and recreational amenity
- Impacts of future tourism and population growth

How can we address these problems?

Ideas for addressing the problems associated with the Brooklyn Estuary were collected from the community, relevant government and council employees, and stakeholder groups

A total of 81 different management options were suggested to address the problems listed above. It would be unrealistic to expect all of these to be implemented, due to funding and time restrictions as well as potential conflicts between some options. The strategies were therefore assessed based on their relative merits and potential for improving the Brooklyn estuarine environment to come up with a final list of 32 preferred strategies.

The preferred strategies are listed in priority order overleaf.

How will the strategies be implemented?

The strategies incorporate on-ground physical works, monitoring programs, administration tasks, planning controls and education projects.

All strategies included in the final Estuary Management Plan will be eligible for 50/50 funding under the NSW Government's Estuary Management Program, which is administered by the Department of Infrastructure, Planning and Natural Resources. Funding for many of the preferred strategies could also be sourced from

state and federal government grants, as well as Councils environmental programs (as a direct outcome of environmental levies imposed on residents).

Responsibility for implementing the management strategies described overleaf will primarily lie with Hornsby and Gosford Councils, with support from other government agencies as appropriate. It is proposed to establish a 'River Keeper' to facilitate and coordinate implementation of the Brooklyn Estuary Management Plan. The River Keeper would be a new position funded by the Councils, whose primary role would be to help improve the environmental health of the Brooklyn Estuary, educate local residents and visitors to the area on the importance and significance of the estuary and to coordinate activities and monitoring around the estuary.

Prioritised list of management strategies

Strategy # and Rank	Description
R9 #1	*Develop a numerical catchment and receiving water model, to identify areas where ecological health may be vulnerable. The model will be used to inform data collection and monitoring programs then be used for future model calibration and verification.* *Once calibrated, the model could be used to assess future strategic landuse management options.*
E1 #2	*Develop an Estuary Health Monitoring Program. Indicators of ecological health for the Brooklyn Estuary could include seagrass distribution and condition, nutrient levels, faecal coliform data and higher trophic level indicator organisms, such as fish.* *The program could include monitoring by community members and other estuary users*
#4	*Employ a River Keeper for the lower Hawkesbury to assist with implementation of this EMP including community education*
FL4 #3	*Prepare a brochure "Living on the Brooklyn Estuary" and disseminate to residents through an interactive website regarding how the general public can contribute to the long term ecological sustainability of the Brooklyn Estuary.*
R2 #4	*Review effectiveness of existing planning frameworks such as Hornsby and Gosford LEPs and DCPs to protect the estuary values. This strategy would include an audit of the types of developments that are being approved for these areas and an assessment of the existing planning documents in ensuring such development fits with the goals for the area described in Sydney Regional Environmental Plan 20 and does not impact significantly on the natural processes of the Brooklyn Estuary.*
DN7 #5	*Enhance current program of auditing and enforcing sediment and erosion controls at all development sites, including rail and road projects.*
FL2 #6	*Rehabilitate public foreshore land through programs such as Landcare /Bushcare, the Hawkesbury Nepean Riverbank Management Program and by promoting the Hornsby Council plant list. Priority areas for rehabilitation include Seymour Creek, sections of Mooney Mooney and Mullet Creeks, the railway causeway, Dangar Island and areas of railway land at the eastern end of Long Island.*
R7 #7	*Promote the EPIC framework for use by Council Planners when assessing development applications by converting the requirements of the EPIC framework into a new or existing DCP The Estuary Processes and Issues Checklist (EPIC) is a tool prepared as a part of this Estuary Management Study, which has been designed to assist the Brooklyn Estuary Management Committee (BEMC) and Council planning staff assess the likely impacts of future proposals on the natural processes and existing values of the Brooklyn Estuary*
R3 #8	*Improve existing community education programs regarding water pollution including boat discharges. Seek out opportunities to set up an estuary research and education facility and to integrate this option with the suggested Environmental Health Monitoring Program*

Strategy # and Rank	Description
WQ 11 #9	*Monitor the ecological impact of the proposed STP outfall using a BACI (before, after, control, impact) approach). In order to obtain as much pre-construction ('before') data as possible, this program should be established immediately.*
WQ4 #10	*Continue discussions with Sydney Water regarding consideration and assessment of alternatives for management of sewage at Brooklyn, including effluent reuse.*
E9 #11	*Ensure all seagrass, saltmarsh and mangrove habitats are recordered accurately in HSC, GCC and DPI Fisheries mapping systems. This strategy would involve a review of all existing Council mapping and comparison with recent habitat identification as presented in the Estuary Processes Study*
WU5 #12	*Develop and implement an oyster lease decommissioning plan. The plan should identify areas for remediation and relative priorities of work.*
WQ1 #13	*Investigate further and implement appropriate options for pump out facilities accessible to larger vessels east of the rail bridge. A recent economic appraisal of 6 options has been undertaken (Roylat, 2005). Further investigations focussing on the key recommendations of the Economic evaluation report, including environmental and social investigations should be undertaken.*
FC1 #14	*Investigate and manage car parking for overnight accommodation in the river settlements. This may be implemented through a Development Control Plan requiring new overnight accommodation developments to provide sufficient parking for guests or to contribute to council run public parking facilities through section 94 of the EP&A Act.*
E2 #15	*Monitor recreational fishing in the Brooklyn Estuary. Data should be collected over the entire Hawkesbury Estuary and combined with information from commercial fishing returns to identify impacts on fish stocks.*
WQ2 #16	*Prepare and implement creek rehabilitation plans for tributaries to the Brooklyn Estuary*
WQ6 #17	*Ensure that road and rail infrastructure within the catchment has sufficient stormwater management controls*
FL8 #18	*Initiate a program for the removal of rubbish (including derelict boats) from riparian areas. The clean up program should focus on larger items such as derelict boats and dumped construction materials, with input and assistance from industry groups. Volunteers from the general public could also be encouraged to assist in the clean up of dumped tyres, plastics, food wrappings and other dumped materials.*
E8 #20	*Identify significant seagrass beds on boating charts and by using navigation markers and undertake an education program to promote the protection of these area*
FC3	*Investigate further options and merits for providing public carpark facilities in Saltpan Reserve and / or McKell Park with connections to nearby small craft berthing facilities for offshore residents*

Strategy # and Rank	Description
#21	
WQ5 #22	Investigate opportunities for allowing some flushing under the causeway
FC2 #23	*Introduce time limited parking zones. A number of options for implementing a parking zone strategy have been suggested through the community and stakeholder consultation. Parking zones should include provisions for both short and long term car parking in Brooklyn to allow for a range of user and commercial opportunities*
DN9 #24	*Determine sources of sediment contamination and impacts of contaminants on estuarine health, through a program of targeted sediment and water quality monitoringResults could be compared to other locations where metals contamination is much more significant than within the study area (such as the southern end of Pittwater).*
FL1 #25	*Upgrade public jetties, wharves and waste facilities at Mckell Park, Brooklyn Park, Parsley Bay, Kangaroo Point and Saltpan Reserve*
E12 #26	*Undertake an environmental flows investigation for the tributaries of the Brooklyn Estuary*
WU4 #27	*Review mooring limits to ensure consistency with estuary capacity.*
H1 #28	*Liaise with the Metropolitan LALC and other indigenous groups to assess if the current level of protection of aboriginal sites is appropriate and to develop opportunities for educational programs*
R8 #29	*Liaise further with CMA to ensure integration with the Catchment Action Plan and associated strategies*
DN3 #30	*Redesign Brooklyn Harbour. Brooklyn Harbour is highly congested during busy times such as weekends and public holidays. The harbour could benefit from a redesign, within the existing land based footprint. A design should be prepared in consultation with existing users and businesses and implemented through a place based DCP.*
DN2 #31	*Periodic maintenance dredging of Sandbrook Inlet and Brooklyn Harbour*

ACRONYMS

Acronym	Definition
BEMC	Brooklyn Estuary Management Committee
CAP	Catchment Action Plan (to be developed for the whole Hawkesbury Nepean Catchment by the CMA)
CMA	Catchment Management Authority
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation
DIPNR	The former NSW Department of Infrastructure Planning and Natural Resources (
DNR	Department of Natural Resources (formerly a part of DIPNR)
DOP	Department of planning (formerly a part of DIPNR)
EIS	Environmental Impact statement
EMP	Estuary Management Plan
EMS	Estuary Management Study
EPA	NSW Environment Protection Authority (now included in DEC)
EPI	Environmental Planning Instrument (includes LEP, REP and SEPP)
EPS	Estuary Processes Study
ESD	Ecologically Sustainable Development
GCC	Gosford City Council
HRC	Healthy Rivers Commission (ceased to exist in 2004)
HSC	Hornsby Shire Council
ISLW	Indian Spring Low Water
LEP	Local Environmental Plan
LGA	Local Government Area
MHL	Manly Hydraulics Laboratory
MHWM	Mean High Water Mark
NHT	National Heritage Trust (Money available for Environmental projects from the partial sale of Telstra)
NPWS	NSW National Parks and Wildlife Service (now included in DEC)
REP	Regional Environmental Plan
SEPP	State Environmental Planning Policy
SREP	Sydney Regional Environmental Plan
SREPP	Sydney Regional Environmental Planning Policy
STP	Sewage Treatment Plant
TN	Total Nitrogen
TP	Total Phosphorus
WRL	NSW Water Research Laboratory (Authors of the Brooklyn Estuary Processes Study)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 The Brooklyn Estuary

The Brooklyn Estuary comprises a section of the lower Hawkesbury River, which is located just north of Sydney. It includes the Hawkesbury River waterway between Croppy Point and the F3 Freeway Bridge, Sandbrook Inlet, Brooklyn Harbour, Parsley Bay, Mooney Mooney Creek and Mullet Creeks to their tidal limits. The study area also includes the catchments of these waters in so far as they impact on the condition of the estuary. Figure 1-1 shows map of the study area.

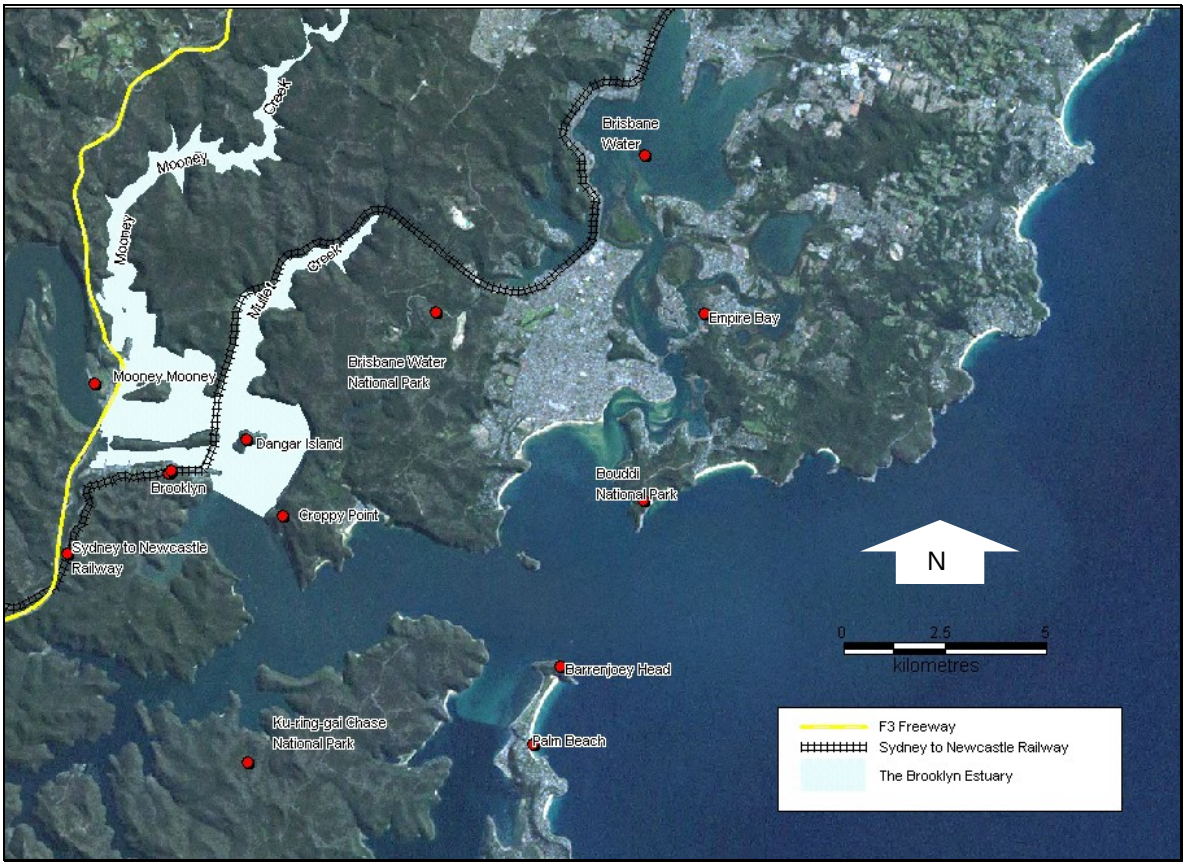

Figure 1-1 The Study Area

The greater Hawkesbury-Nepean River catchment has a total area of about 22,000km^2. In comparison, the local catchment of the Brooklyn Estuary is about 185km^2. The estuary is a drowned river valley, carved into Hawkesbury sandstone bedrock during historical ice ages, when ocean levels were much lower than present.

The Brooklyn Estuary has been valued by residents and visitors for a long time. Both Aboriginal and European heritage around the estuary is significant. Presently, oyster farming, commercial fishing and tourism are important local industries. The area's accessibility to the population of Sydney and the Central Coast, the open waterway with sheltered bays and harbours, and its scenic quality make it a very popular destination for a large number of recreational visitors. About 500 boats are moored in the estuary (WRL, 2003). The township of Brooklyn is also an important launching point for those accessing the many offshore villages both within and beyond the study area.

The ecology of the Brooklyn estuary is diverse. It contains mangroves, seagrass, saltmarshes, soft sediments and rocky foreshores. The surrounding nature reserves and National Parks are important from habitat, nature conservation, research and recreational perspectives.

Significant changes to the Brooklyn Estuary have already occurred as a result of the construction of the Sandbrook Inlet rail causeway, construction of dams within the upper valleys, and the general development and landuse changes around the estuary foreshores and within the whole catchment area.

The primary aim of this report is to produce a set of prioritised management strategies/options that enhance, preserve and minimise the impacts of human activities on the estuary's environmental and recreational values.

This report is part of a set of documents that are being prepared for the Brooklyn Estuary under the provisions of the NSW Governments Estuary Management Framework as described in Section 1.2

1.2 The NSW Government Estuary Management Framework

In 1992, the NSW State Government introduced an *Estuary Management Policy*, aimed at managing the growing pressures on estuarine ecosystems. The policy is implemented through an Estuary Management Program, which is co-ordinated by the Department of Natural Resources (DNR, formerly DIPNR) in co-operation with local government and the community.

The process of managing an estuary, in accordance with this Policy, is initiated by the establishment of an Estuary Management Committee. This Committee is then responsible for the development of an Estuary Processes Study, which outlines all the hydraulic, sedimentation, water quality and ecological processes within the estuary, and the impacts of human activities on these processes. The Brooklyn Estuary Processes Study was completed by the University of NSW Water Research Laboratory (WRL) in 2003.

The Estuary Processes Study (WRL, 2003), provides the necessary understanding of physical, chemical and biological processes for the preparation of an Estuary Management Study. This Estuary Management Study identifies the essential features and the current uses of the estuary, and determines the overall objectives required for management of the estuary. The Management Study also identifies options for meeting these objectives, and determines hydraulic and ecological impacts of the proposed options.

From the findings of the Management Study, an Estuary Management Plan is then prepared. The Plan describes how the estuary will be managed, gives recommended solutions to management problems, and details a schedule of activities for the implementation of the recommendations. Once the Plan has been accepted by both the Community and the relevant Government Departments, the Plan can be implemented through planning controls, works programs, monitoring programs, and education services. The general estuary management process, as established by the NSW Government, is shown in Figure 1.2.

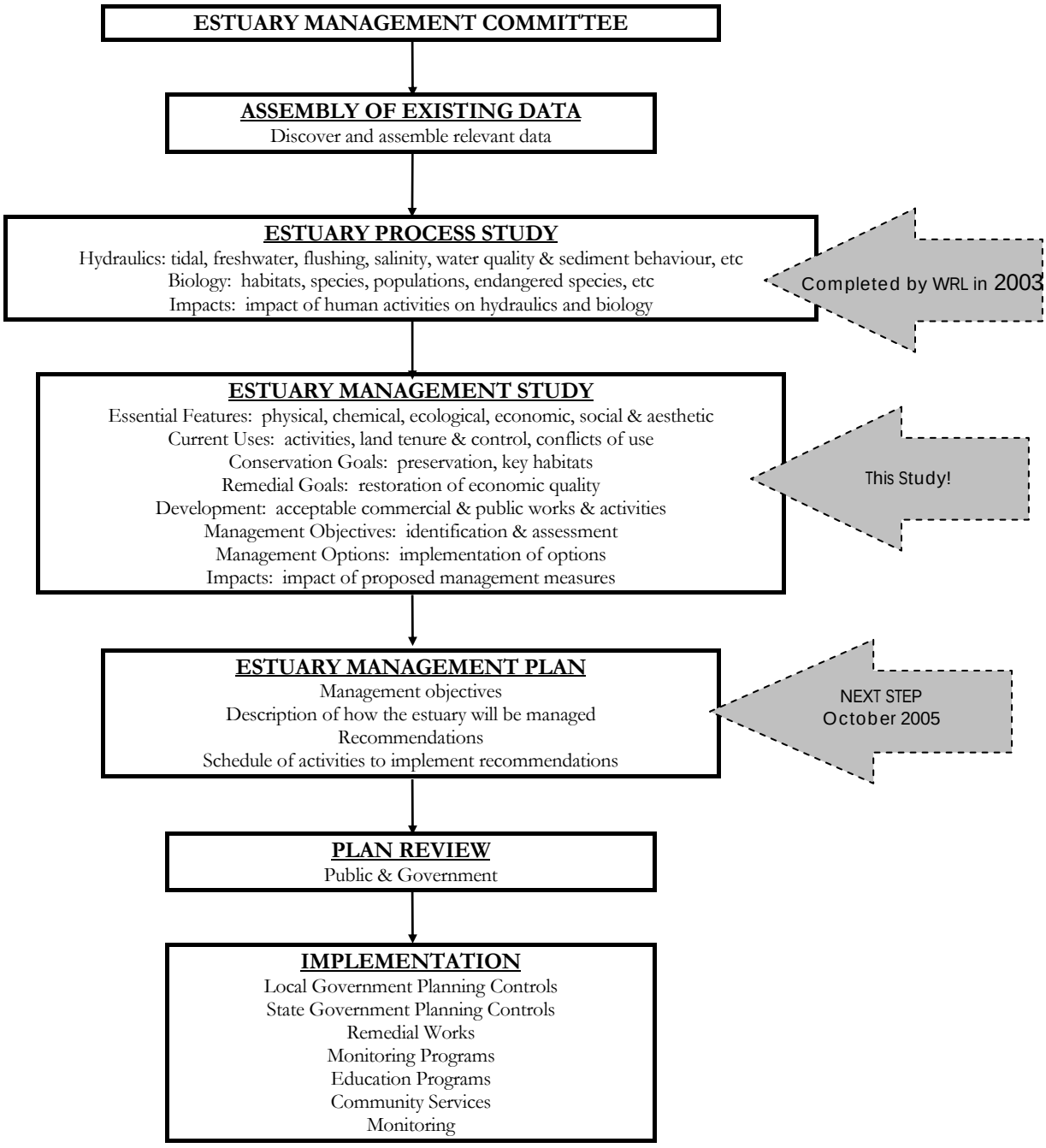

Figure 1-2 NSW Government's Estuary Management Process

1.3 Structure of this Report

This document provides the basis for selection of strategic management actions that will be incorporated into the Brooklyn Estuary Management Plan. As such, the document contains an array of information regarding the physical and biological processes, the community values, and the planning framework of the Brooklyn Estuary.

In arriving at the strategic management actions, a process was followed to determine which actions, should be included in the Estuary Management Plan. The various steps of this process are detailed in this Estuary Management Study report and described in Figure 1-3.

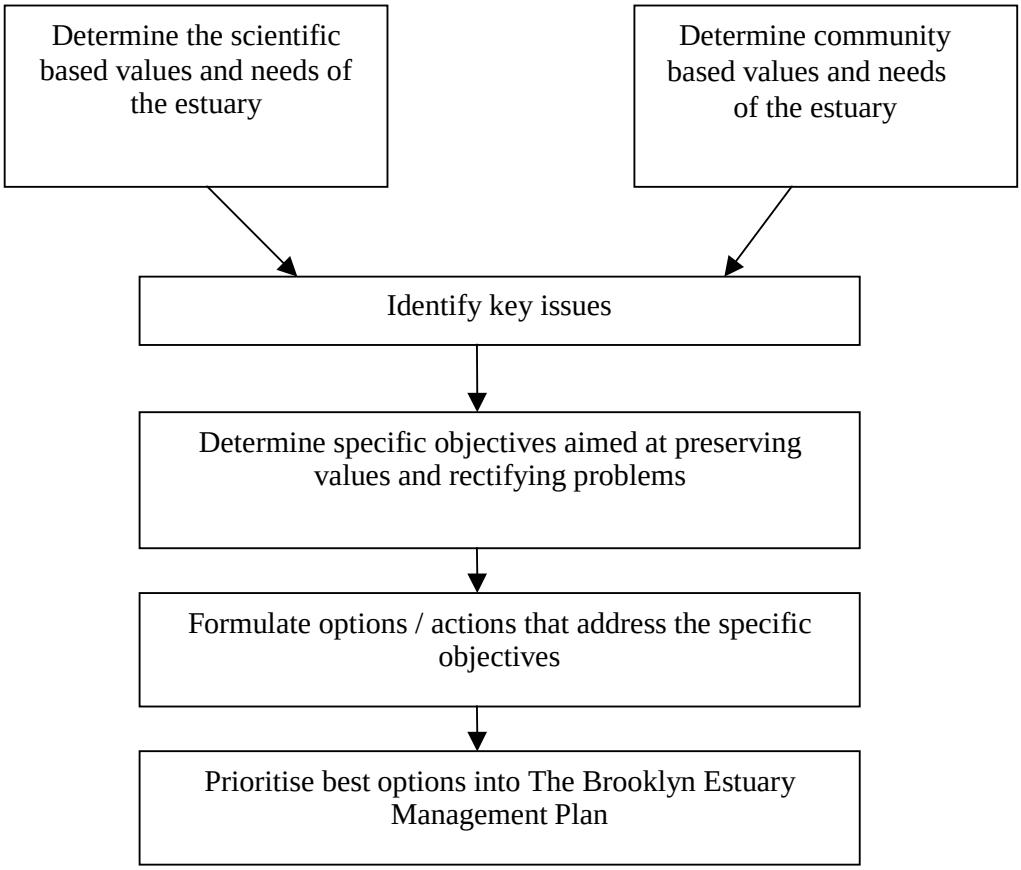

Figure 1-3 Schematic outline of process for developing management strategies

Presented below is a basic outline of the contents of each chapter, as they relate to the process adopted in arriving at the final list of future management strategies.

Chapter 2 presents a **summary of the Estuary Processes Study**. This outlines all of the fundamental physical, chemical and biological processes that currently occur within the Brooklyn Estuary, and how these processes need to be considered and managed in the future.

Chapter 3 presents **results of the community consultation** carried out for this project. It details the issues that the community feel are most important to the Brooklyn Estuary, the ways in which they currently use the Brooklyn Estuary, and some suggested options for sustainable future management.

Chapter 4 gives an overview of the **planning context** that is currently applicable to the Brooklyn Estuary. This includes all local, regional, state and federal legislation.

Chapter 5 discusses the current **land uses** and future **development potential**

Chapter 6 summarises the **values and significance** of the Brooklyn Estuary and also details the key **Management Issues** that need to be addressed in order to maintain a healthy and sustainable estuarine environment in the future.

Chapter 7 defines **Management Objectives** that need to be addressed. The objectives have been based on specific details relating to each of the Key Management Issues.

Chapter 8 outlines the **selection of management options** that could be employed to address the management objectives.

Chapter 9 gives **specific details relating to the most preferred Management Options** based on the preceding prioritisation in the format of individual information sheets. These details include where the options will be implemented and how. This will form the basis for the Estuary Management Plan.

Additional information is also provided in Appendices to this document, where necessary.

1.4 Membership of the Brooklyn Estuary Management Committee

Table 1-1 Current members of the Brooklyn Estuary Managment Committee

Member	Stakeholder represented
Sonny Armstrong	Community
Steve Baxter	Sydney Water
Tony Bray	Community
Roger Campbell	Community
Belinda Cowdroy	Hornsby Shire Council
Joanne Edney	NSW Department of Environment and Conservation
Earl Erling	Hawkesbury River Marina
James Farrington	Hornsby Shire Council
Andrew Fenwick	Fenwicks Marina
Peter Freewater	Gosford City Council
Bill Gollop	Community representative
Kieran Horkan	NSW Department of Environment and Conservation
Leanne Houlcroft	Community
Terri Latella	Gosford City Council
Janelle McIntosh	Hornsby Shire Council
Wendy McMurdo	Hornsby Shire Council
Arthur Michos	Department of Natural Resources
Rolf Norington	Community representative
Tony Phillips	Boat Owners' Association
Justin Pigneguy	Community
Harry Recher	Community
Joanne Scarsbrick	Community
Paul Schuetrumpf	NSW Fisheries- Office of Conservation
Paul Scurry	NSW Maritime
Garry Whitaker	Hornsby Shire Council
Danny Wiecek	Department of Natural Resources

2 OVERVIEW OF ESTUARY PROCESSES

The Brooklyn Estuary Processes Study was prepared in 2002/03 by UNSW Water Resources Laboratory (WRL) with assistance from Manly Hydraulics Laboratory, The Ecology Lab, Coastal and Marine Geosciences, and the Centre for Research on Ecological Impacts of Coastal Cities (Sydney University).

A summary of the Brooklyn Estuary Processes Study (WRL, 2003) is provided below. Some additional interpretation of the data provided within the Estuary Processes Study is also presented within the relevant sections of this Chapter.

2.1 Catchment Development

The Brooklyn Estuary study area lies within the greater Hawkesbury-Nepean River catchment, which has a total catchment area of about 22,000km^2. The Brooklyn Estuary study area has a local catchment of 185km^2, of which approximately 139km^2 drains to Mooney Mooney Creek, 28km^2 drains to Mullet Creek, and 18km^2 drains directly to Sandbrook Inlet. The vast majority of the Hawkesbury-Nepean catchment is located upstream of the study area, and thus has a potential impact on the study area.

Development within the study area is restricted to a few riverside settlements, including Brooklyn, Dangar Island, Little Wobby, Cogra Bay, Mooney Mooney, and Cheero Point, as well as the upper catchment area of Mooney Mooney Creek, which contains a range of agricultural and industrial landuses at Somersby, Kariong and Peats Ridge. The vast majority of the local catchment draining to the study area comprises bushland, of which most is contained within Ku ring gai Chase National Park or Brisbane Water National Park. Over the past 42 years, however bushland within the catchment has decreased by 13.3%. Ridge-top development at Kariong and Somersby represent the only significant potential for expansion of development within the study area.

On average, approximately 47,000kg of TN and 8,200kg of TP are generated from the local study area catchment each year. Catchment modelling estimates that only 1.4% of the TN is in an inorganic form, while only 0.3% of the TP is in an inorganic bioavailable form. Runoff from the road and rail transport corridors is considered to be insignificant in terms of total nutrient loading, however, the relatively high inorganic forms of nutrients that runoff from these landuses means that the total dissolved inorganic nutrient loads (both nitrogen and phosphorus) are increased by about 50% as a result of these corridors.

Pollutant loadings from the local catchment are considered small compared to the total quantity of pollutant moving through the study area, as a result of catchment runoff and other catchment-based activities within the entire 22,000km^2 Hawkesbury-Nepean River catchment.

2.2 Hydrodynamics

Hydrodynamics within the study area are dominated by everyday tidal processes, interspersed by occasional flood events within the river. Tidal flows discharge about 150,000 ML/day of relatively clean oceanic water to the study area from Broken Bay. This compares to less than 300 ML/day of low flow from the upstream reaches of the Hawkesbury River. During flood times, however, more

than 1,000,000 ML/day of freshwater can be discharged down the river. Catchment runoff from the local study area catchment essentially only influences hydrodynamics in the poorly flushed upper reaches of the Brooklyn Estuary waterways.

The tidal range in the study area is very similar to the ocean tidal range with a slight amplification of the tides towards the upper reaches of Mullet and Mooney Mooney Creeks. About 75% of the tidal prism entering the study area passes straight through to move further up the Hawkesbury River. About 10%, 4% and 1.5% enter Mooney Mooney Creek, Mullet Creek and Sandbrook Inlet, respectively, while the remaining 12% stays within the main channel between the upstream and downstream study boundaries.

The maximum tidal velocities in the study area are between Long Island and Dangar Island, and were measured by WRL to be about 1.2 m/s. Velocities in Sandbrook Inlet are about 0.1 m/s at the western end, decreasing to essentially zero at the eastern end of the inlet. Under flood conditions, velocities in the river are approximately double peak tidal velocities.

Modelling was undertaken to examine the impacts of the Sandbrook Inlet rail causeway on river hydrodynamics. The impact of the causeway was found to be relatively localised to Sandbrook Inlet only, with predicted velocities in the order of 0.3 m/s travelling through the inlet under normal tidal conditions, increasing to around 0.8 m/s during flooding.

Modelling also showed that tidal flushing of the study area is relatively rapid, although there was notable spatial variability in the results. In relative terms, the main channel was predicted to take 3 – 5 days to flush, which compares to about 9 days for Sandbrook Inlet, 8 days for Mullet Creek and 14 days for Mooney Mooney Creek. If the causeway was removed, tidal flushing of Sandbrook Inlet would be approximately equivalent to flushing times in the main channel (ie 3 – 5 days). Closer inspection of the flushing plot without the causeway shows that tidal ingress into Sandbrook Inlet occurs via both ends, with a tidal null point in the middle of the inlet (ie tidal flows are zero where the water meets in the middle). It is likely that this lack of net tidal through-flow within Sandbrook Inlet resulted in natural deposition of sediment prior to construction of the causeway (although the rate of deposition with Sandbrook Inlet is likely to have been exacerbated by the causeway construction).

Particle tracking modelling of hydrodynamics indicates that pollutants discharged to Sandbrook Inlet under dry weather conditions tended to remain within the inlet. During wet weather conditions, however, pollutants discharged to Sandbrook Inlet were predicted to be evacuated from the inlet, except for those discharged at the very eastern end of the inlet.

Pollutants discharged in the vicinity of Dangar Island were shown to be advected out of the study area very quickly, due to the high rates of tidal flushing within the main river channel.

While the main channels within the study area are well flushed, the upstream extremities of the study area are generally not well flushed. Local catchment runoff pollutant loads delivered to these upstream areas can therefore have a significant impact on water quality in the upper reaches. These impacts may be exacerbated by vertical stratification that could occur within the upper reaches (with a saltwater wedge under a more freshwater surface). Tidal currents in the main river channel and downstream tributary reaches induce intense turbulent mixing that would prevent stratification.

Groundwater inputs to the estuary are mostly considered to be negligible due to the underlying Hawkesbury sandstone bedrock.

2.3 Water Quality

Water quality is quite variable within the study area, and is influenced by a number of factors, the most important of which is tidal flushing. Urban development at Brooklyn, Dangar Island and in the upper catchment of Mooney Mooney Creek can introduce a range of pollutants to the estuary, including suspended solids, nutrients, oxygen reducing substances, bacteria and pathogens, pesticides, trace metals, petro-chemicals and other industrial-based organic compounds. The majority of these pollutants are delivered to the estuary during wet weather periods, however, some activities, such as the major transport links across the waterway, the licensed discharge from the hotel and some marina developments, may also have a continuous input of pollutants to the system.

Essentially all riverside dwellings and premises within the study area are serviced by on-site sewage treatment (either septic tanks, holding tanks, or aerated wastewater treatment systems). WRL (2003) report that a Council audit indicated that more than 50% of inspected properties had problems with their on-site systems. It was considered that existing on-site systems are responsible for high pollutant loadings in surface water and groundwater in the area. Modelling shows, however, that during wet weather conditions, when the systems would be failing, the contaminants move out of Sandbrook Inlet and other backwater areas at a relatively rapid rate.

A sewage reticulation scheme is proposed within the study area and would reduce existing nutrient and faecal coliform loads to the estuary, associated with sewage inputs, by about 80%. The existing small STP that services Peat Island and some Mooney Mooney properties is considered unsatisfactory, with relatively poorly treated effluent discharged directly to the river.

Vessels can also represent a source of pollution, if they discharge waste directly to the water. Approximately 400 vessels in the Brooklyn area are of a size that could have a toilet fitted, of which approximately 75 are commercial houseboats (WRL, 2003). The discharge from vessels has the potential to introduce high concentrations of faecal material and pathogens to the water. However, as the total discharge volume is small, the load is rapidly dispersed, particularly if discharged in the main river channel. Holiday periods, such as Christmas and Easter breaks, represent the greatest risk to water quality deterioration due to boat discharges.

Typical dry weather total nitrogen (TN) concentrations in the Hawkesbury River channel are higher at the upstream end than the downstream end (0.64mg/L compared to 0.35mg/L). Meanwhile, typical dry weather total phosphorus (TP) concentrations in the river are essentially the same at the upstream and downstream boundaries. This suggests that TN sourced from further upstream in the Hawkesbury River is still being assimilated and diluted by the river within the study area. TP concentrations within the River approximately represent basal oceanic concentrations. TP loads delivered to the Hawkesbury-Nepean River all appear to be assimilated upstream of the study area.

Further monitoring indicates that inorganic nitrogen concentrations (i.e. ammonia and oxidised nitrogen) are relatively high within the study area, and exceed ANZECC guidelines.

Within Sandbrook Inlet, water quality is considered to be poor - very poor, with elevated nutrient concentrations. However, algae (as indicated by chlorophyll-a concentrations) is not a significant

problem in Sandbrook Inlet, which is probably due to associated higher turbidity concentrations (and hence less light penetration) and relatively rapid evacuation of pollutants from the Inlet during wet weather conditions, as highlighted by particle tracking modelling.

High chlorophyll-a concentrations were recorded in the upper reaches of Mooney Mooney Creek (upstream of Piles Creek), which is indicative of an algal bloom. It is likely that a large proportion of pollutant runoff generated from the local catchment becomes trapped within the upper reaches of the tributaries (primarily Mooney Mooney Creek and Mullet Creek), where it is then taken up by algae within the waterway. Algae blooms in the upper reaches is likely to follow closely rainfall events in the catchment, as response times for algae are generally quite quick.

During wet weather, water quality within stormwater drains at Brooklyn contains high concentrations of faecal coliforms, enterococci, and nutrients, with these pollutants most likely coming from leaking septic systems. Sewage contamination on Dangar Island has also been identified, however, the pollutant loading to the river would be quickly advected and assimilated by the large Hawkesbury River tidal flows.

Pollutants introduced to Sandbrook Inlet during dry weather conditions are likely to become trapped within the inlet, and could potentially attach to suspended sediments and accumulate in the bed upon settlement.

2.4 Sediments

The main Hawkesbury River channel is dominated by coarse sediments (ie sands), whereas the tributaries of the river, including Mooney Mooney Creek, Mullet Creek and Sandbrook Inlet, are mostly fine muds and sandy muds.

Sedimentation is a natural feature of backwater areas, particularly in drowned river valley estuaries, such as the Hawkesbury-Nepean. However, sedimentation within Sandbrook Inlet is likely to have been exacerbated by the construction of the railway causeway in the mid 1880s. Sedimentological studies suggest that accretion rates within the main navigation channel of Sandbrook Inlet are about 10 – 20 mm/yr (with minimal accretion at the eastern end of the Inlet). Within Brooklyn Harbour, dredging has been undertaken in the past, with navigation channels infilling at a rate of approximately 80 mm/yr. If the causeway was to be opened or removed, sedimentation rates within Sandbrook Inlet and Brooklyn Harbour are likely to decrease. In fact, in the immediate vicinity of the causeway, it is likely that increased tidal and flood velocities will remobilise and scour existing bed sediments. This eroded material would then be advected out of the Inlet and deposited elsewhere within the estuary subject to dominant tidal and flood hydrodynamics.

During dry weather conditions, approximately 70 tonnes of suspended fine sediment passes through the study area in the main Hawkesbury River channel during each ebb tide. A very small proportion of this sediment would fall out of suspension in the less flushed, quiescent parts of the study area, forming a thin layer of fine mud, which would typically overlie coarser material. During wet weather / flood conditions, the thin layer of mud would be quickly resuspended into the water column and transported downstream along with the very large quantity of sediment coming from upstream. Turbidity is high during wet weather / flood conditions. Settlement of suspended sediment would mostly occur post-flood.

In terms of sediment quality, measured TP within the sediment was within the general range of 200 – 800 mg/kg, while TKN was generally between 400 and 2200 mg/kg. Higher concentrations were measured in sediments with larger fines content. Based on measured water quality concentrations at the upstream and downstream boundaries, WRL suggest that denitrification is an important nitrogen sink process within the study area, particularly in Sandbrook Inlet and probably in the upper reaches of Mooney Mooney and Mullet Creeks.

The relatively high total organic carbon (and nutrients) content of the sediments throughout the study area (including the main river channel) indicates that the area is a natural deposition environment for catchment organic loads delivered from upstream (particularly in post-flood times). These organics would be subject to natural recycling and burial processes in the bed, with the release of inorganic bioavailable nutrients to the water column moderated by benthic productivity, including benthic microalgae.

With regard to trace metals, slightly elevated concentrations of mercury, copper, lead and zinc were recorded within the surface sediments of Sandbrook Inlet, which would most likely be related to boating activities, marina developments and general urbanisation of the waterway fringe. Slightly elevated concentrations of a few metals including mercury, cadmium and lead were also recorded in surface sediments adjacent to Spectacle Island, downstream of the road bridges. It is possible that construction of the bridges introduced these materials to the estuary. No trace metals were at concentrations that warrant significant concern. Even concentrations in Sandbrook Inlet, although elevated, were lower than other areas of intense boating activity (eg southern end of Pittwater), and are considered not to be a significant threat to estuarine ecology.

Similar results were found for anthropogenic organic compounds (indicated by polycyclic aromatic hydrocarbons), with concentrations elevated in Sandbrook Inlet, signifying disturbance and human influences at this location. Measured concentrations have not exceeded recommended guideline values, however, and associated risks to the environment are considered to be low.

2.5 Ecology

A number of seagrass beds are located within the study area, including beds at the head of Mullet Creek, east of Kangaroo Point, south of Dangar Island, and to the east of the railway causeway between Brooklyn and Long Island. The cover of seagrasses within the study area has increased over the past 16 years. Seagrasses are particularly valuable as they stabilise sediments, provide important habitat for juvenile fish and mobile invertebrates, and are significant components in the cycling of nutrients within estuaries. Overall, the seagrass within the study area were determined to be healthy with relatively low epiphyte load.

Mangroves also contribute significantly to estuarine productivity and are vital to the production and cycling of nutrients within estuaries. Mangroves are present at a number of locations within the study area. The extent of mangroves in Sandbrook Inlet (particularly at the outlet of Seymours Creek) has remained relatively unchanged for the last 15 years, as has the mangroves within Mooney Mooney Creek and Mullet Creek. Mangroves to the west of Spectacle Island and around Mooney Mooney Point, however, have increased in recent years.

Saltmarshes are relatively uncommon in the study area, with isolated stands located around Brooklyn, Long Island and Spectacle Island, and at the head of Mooney Mooney Creek.

Riparian vegetation is dominated by tall open forest, and open forest and woodland formations. Introduced species have penetrated many riparian areas, however, the dominant vegetation is still native.

Sampling has identified fewer benthic invertebrates in Brooklyn Harbour compared to reference locations. Sampling has also identified that benthic and intertidal rocky shore invertebrate communities on the Sandbrook Inlet side of the causeway were significantly different and relatively depauperate compared to the Brooklyn Harbour side.

Recreational fishing is common within the study area, and is most prevalent around the main channel of the Hawkesbury River, with increased intensity on weekends and public holidays (particularly in summer months). This unfortunately clashes with peak periods for usage of the estuary for other activities, including general boating, site seeing and bushwalking.

Boat launching is primarily from Parsley Bay, Sandbrook Inlet (Kangaroo Point) and Mooney Mooney Point (west). Commercial fishing also occurs within the study area, with commercial vessels moored in Brooklyn Harbour and Sandbrook Inlet. The (entire) Hawkesbury River is the 4th largest commercial fishery in NSW, producing over 268 t fish/yr (based on 2001 figures). The number of commercial fishers has reduced over the past 10 years, it is difficult to assess the impact of this on fish stocks.

Oyster farming is also prevalent in the study area with 15 different operators holding leases in Mooney Mooney Creek, Mullet Creek and Sandbrook Inlet. The lower Hawkesbury River is the 2nd largest oyster producing area in NSW. Oysters can concentrate metals and other contaminants within their flesh many times in excess of the ambient water levels. Analysis of wild oyster flesh from the study area showed elevated concentrations of copper in oysters taken from Sandbrook Inlet and Brooklyn Harbour, as well as elevated concentrations of arsenic and zinc in oyster flesh in Brooklyn Harbour. The copper and arsenic levels were measured at concentrations exceeding the ANZFA standards. The elevated concentrations of heavy metals in the oyster flesh are attributed to anthropogenic effects, including the road and rail networks, and antifouling paints used on boat hulls (particularly in respect to copper).

2.6 Human Activities and Values

The Brooklyn area is important and highly valued from a human usage perspective. It is popular for recreation, local and regional economics, and for residential uses. The Brooklyn area also serves as a hub for waterway access and boating activities that service many remote areas of the Hawkesbury River that are accessible by water only. The relatively sheltered waters of Sandbrook Inlet have also made it ideal for mooring and berthing of boats, while ready access to the Sydney-Newcastle freeway makes the area desirable to the general Sydney community.

The population of riverside settlements has remained relatively fixed for at least the past 20 years. The lack of population growth is primarily because there is little opportunity for additional development due to zoning restrictions and the natural environmental constraints. Ridgetop settlements of Kariong and Somersby, however, have a significant potential for population growth, which would potentially affect the upper reaches of Mooney Mooney Creek and the Brooklyn estuary in general. Meanwhile, the population increase in the general Sydney and Central Coast areas means

that tourist activity in the Brooklyn study area is likely to increase, which will place greater pressure on existing infrastructure and increase waterway usage.

The drowned river valley morphology of the study area limits public access to the water. Those foreshores that are relatively flat are mostly occupied by private development or natural mangrove barriers, although a mangrove boardwalk is provided in Brooklyn Park. Boating access is provided by public and commercial wharves, however, there is a lack of wheelchair access via these facilities. Public beaches on Dangar Island are highly valued and well patronised by the local community, while access to the Long Island and Spectacle Island Nature Reserves is restricted to the general public.

The Parsley Bay boatramp is the most popular location to launch vessels within the study area, although boatramps are also located at Mooney Mooney and Kangaroo Point.

There are approximately 550 moorings within the study area, most of which are in Sandbrook Inlet or Parsley Bay. The majority of these are swing moorings, although some fore and aft moorings are located in Sandbrook Inlet. The ceiling limits for moorings in Sandbrook Inlet and Parsley Bay have been reached, with little capacity to increase unless existing moorings are converted to fore and aft moorings. The 550 moorings include NSW Maritime moorings and approximately 100 private moorings associated with the 7 marinas in Sandbrook Inlet and Brooklyn Harbour. The marinas also provide 320 fixed berths, as well as slipways and other typical marina facilities.

It is believed that relatively intense Aboriginal occupation of the catchment occurred for at least 4000 years before European settlement, with the Hawkesbury River serving as a social nexus for various Aboriginal groups. There are over 1000 identified Aboriginal sites within the study area, as well as two Aboriginal archaeologically sensitive areas: McKell Park and Kangaroo Point.

European heritage is also relatively significant within the Brooklyn area, with Hornsby Shire Council considering classifying the whole of Brooklyn as a heritage area. Heritage items within the study area are identified in planning instruments for both Hornsby and Gosford Councils. Sites of State heritage significance include the railway tunnels and the 1889 railway bridge piers, pylon and plaque on Long Island, as well as the road remains from the disused Old Peats Ferry Road.

With its tall and highly weathered Hawkesbury sandstone vertical cliffs and gorges, the Lower Hawkesbury River is one of the most visually spectacular waterways in New South Wales. Conservation of this enormous scenic value is critical in consideration of any future development.

2.7 Human Influences on Estuarine Processes

Human activities affecting the functioning of estuarine processes within the study area date back to the construction of the railway causeway between Brooklyn and Long Island in the mid 1880s. The construction of dams within upper catchment areas of Mooney Mooney Creek and the Hawkesbury-Nepean River, have also changed the natural hydrological regime of the estuary.

Agricultural and urban development within the catchment of the study area, as well as within the catchment of the entire Hawkesbury-Nepean River, has altered the rates of runoff of sediment and pollutants, while anthropogenic activities (particularly major transportation services) have also introduced trace metals and organic compounds to the estuary. Urban development near the estuary has resulted in elevated nutrient and bacterial loads associated with poor management of sewage.

Usage of the waterway by boats and associated services has also introduced a range of pollutants to the estuary, including metals, petro-chemicals, nutrients and bacteria.

2.8 Interactions Between Estuary Processes

Descriptions of the actual interactions between the various estuarine processes were not highlighted within the Brooklyn Estuary Processes Study report (WRL, 2003). Therefore, this section has been prepared to assist the Brooklyn Estuary Management Committee and the general community in appreciating the linkages between the processes, and the potential implications of altering one or more estuary functions through future management works.

The processes interactions tree provided below (see Figure 2-1) gives a very simplified summary of the key linkages between the various processes. Descriptions of each linkage are provided in the remainder of this Chapter.

In essence, the estuary processes can be considered at a series of different levels (refer Figure 2-1). The highest level (or 1st order) processes are generally unaffected by other natural processes, although they can be affected by human influences and interventions. The middle level (or 2nd order) processes are strongly influenced by the 1st order processes, but can also be affected somewhat by other 2nd order processes. The lowest level (or 3rd order) processes are affected by 1st and 2nd order processes, either directly or indirectly. 3rd order processes generally do not affect 2nd order processes, and similarly, 2nd order processes generally do not affect 1st order processes thus a one-way flow is produced from top to bottom in the Estuary Processes Interactions Tree (Figure 2-1).

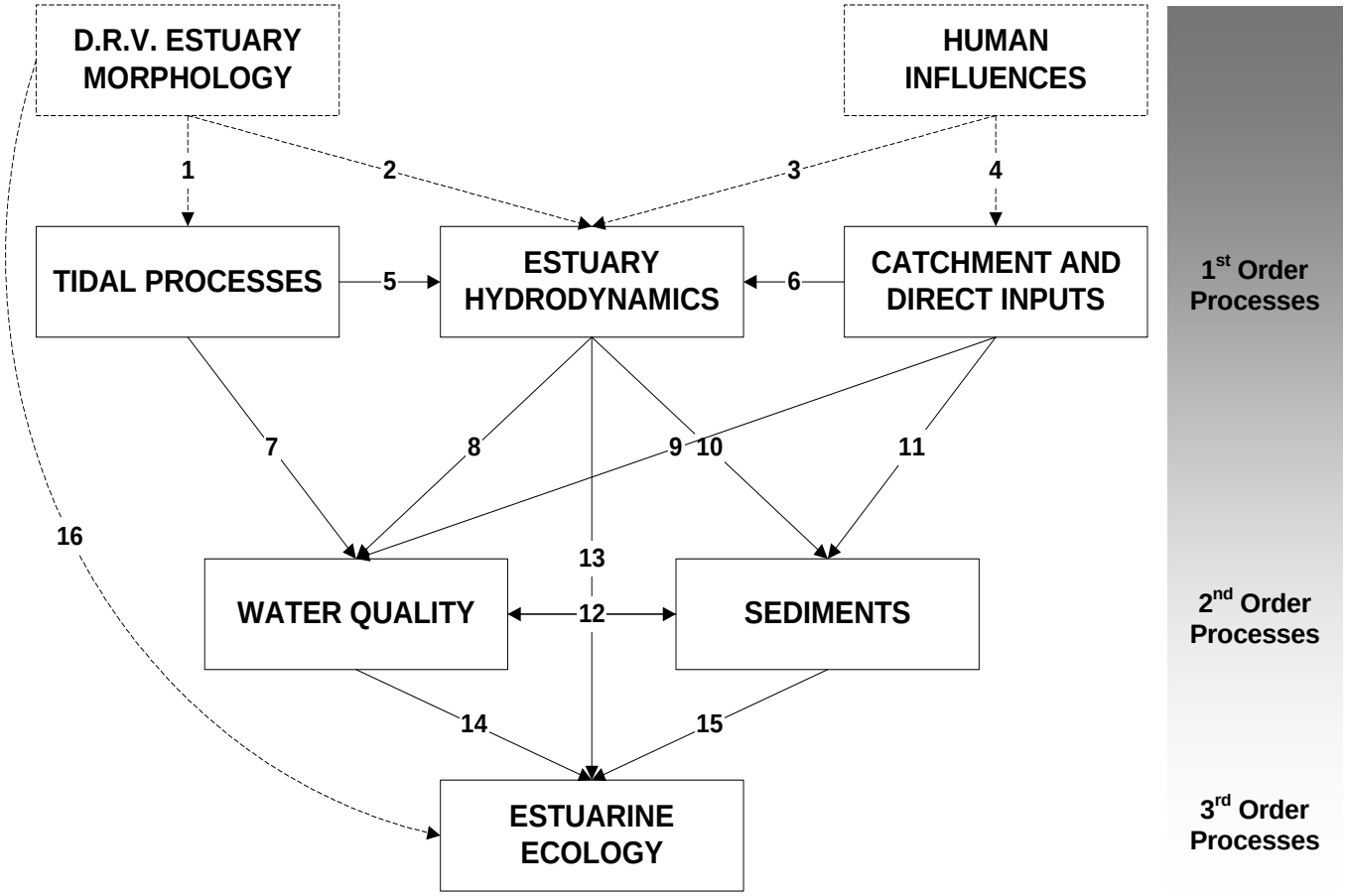

Figure 2-1 Estuary Processes Interaction Tree

Link 1. Drowned River Valley (DRV) Estuary Morphology and Tidal Processes

The drowned river valley morphology of the Lower Hawkesbury River means that tides within the Study Area are approximately the same as full oceanic conditions (albeit delayed behind the tides on the coast). Tidal processes in the estuary would be significantly different if the estuary morphology was different, eg a barrier estuary system.

Link 2. Drowned River Valley Estuary Morphology and Estuary Hydrodynamics

The drowned river morphology of the estuary means that most of the Lower Hawkesbury River is a depositionary environment. That is, tidal velocities are slow because the flow conveyance in large. There are also backwater areas within drowned tributary valleys, such as Mooney Mooney Creek and Mullet Creek.

Link 3. Human Influences and Estuary Hydrodynamics

Human activities can have significant impacts on estuary hydrodynamics. Within the Brooklyn Estuary, the major activity affecting hydrodynamics has been the construction of the railway causeway between Brooklyn and Long Island. This has reduced tidal flows to the section of estuary behind Long Island, and is likely to have increased flows within the main river channel during floods (as there is now no passage of flood flows between Long Island and the mainland).

To a lesser extent, dredging has also affected estuary hydrodynamics. Dredging has primarily been for navigation purposes only, and would result in hydrodynamic conditions that tend to exacerbate sedimentation within the actual dredged channels.

Link 4. Human Influences and Catchment & Direct Inputs

Changes to the catchment, along with direct inputs to the estuary, are probably the biggest impact of human activities on estuary processes in the Brooklyn area. Landuse changes within the catchment have altered runoff quantities / volumes, as well as pollutant runoff rates and the types of pollutants now entering the estuary.

Also, human activities now introduce a range of direct inputs to the estuary, including septic overflows, boat effluent discharges, boat antifoulant paints (and other maritime pollutants), and licensed discharges, such as from the Hotel at Brooklyn.

Link 5. Tidal Processes and Estuary Hydrodynamics

Tidal processes are the dominant factor driving estuarine hydrodynamics in the study area. Flood events can also influence hydrodynamics, however, the infrequency of floods means that the vast majority of flow through the study area is the result of tides.

With approximately 75% of tidal flows passing straight through the study area, the Hawkesbury River channel essentially forms a “torrent of tidal flow” when compared to hydrodynamic processes in the remainder of the study area. The side tributary channels receive local inputs, which, depending

on the volume of the side tributaries and the volume of the inputs, can be pushed into the main channel 'torrent', which can then quickly remove the inputs from the entire study area.

Particle tracking modelling carried out as part of the Estuary Processes Study highlights the significance of the main channel flows in removing particles from backwater areas such as Sandbrook Inlet and Mooney Mooney Creek.

Link 6. Catchment & Direct Inputs and Estuary Hydrodynamics

During low flow conditions, the catchment has no impact on the hydrodynamic processes of the Brooklyn estuary. During wet weather conditions that result in relatively high runoff flows from the local catchment, this runoff is quickly advected into the main channel, where it is then flushed away by the dominant tidal flows.

During high flows generated from the whole Hawkesbury-Nepean River catchment, there is a significant flow of freshwater, which provides a net downstream flow through the study area. During particularly large floods, velocities increase well above typical values experienced under tidal conditions, both within the main river channel and within the side channel tributaries.

Link 7. Tidal Processes and Water Quality

Dominant tidal processes within the study area and the relatively close proximity of the study area to the ocean means that the water quality entering the study area during each flood tide is relatively good, and capable of assimilating most pollutants discharged from within the study area (subject to the location of discharge – see Link 8).

Link 8. Estuary Hydrodynamics and Water Quality

The elongated shape of some sections of the study area (most notably Mooney Mooney Creek, Mullet Creek and even Sandbrook Inlet) means that waters at the extremities of these sections of the estuary are not as well flushed as the main river channel. Thus, there is significant spatial variation in flushing capacity throughout the study area. This has the potential to generate similar spatial variability in water quality within the study area, as pollutants that are discharged to the more poorly flushed sections (eg within Sandbrook Inlet or the upper reaches of Mooney Mooney Creek) would be retained more than those discharged directly to the main river (eg from Dangar Island).

Link 9. Catchment & Direct Inputs and Water Quality

Pollutant loads derived from the catchment and/or direct inputs will contribute to the water quality of the estuary. Resulting water quality is a function of the quantity of the pollutant input and the tidal flushing capacity of the location of the input. Areas closest to the discharge location will be most degraded. In areas of poor tidal flushing, pollutant gradients away from the source will be relatively shallow, particularly when compared to pollutant gradients for inputs in well-flushed sections of the study area.

Catchment inputs will mostly tend to occur during wet weather events, while direct inputs could occur during either wet or dry weather conditions.

During flood conditions in the river, the water quality of the study area will be dominated by catchment runoff from the upstream areas, which may include high concentrations of suspended sediment, nutrients and possibly algae.

Link 10. Estuary Hydrodynamics and Sediments

Bed sediments within the estuary are inextricably linked to the hydrodynamic processes. Estuarine hydrodynamics are responsible for transportation of sediments through the estuary. Areas of typically low velocities tend to accumulate sediments, while areas of high velocities would keep sediment in motion (either as suspended load or bed load) or may even erode sediments from the bed and banks.

The mobilisation and transportation of sediment is also related to the characteristics of individual sediment particles. Fine sediment can be mobilised and transported by relatively low velocities, whereas coarser sediment required much larger velocities to initiate and maintain particle motion. Therefore, estuarine hydrodynamics also defines the sediment facies within the study area. That is, it defines which areas the bed will be dominated by fine silts and muds, and which areas will be dominated by coarser sands.

Within the Brooklyn estuary, it is the more quiescent backwater areas of Mooney Mooney Creek, Mullet Creek and Sandbrook Inlet that contain fine bed sediments, while the main river channel contains sandy muds and sands.

Link 11. Catchment & Direct Inputs and Sediments

Catchment runoff provides the primary source of sediment to the study area. Coarser grained sediment will tend to be deposited as alluvial deltas at the outlets of creeks and drainage lines (eg the Seymours Creek delta), while finer grained sediments will remain suspended in the water column and slowly settle within the general mud basin of the Lower Hawkesbury River (and side tributary valleys).

Rates of sediment accretion within the estuary, both at the alluvial deltas and within the deeper mud basin, are a function of the rates of sediment runoff from the catchment, which in term is a function of catchment characteristics, including vegetation cover, soil type, catchment slope and the extent of development / soil disturbance.

Link 12. Water Quality and Sediments

Within estuaries, nutrients (particularly nitrogen, phosphorus and carbon) can migrate from the water column to the sediments, and from the sediments to the water column. Typically, organics within the water column settle to the bed, where they become buried within the sediments. Anaerobic bacteria within the sediments break down the organic material and remineralise it back into inorganic nutrients. Under certain environmental conditions, some, or all, of these nutrients can then be effluxed back into the water column where they are then converted to organic forms through the uptake by algae.

The Estuary Processes Study suggests that the study area is a net sink for nitrogen, as typical TN concentrations at the upstream end are higher than at the downstream end. However, in some

circumstances, this situation may be reversed and the study area may become a net source of nitrogen (and other nutrients).

Some pollutants, such as trace metals, when discharged in a dissolved form, have the ability to attach to fine grained sediment particles. These contaminated sediments then settle to the bed and accumulate with little or no avenue for release of the adsorbed metals. Therefore, areas where water quality is contaminated by pollutants such as metals, would generally also contain contaminated sediments. This is particularly the case in areas that are poorly flushed and sediments do not have much opportunity to be transported away prior to settlement, such as Sandbrook Inlet.

Link 13. Estuary Hydrodynamics and Estuarine Ecology

The structure of the estuarine ecology is based on a number of factors including the hydrodynamics. The simple motion of tides provides a unique element of the environment where land is sometimes wet and sometimes dry. Many estuarine species are reliant upon regular water level variation, including mangroves, saltmarshes, and various invertebrates.

The drowned river valley morphology of the Lower Hawkesbury River means that slopes adjacent to the waterway are steep, and the actual intertidal area is very narrow. Nonetheless, mangroves have established in the study area, but tend to be concentrated in areas that are less steep, such as the alluvial delta at the outlet to Seymours Creek.

Link 14. Water Quality and Estuarine Ecology

Water quality is also a factor in the structure of estuarine ecology. As water quality is a variable that can change rapidly (due to advection and dilution by tides and floods), highly responsive elements of the ecology, such as algae, are the most affected by water quality. High nutrient concentrations in the water can lead to rapid growth of pelagic (suspended) algae (ie eutrophication), while more sustained nutrient loadings tend to result in increased epiphytic (attached) algae and macroalgae.

If water quality is changed for an extended period of time, then particular ecological species may become stressed. This may, for example, be the result of extended freshwater flows within a predominantly saline environment, or may be related to the introduction of a new pollutant discharge.

Within the Brooklyn Estuary, good water quality is essential for the economic viability of the local oyster farming industry. Oysters are filter feeders, and as such, intake pollutants within the water and can transfer those pollutants into their flesh. Measured differences in the level of pollutants in oyster flesh taken from locations in Sandbrook Inlet and Brooklyn Harbour compared to locations in Mullet Creek and Mooney Mooney Creek relate to different water quality conditions across the study area. This pattern was also evident for other aquatic invertebrates. Areas close to urban development, transportation services and maritime facilities clearly have poorer water quality, which translates to a more depauperate and stressed ecological environment.

Link 15. Sediments and Estuarine Ecology

The ecology of the bed sediments (ie benthos) can differ depending on the structure of the sediments, ie fine muds benthos is quite different to coarse sands benthos. Aquatic vegetation (seagrass) can also differ depending on the type of sediment.

Sediment quality can also have an impact on benthos. Contaminants within the sediments, such as metals and anthropogenic organic compounds, can bioaccumulate within the benthos, particularly filter feeders, such as pipis.

High suspended sediment within the water column can suppress biological productivity within the estuary, through restricting light penetration to the water, and particularly to the benthic environment.

Link 16: Drowned River Valley Estuary Morphology and Estuarine Ecology

The estuarine ecology of the study area will also be influenced by the fact that the estuary is a drowned river valley. Being a drowned river valley, most of the estuary is actually very deep. This depth affects the benthic environment, as only benthos adapted to low light conditions can be supported. Benthos typically includes invertebrates as well as the microscopic benthic microalgae present amongst the sediment grains in the top 5 – 10 mm of the bed.

The drowned river valley nature of the estuary also means that there is unrestricted passage of demersal fauna between the study area and the ocean, as well as recruitment of juveniles from the ocean to the estuary.

3 COMMUNITY VALUES AND ASPIRATIONS

The aspirations and values of the community were canvassed through an extensive program of consultation. This program included:

- A newsletter and questionnaire mailed to 1600 ratepayers, residents and mooring lessees in May 2004;
- A dedicated internet website (www.brooklyn-ems.com.au) activated in April 2004;
- Media releases in May 2004;
- Onsite meetings ;and discussions with community members upon request, during June 2004;
- Consultation with a broad ranges of stakeholder groups during June 2004;
- Telephone interviews and follow up meetings with the Brooklyn Estuary Management Committee, during June 2004 and throughout the project;
- A second community newsletter outlining the results of consultation to date mailed out to over 100 residents and ratepayers that had registered interest after the questionnaire in July 2004;
- A workshop with the BEMC to confirm issues and rank objectives in October 2004;
- A third community newsletter outlining the management objectives mailed out in October 2004; and
- A community education stall at the Brooklyn Spring Fair.

The consultation was the subject of an earlier report completed by WBM as a part of this study. The report is titled Brooklyn Estuary Management Study and Plan Progress Report on Community Consultation. The report was released in August 2004 and is available through the Hornsby Shire Council Library or the project web site.

3.1 Recreational Use of the Estuary

The activities most frequently undertaken on and around the Brooklyn Estuary are:

- Boating;
- Bush walking;
- Boat fishing;
- Picnicking;
- Swimming;
- Bird watching; and
- Commuting.

The areas most frequently used for these activities are the Hawkesbury River around Dangar Island and Spectacle Island, and along Mooney Mooney Creek.

3.2 Aspects of importance

The aspects of the Brooklyn Estuary most valued by the community are:

- Environmental qualities – including native animals and plants, clean water, healthy fisheries and biological diversity;
- Access- proximity to major road and rail links;
- Character – including heritage, village atmosphere, diversity of river traffic and oyster farming traditions;
- Recreational opportunities – including choice of boating grounds, fishing potential, picnic and bushwalking opportunities; and
- Income from the estuary – including oyster farming, fishing, seafood supply and tourism.

3.3 Issues of concern

The most significant issues of concern for the community of the Brooklyn Estuary are:

- Protection of ecosystems and biodiversity;
- Sediments and sedimentation;
- Public access and recreational amenity;
- Water Quality

These issues are expanded on in Section 6.6.

3.4 Management Options

The community has suggested a broad range of management options to address the issues of concern for the Brooklyn Estuary. The most popular suggestions are listed below. A complete list of all the options suggested is included in Appendix B.

- Open the railway causeway;
- Connect the sewer ASAP;
- Rethink Sydney Waters most recent sewer strategy to include more sustainable technologies;
- Better manage upstream pollution;
- Further limit the number of boats moored in Sandbrook Inlet;
- Better implementation of existing regulations;
- Improve boat pump out facilities;
- Reduce tourism and development;
- Clean up existing derelict oyster leases;
- Improve stormwater management; and
- Improve foreshore access.

4 LEGISLATION AND PLANNING FRAMEWORK

Fragmented river management was identified as a key frustration of the community through the Healthy Rivers Commission Inquiry into the Hawkesbury Nepean River (HRC 1998). As the following review of legislation, plans and policies applicable to the Brooklyn Estuary shows, understanding the planning environment for this river is quite difficult. This chapter attempts to provide an overview of the most relevant legislation and planning instruments applicable to the Brooklyn Estuary. In an attempt to simplify the planning information, a summary table (Table 4.1) has been developed and is presented at the end of the chapter. Table 4.1 has been designed to help simplify the application of specific legislation for various management options considered as part of this Estuary management Study.

4.1 Environmental Planning and Assessment Act 1979 and associated plans

One of the key pieces of NSW legislation is the Environmental Planning and Assessment Act 1979 (EP&A Act). The EP&A Act establishes the framework for the planning system in NSW, including:

- Plan making;
- Development assessment; and
- Environmental assessment.

Operating at the State, regional and local levels, administration of the planning system is primarily shared between the Department of Infrastructure, Planning and Natural Resources and local councils. Other agencies also have responsibilities in defined circumstances.

Of particular importance to the development of management options for the Brooklyn Estuary Management Study and Plan will be the various forward planning documents called Environmental Planning Instruments (EPIs). EPIs may include Local (LEP), State (SEPP) and Regional (in this case - SREP) Environmental Plans and Planning Policies. These are discussed individually in the following sections of this chapter. Planning guidelines may also be set out at a local level in Development Control Plans (DCPs).

The EP&A Act will also be relevant for considering the likely environmental impact assessment required for management options.

4.1.1 Local Environmental Plans

LEP's provide the broad framework for environmental planning and development control. They deal with local issues such as land use controls, approval criteria, urban structure, heritage conservation, protection of environmentally sensitive land and reservation of land for public purposes such as roads and open space. The landuse zonings applicable to the Brooklyn Estuary as defined by the Hornsby LEP (refer to section 4.1.1.1) and the Gosford LEP (section 4.1.1.2) are presented in figure 4.1.

4.1.1.1 Hornsby Local Environmental Plan (LEP)

A significant portion of the study area in the Hornsby LGA is zoned Environmental Protection (River Catchment). This includes:

- The majority of residential houses on Dangar Island;
- Undeveloped land on the eastern side of Sandbrook inlet bound by the Ku-ring-Gai National Park, Great Northern Railway and the Brooklyn Village; and
- The land bound by the Great Northern Railway, Brooklyn Road and Brooklyn Park.

Smaller areas on Dangar Island are zoned for Open Space A (Public Recreation-Local). This includes land along Bradleys Beach and the beach east of the Public Wharf.

Within the township of Brooklyn there are areas of residential (low density), Business (General) and Business (aquaculture) as well as areas of Open space (Public recreation- local) and Open Space (Public Recreation – District). Land zoned for environmental protection includes, the mangrove area adjacent to Brooklyn Park in Sandbrook Inlet, and a parcel of land between Fenwicks and Dolphin Boatshed, and the bay south of Kangaroo Point (Environmental Protection – Wetlands).

As in most LEPs, land below high water mark is unzoned. However, under Part 4 of the LEP, the consent of the Council is still required for all development below mean high water mark.

Hornsby Council completed a review of the planning controls applicable to the waterways within Hornsby Shire (SJB Planning, 2005). The report recommends appropriate zoning and development controls. It is anticipated that the review will result in new zoning and development controls for the waterways below MHWM.

4.1.1.2 Gosford Local Environmental Plan (LEP)

Within the Gosford LGA, the catchment for the Brooklyn estuary includes a large portion of waterside land zoned for Conservation and Scenic Protection. This includes the townships at Cogra Bay and Cheero Point (Scenic Protection Residential), and areas zoned for Conservation, including the area near Wondabyne station and Gosford Quarries, Cogra Point and a parcel of land behind the township of Cogra Bay, Alison Point and areas along Mooney Mooney Creek such as Green Point, Two Dollar Bay, Native Dog Bay and on the opposite side of the river to Morrow Point. Mooney Mooney is zoned Residential (refer to figure 4.1).

The area along the west side of Mooney Mooney Creek and the East side of Mullet Creek, as well as Spectacle Island, are zoned for Open Space Public Recreation.

There is an area zoned for special uses that includes a tennis court and chapel and may be linked to the Peat Island Centre between the Pacific Highway and F3 at Mooney Mooney. There is a riverside strip of land along the western bank of Mullet Ceek from the junction with the Hawkesbury River that is zone for Special Uses Railways.

The area of land adjacent to Fisherman's Rock and including the Mooney Mooney Workers Club, Rugby League Football Club and Public School is not zoned.

There is a large area of Industrial land (zone 4 (a) – General) in the upper catchment of Mooney Mooney Creek at Somersby.

There are some areas zoned non urban (12 and 1b) on the western edge of the catchment and also to the north of the Somersby Industrial area. These are primarily being used for agricultural purposes, although some bushland remains.

The LEP adopts clause 31 of the Environmental Planning and Assessment Model Provisions 1980 requiring development consent for any development below high water mark. Thus, estuarine waters within a council's area will normally be subject to planning controls.

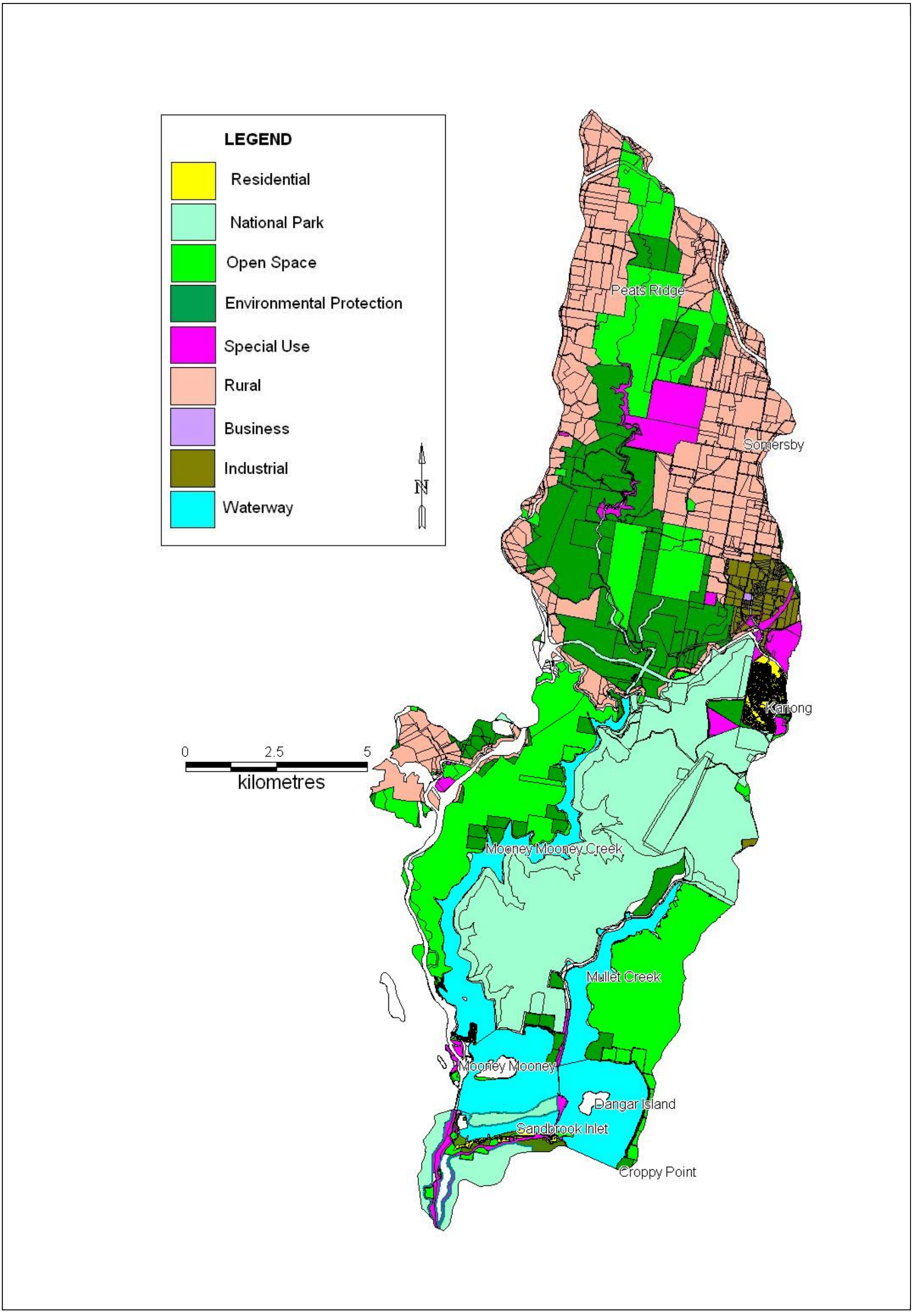

Figure 4-1 Broad Catchment Zoning

4.1.2 Regional Environmental Plans

These deal with regional issues such as transport planning, economic development and protection of river catchments, thereby providing a framework for detailed local planning.

4.1.2.1 Sydney Regional Environmental Plan No 6 -Gosford Coastal Areas

SREP 6 does not apply to land within the study area.

4.1.2.2 Sydney Regional Environmental Plan No 20 - Hawkesbury/Nepean River (No 2 –1997)

The aim of this plan is to protect the environment of the Hawkesbury Nepean River system by ensuring that the impacts of future land uses are considered in a regional context. The Plan sets out general planning considerations, specific planning policies and recommended strategies that must be taken into account:

- By consent authorities (in the case that development consent is required);
- By any person, company or public authority proposing to carry out a development (where development consent is not required); and
- In the preparation of each environmental plan that applies to land to which this Plan applies.

The topics covered in SREP 20 are:

- Water Quality;
- Significant vegetation habitats (including wetlands);
- Extraction;
- Environmental heritage and scenic quality; and
- Recreation and tourism.

The Plan also lists development controls.

Sydney Regional Environmental Plan No 20 covers the entire study area and needs to be consulted in developing management options for the Brooklyn Estuary Management Study and Plan. The opportunity has been taken to integrate the Estuary Management Plan with SREP 20.

4.1.3 State Environmental Planning Policies

These address matters that are of significance for the State, such as major employment-generating development and coastal wetlands, and provide consistency in the development assessment framework and important projects or sites.

4.1.3.1 State Environmental Planning Policy 14 – Coastal Wetlands

The policy defines over 1300 areas along the NSW Coastline as Wetlands. The areas are shown on maps held by the Department of Infrastructure, Planning and Natural Resources. Under the policy, land clearing, levee construction, drainage work and filling requires development consent. Such

development is also 'designated development' requiring development applications to be accompanied by an Environmental Impact Statement. The consent authority is the local council.

There are no SEPP 14 Wetlands in the Study area

4.1.3.2 State Environmental Planning Policy 26 – Littoral Rainforests

The policy applies to defined areas of littoral rainforest shown on maps held by the Department of Infrastructure, Planning and Natural Resources. Development within the defined areas of the map are defined as designated development thereby requiring development applications to be accompanied by an Environmental Impact Statement. There are no mapped areas of SEPP 26 Rainforest in the study area.

4.1.3.3 State Environmental Planning Policy 35 – Maintenance Dredging of Tidal Waterways

The Policy enables public authorities to undertake maintenance dredging of waterways without the need to obtain development consent. Maintenance dredging means the winning or removal and the disposal of extractive material from the bed of a tidal waterway to enable the waterway to continue to function as a tidal waterway, or to resume its function as a tidal waterway.

Schedule 1 of SEPP 35 lists land for which the SEPP does not apply. This includes land covered by Sydney Regional Environmental Plan No 20 - Hawkesbury/Nepean River (No 2 –1997). SREP 20 covers the entire study area and therefore SEPP 35 does not apply to the Brooklyn Estuary.

4.1.3.4 State Environmental Planning Policy 44 – Koala Habitat Protection

This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. This SEPP applies to the whole study area, with exception of areas dedicated or reserved under the National Parks and Wildlife Act 1974 or to land dedicated under the Forestry Act 1916 as a State forest or flora reserve. The SEPP frames development controls, plans of management and other environmental planning measures for development requiring consent that could impact on core Koala habitat. It is unlikely that management options developed for the Brooklyn Estuary Management Study and Plan will impact on core Koala habitat.

4.1.3.5 State Environmental Planning Policy 62- Sustainable Aquaculture

Currently the Policy only applies to pond, or tank based aquaculture in the North Coast region of NSW. Its operation may be extended to natural water-based aquaculture in the future by use of Schedule 2 of the SEPP.

Significantly, the Healthy Rivers Commissions' review of the Relationship between Healthy Oysters and Healthy Rivers (HRC 2003), recognisees SEPP 62 as an indication that the state government aims to encourage aquaculture development throughout NSW.

4.1.3.6 State Environmental Planning Policy 71 – Coastal Protection

This policy seeks to ensure that the development within the coastal zone is appropriate and suitably located and is consistent with the principles of Ecologically sustainable Development. Under this policy the Minister for Infrastructure and Planning becomes the consent authority for State Significant Development, Significant Coastal Development and Development in Sensitive Coastal Locations. Schedule 2 of the policy defines Significant Coastal Development as mining, extractive industry, industry, landfill, recreational establishments, marinas, tourist facilities (except bed and breakfast establishments, and farm stays) and buildings greater than 13 metres in height above the natural ground level. It also includes development, comprising subdivision of land:

- Within a residential zone into more than 25 lots;
- Within a rural residential zone into more than five lots; or
- Within any zone into any number of lots if the future development of any lot created by the subdivision will require effluent to be disposed of by means of a non-reticulated system.

A Sensitive Coastal Location is described in the Policy as:

- A coastal Lake (as listed in Schedule 1);
- Land within 100m above mean high water mark of the sea, a bay or an estuary;
- Land within 100m of the waters edge of a coastal lake, a declared Ramsar Wetland, a World Heritage property, an aquatic reserve, a marine park, a national park, a nature reserve, or a wetland subject to SEPP14; or
- Residential land within 100m of land identified under SEPP26.

At present the local government areas of Gosford and Hornsby are not included in the NSW Coastal Zone (as defined in section 4A of the Coastal Protection Act 1979). However, mapping of these areas into the coastal zone is currently underway and should be signed off by the Minister for Infrastructure and Planning in the near future. As such the SEPP is likely to apply during the Plan's implementation phase and should be considered in developing management options.

4.1.4 Development Control Plans (DCPs)

The EP&A Act also allows for the preparation of development control plans by local councils. These are supporting documents to LEPs that provide detailed guidelines for the determination of development applications. Their contents are not statutory, but must still be taken into consideration.

4.1.4.1 Hornsby Shire Dangar Island Development Control Plan

The Dangar Island DCP provides controls and guidelines for development on Dangar Island. The objectives of the DCP are:

- To provide measures to protect the natural and built environment;
- To protect the amenity and scenic qualities of the area; and
- To maintain the low-density character of Dangar Island.

The DCP outlines objectives, performance criteria and prescriptive measures for 12 elements of proposed development. These elements are, density, design, height, setbacks, views, sunlight and privacy, soil and water management, landscaping, environment protection, waterway structures, heritage, energy efficiency and urban streams.

The DCP was consulted to ensure consistency with proposed management options on Dangar Island.

4.1.4.2 Hornsby Shire Sustainable Water Development Control Plan

The *Sustainable Water DCP* applies to all development under the Hornsby Shire Local Environmental Plan. The purpose of the DCP is to provide controls for development to ensure that in the pursuit of Ecologically Sustainable Development (ESD) of the Shire, all development activities adopt a sustainable water approach to design management.

Three levels of sensitivity, for urban land within Hornsby Shire are described. This sensitivity level is determined by use of a table given in the DCP. If a high sensitivity level applies to the site of a proposed development, further information showing compliance with the prescriptive measures of the DCP will be required to accompany a Development Application.

The prescriptive measures outlined in the DCP relate to the areas of:

- Sustainable water strategy;
- Site Planning;
- Construction;
- Materials and design;
- Topography;
- Watercourses;
- Soil dispersibility;
- Soil landscapes;
- Native plant communities;
- Bushland;
- Fauna habitat; and
- Operations and maintenance.

This DCP was referred to when developi ng management options for the Brooklyn Estuary.

4.1.4.3 Hornsby Shire Heritage Development Control Plan

The purpose of this DCP is to manage the heritage in Hornsby Shire and to provide guidance and outline specific controls for the development relating to heritage items and heritage conservation areas.

The objectives of the DCP are:

- To conserve the heritage of the natural and built environment and ensure new development is sympathetic to heritage values;
- To provide guidance for development in relation to heritage items and heritage conservation areas; and
- To encourage an understanding of heritage significance and promote the conservation of heritage within Hornsby.

The DCP states that a Heritage Impact Assessment will be required for development applications relating to heritage items. Where a heritage item is of Regional or State significance, a Conservation Plan may be required to form part of the development application.

Heritage items for the Shire of Hornsby are listed in the DCP. The list is quite extensive and ranges from covering individual houses to large parcels of land. Within the Study area for the Brooklyn Estuary Management Plan, the heritage items include:

- More than fifty sites in Brooklyn (including residential houses, railway infrastructure, hotels, bushland and government buildings); and
- More than fifteen sites on Dangar Island (including roadwork's, bushland, trees and residential houses).

The DCP was consulted when developing management options for the Brooklyn Estuary.

4.1.4.4 *Hornsby Shire Brooklyn Development Control Plan*

The purpose of the DCP is to provide updated and more detailed provisions for the control of development within Brooklyn and to implement the findings and recommendations embodied in the Brooklyn and Environs Management Plan 1990.

The DCP is divided into Part A and Part B. Part A is the Planning Strategies and Part B is the development controls. These two parts are described below.

Part A

A planning strategy for the areas of aquatic environment, traffic and parking, services, tourism and heritage are outlined. For each of these planning strategies, the DCP describes an objective, performance criteria and prescriptive measures. Within these prescriptive measures there are many measures directly related to management options to be considered for the Brooklyn Estuary.

The DCP outlines a jetty limit in Sandbrook Inlet. This jetty line was raised as an issues during the community consultation and is shown in . It is further discussed in section 6.6.2.13.

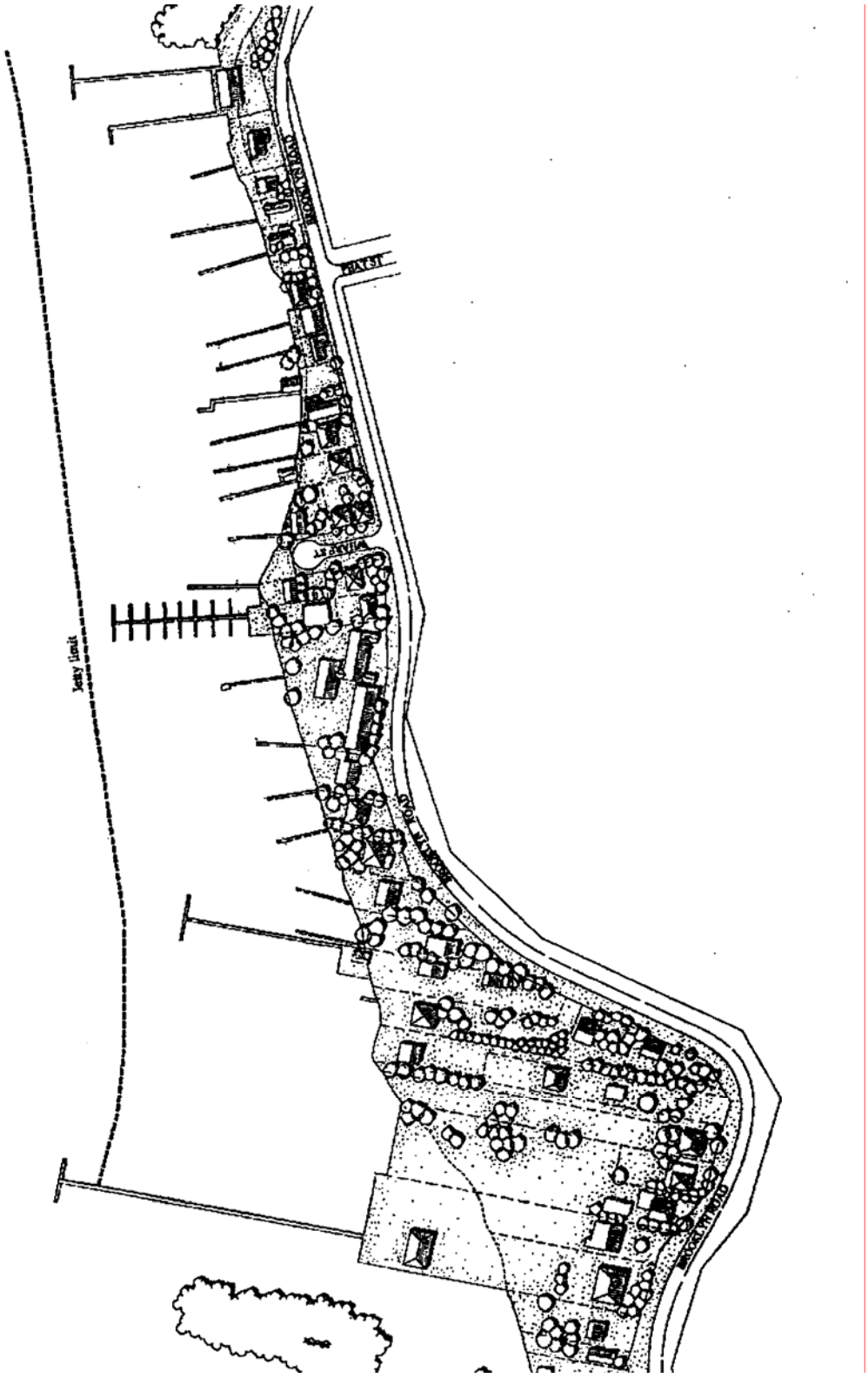

Figure 4-2 Jetty Limits in Sandbrook Inlet (source: Brooklyn DCP)

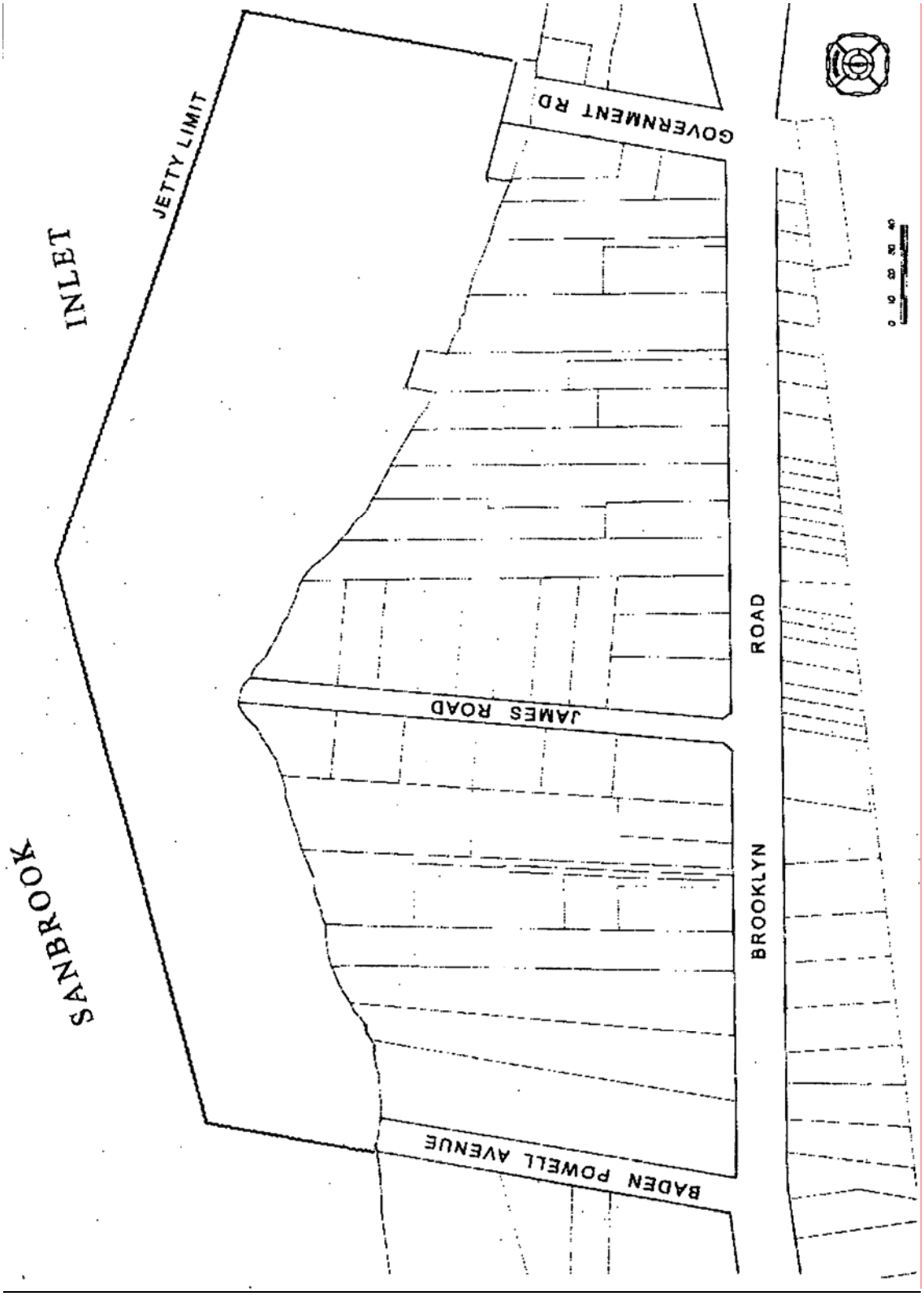

Figure 4-3 Jetty Limit-in sandbrook Inlet – Baden Powell Avenue to Government Road (source Brooklyn DCP)

Part B

Part B is divided into the primary control elements. For each of the control elements objectives, performance criteria and prescriptive measures are given. There is a substantial amount of information in this part of the DCP. Detailed review of these elements will need to be undertaken when considering management options

4.1.4.5 Gosford Development Control Plan 89 – Scenic Quality

The objectives of the Development Control Plan are:

- To provide a detailed assessment of Gosford's landscape character which highlights the diversity between and within landscape units;
- To detail the components of that landscape character;
- To provide a comparative ranking of the landscapes; and
- To develop appropriate guidelines for the management of the landscape character.

The DCP applies to all land within Gosford. Where a development application or a rezoning application is lodged which relates to land applicable to this plan Council shall take the provisions of this plan into consideration in determining that application.

For the Brooklyn Estuary Landscape Unit the issues highlighted by the DCP are the residential and informal scale of development. The DCP explains that these should be retained with ridge tops, cliff lines and conspicuous slopes exempt from development. For the Mooney Mooney Creek Landscape Unit, the DCP advises that further development should be confined to the settled area. For the Mullet Creek Landscape Unit the DCP advises that the area should be exempt from development with the railway works already considered unsympathetic. These considerations should be integrated into management options.

4.1.4.6 Gosford Development Control Plan 119 – Wharves and Jetties

This DCP applies to Brisbane Water and does not apply to the Study Area.

4.2 Other important NSW Parliamentary Acts

4.2.1 The Rivers and Foreshores Improvement Act, 1948

Under part 3A of the Rivers and Foreshores Improvement Act, 1948, a person must not:

- Make an excavation on, in or under protected land, or
- Remove material from protected land, or
- Do anything, which obstructs, or detrimentally affects, the flow of protected waters, or which is likely to do so.

The above conditions apply unless the person is either authorised to do so by a permit from the Department of Infrastructure, Planning and Natural Resources and does so in accordance with any

conditions to which the permit is subject, or is authorised to do so by the regulations. Protected land means:

- Land that is the bank, shore or bed of protected waters, or
- Land that is not more than 40 metres from the top of the bank or shore of protected waters (measured horizontally from the top of the bank or shore), or
- Material at any time deposited, naturally or otherwise and whether or not in layers, on or under land referred to in paragraph the two points above.

Protected Water means a river, lake into or from which a river flows, coastal lake or lagoon (including any permanent or temporary channel between a coastal lake or lagoon and the sea).

There are a number of cases where the provisions of the RFIA do not apply. Under s.22H of the Act, local councils and other public authorities are not bound by the Act when carrying out works themselves. Also, those in possession of a licence or lease under the Crown Lands Act do not have to seek consent under this Act. However, in the above circumstances, the relevant authority under the RFIA can still play a role. It can direct the person or body responsible for undertaking the activity to implement remedial works where the excavation or removal of soil is likely to harm protected land or interfere with the flow of protected waters.

Management options considered in this study have taken into account the requirements of the River and Foreshore Improvement Act. The Act is to be repealed at some stage by the Water Management Act 2000.

4.2.2 Water Management Act 2000

The *Water Management Act* 2000 seeks to promote the integrated and sustainable management of the States waters for the benefit of both present and future generations.

Key features of the Act include, outlining statutory rights for environmental water, providing for the development of statutory water plans and development of a water trading system.

The Water Management Act 2000 also contains provisions for approvals of 'controlled activities' and should be consulted in relation to estuary management options. Dredging, for example, will be a controlled activity under the Water Management Act and may require a works approval.

Most of the Act's provisions commenced on 1 January 2001, but some provisions relating to harvestable rights, access licences, approvals and the Water Investment Trust are not yet in force. For the time being, matters relating to licences and approvals continue to be dealt with under the *Rivers and Foreshores Improvement Act 1948* and the *Water Act 1912*.

4.2.3 Catchment Management Authorities Act 2003

The Catchment Management Authorities Act establishes 13 Catchment Management Authorities across NSW. The Catchment Management Authorities replace the Catchment Management Boards and Trusts set up under the repealed Catchment Management Act. The Hawkesbury Nepean Catchment Management Authority will cover the Brooklyn Estuary. Certain natural resource management functions are devolved to the Catchment Management Authorities. This includes the

preparation of a draft Catchment Action Plan as soon as practicable for approval by the Minister under Part 4 of the Act.

The Act also repeals the Catchment Management Act 1989 and to amends various Acts consequentially.

It is expected that the Draft Catchment Action Plan will be based on the Hawkesbury Nepean Catchment Blueprint prepared by Hawkesbury-Nepean Catchment Management Board.

4.2.4 Natural Resource Commission Act 2003

The Act creates an independent Natural Resources Commission to make recommendations on natural resource management standards and targets, audit the performance of the catchment management authorities (CMAs), report on the achievement of targets, and carry out inquiries.

4.2.5 The Coastal Protection Act 1979

The *Coastal Protection Act 1979* originally established the Coastal Council of New South Wales and specified its functions. This part of the Act has recently been repealed.

Parts 3-5 of the Act remain in force and contain provisions relating to the use and occupation of the coastal zone, the carrying out of certain coastal protection works, the preparation of coastal zone management plans and certain ancillary matters relating to the coastal zone.

The coastal zone is delineated on maps approved by the Minister for Planning and Natural Resources. As with SEPP 71, the study area is not included in the coastal zone, at this time. Mapping is currently underway, however, and it is likely that at least some parts of the study area will be included within the coastal zone within the next 12 months.

Once the study area is included in the coastal zone, Part 3 of the Act will apply. Part 3 of the Act provides for general supervision of the use, occupation and development of the coastal zone. This includes a requirement for public authorities (if notified under section 38) to gain concurrence from the Minister for Planning and Natural Resources before any development is carried out or consent is given for the use, occupation or development of the coastal zone. It also provides for general supervision of development within the coastal zone that is not otherwise subject to the provisions of an environmental planning instrument (other than a State Environmental Planning Policy).

Part 4A of the Act provides for the preparation of coastal management plans by local councils.

Part 4B of the Act modifies the common law doctrine of erosion and accretion in relation to foreshore land. Under this doctrine, the position of any boundaries defined by reference to the mean high water mark are not fixed, but migrate in accordance with gradual, natural and imperceptible movements in the position of the mean high water mark. The Act requires that any mean high water mark property boundary determination involving an increase in the area of land on the landward side of the boundary will only be allowed if it can be established that the trend of accretion will be indefinitely sustained through natural means, and that no public access to a beach, headland or waterway will, or is likely to be, restricted or denied.

Part 5 outlines the penalties for offences against the Act.

In terms of the Brooklyn Estuary Management Study and Plan, due reference has been made to the Coastal Protection Act 1979, as it is likely that the study area will be within the NSW Coastal Zone during the Plan implementation phase.

An amendment in 2003 modifies the doctrine of erosion and accretion so that a perceived trend by way of accretion must be proven to be indefinitely sustained and to not restrict or deny public beach, headland or waterway access.

4.2.6 Local Government Act1993

The *Local Government Act 1993* (LG Act) defines the powers, duties and functions of all local councils in New South Wales. In particular, it:

- Enables councils to provide a wide variety of service functions;
- Sets out a framework for the use and management of most council-managed public land, known as 'community land';
- Outlines mechanisms for setting rates and charges and may possibly be applied to funding management options;
- Establishes a regulatory system for certain activities that require approval or are subject to the making of orders;
- Outlines the land and waters to be taken within Council's area;
- Requires councils, councillors and council employees to have regard to the principles of ecologically sustainable development when carrying out their responsibilities;
- Governs the operation of the Coastal and estuary management committee;
- Provides council with a statutory exemption from liability in relation to coastline hazards and flood impacts, providing the steps outlined in the appropriate manuals have been followed.

4.2.7 Fisheries Management Act, 1994

The general objective of the *Fisheries Management Act 1994* is to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

As well as providing authorisation and permits for aquaculture, recreational and commercial fishing activities, the Act also lists threatened marine species, populations and ecological communities.

The Fisheries Management Act specifies that a public authority authorising or carrying out of dredging or reclamation work or interrupting fish passage must give notice of the proposed work to the Minister of Fisheries and consider any maters raised.

The main provisions of this legislation that relate to Estuary Management works are:

i) Habitat Protection Plans - which allow for the gazettal of management plans for the protection of specific aquatic habitats;

iii) Dredging and Reclamation Plans - which allows for the control and regulation of dredging and reclamation works, which may be harmful to fish and fish habitat. It establishes requirements to

obtain a permit from or to consult with NSW Fisheries (now known as the Department of Primary Industries).

iv) Protection of mangroves and certain other marine vegetation, which requires permits to be obtained for the regulation of damage to or removal of certain marine vegetation including seagrass.

Of particular relevance to the Brooklyn Estuary Management Plan are provisions within the Act relating to the preparation of Habitat Protection Plans. Fish Habitat Protection Plans describe potential threats to fish habitat and recommend actions to mitigate the effects of potentially damaging activities. There are three habitat protection plans gazetted to date and they are all relevant to the study site. These are outlined briefly below.

Habitat Protection Plan No 1 General

This is an advisory document summarising various protective measures in relation to dredging and reclamation activities, fish passage requirements, and the protection of mangroves, other marine vegetation and snags.

Habitat Protection Plan No. 2 Seagrasses

The Plan deals specifically with the protection of seagrasses across NSW, and discusses activities which impact on seagrasses, including the construction of jetties, wharves, and bridges, dredging and reclamation, and the collection of seagrasses.

Habitat Protection Plan No 3 Hawkesbury Nepean River System

The Plan outlines management strategies and protection measures for aquatic habitats essential for the spawning, nursery, shelter and feeding requirements of fish in the Hawkesbury-Nepean River.

The Fisheries Management Act also protects fish species listed as endangered or vulnerable. Three vulnerable species of fish that potentially use the estuary during part of their lifecycle are the grey nurse shark (*Carcharias taurus*), the great white shark (*Carcharadon carcharias*) and the black rock cod (*Epinephelus daemilii*) (The Ecology Lab 2003).

4.2.8 Threatened Species Conservation Act, 1995

The Act provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species. Unless a licence has been obtained under the National Parks and Wildlife Act 1974 or the Threatened Species Conservation act 1995, or approval under the EP&A Act, it is an offence under the National Parks and Wildlife Act to harm any animal or plant that is a threatened species, population or ecological community (NPWA s.118(1)(b)).

Threatened species, populations and communities are listed as endangered or vulnerable in Schedules 1 and 2 respectively.

Eight endangered and twenty vulnerable fauna species, and two endangered and nine vulnerable plant species were recorded within 5km of the Brooklyn area at the time of the preparation of the Estuary

Processes Study (The Ecology Lab 2003 in WRL 2003). The Schedules are updated frequently and the numbers may have changed since this time.

The impacts of management options on these species have been considered in the development of management options for the Brooklyn Estuary.

4.2.9 Protection of the Environment Operations Act, 1999

The Protection of the Environment Operations Act replaces the Clean Air Act 1961, Clean Waters Act 1970, Noise Control Act 1975, Pollution Control Act 1970, Environmental Offences and Penalties Act 1989 and regulatory provisions of the Waste Minimisation Act 1995. The Act makes it an offence to pollute the environment without an environment protection licence issued by the Environment Protection Authority (now the Department of Environment and Conservation). Schedule 1 lists activities, which require an EPA licence. The schedule includes dredging works and extractive industries, however the definitions of both of these activities require quantities of more than 30,000m^3 per year before they fall under the Act. If the sediment to be dredged were classified as hazardous or industrial waste, the activity would require an environment protection licence.

4.2.10 The National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NSW) (*NP&W Act)* established the NSW National Parks and Wildlife Service (NPWS- Now integrated into the Department of Environment and Conservation). Under the Act, the Director-General considers and investigates proposals for additions to any national park, historic site, state recreation area, nature reserve, state game reserve, karst (limestone) conservation reserve, regional park or Aboriginal area.

Division 1 of the Act describes land, which may be reserved, and this includes crown lands reserved under the Crown Lands Act.

Allowances for moorings in the waters of the Ku-ring-gai Chase National Park are set out in *National Parks and Wildlife Regulation 2002.*

Under the National Parks and Wildlife Act 1974, the National Parks and Wildlife Service protects native aquatic macrophytes and riparian vegetation on lands under its control. Freshwater plants scheduled under the Threatened Species Conservation Act 1995 are afforded greater protection.

The National Parks and Wildlife Act 1974 requires that a Plan of Management be prepared for each National Park. A Plan of Management is a legal document, which outlines how a National Park will be managed in the years ahead. Plans of management prepared for Brisbane Water National Park and Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves are considered in sections 4.5.2 and 4.5.3.

4.3 Crown Lands Assessment

The *Crown Lands Act 1989*, requires a land assessment to be undertaken prior to the reservation, dedication, exchange, vesting or sale of Crown land, or the granting of easements, leases or licences in respect of such land. The process for land assessment is specified by the Act and the *Crown Lands Regulation 2000*. It requires the physical characteristics of the land to be identified, the land's

capabilities to be assessed and suitable uses identified. A draft land assessment is publicly exhibited for 28 days for comment. The exhibited draft may indicate a preferred use or uses.

4.3.1 Assessment of Crown Land for the Lower Hawkesbury River

A Draft Assessment of Crown Land for the Lower Hawkesbury River (including Berowra Creek, Milsons Passage and Dangar Island) was prepared in 1991. The area within the study area covered by the assessment includes the land below Mean High Water Mark (MHWM) adjoining freehold residential lands fronting Dangar Island and Milsons Passage. This land is within Hornsby Shire, but is unzoned.

The area assessed was divided into mapping areas (13 within the present study area). Each of these mapping areas were examined and inventories of the lands attributes and current use patterns were undertaken. The capabilities of the land were then determined in accordance with Department of Lands Policies. The following general recommendations were made:

- Where unauthorised reclamation assists public foreshore access, it should be reserved for public access; and
- That a program be developed to review the condition of the foreshore structures within the study area, with a view to ensure that derelict structures and those that inhibit access be removed.

In addition to these general recommendations, specific recommendations for each of the mapping areas were made. Four mapping areas were found to contain features of individual distinction. These are all within the Brooklyn Estuary Management Study Area. The assessment advises that additional private foreshore structures will not be permitted within these areas. For all other areas the assessment recommends that foreshore structures for private recreational boating purposes be permitted. It is also advised that a commuter facility will be permitted within one (or if necessary two) of the mapping areas. This would be permitted subject to stringent controls. The final recommendation is that the area above ISLW for two of the mapping areas be reserved. These recommendations are shown on Figure 4-4

The Assessment also reiterates the point that residents are permitted to erect structures on the foreshore as a privilege requiring payment of a levy and that this privilege may be withdrawn at any time.

As a part of the preparation of the Brooklyn Estuary Management Study and Plan, a review of the Crown Lands Assessment has been undertaken to determine if the principles of the assessment remain current and applicable.

Applications to modify the Crown Lands Assessment in the vicinity of North Beach have been brought to the attention of the study team by the Department of Infrastructure, Planning and Natural Resources. Application to develop a private and communal (shared by 7 landowners) structure in mapping area 9 (see figure 4.3) has been made. So far these applications have been rejected, as they are not considered consistent with the recommendation ‘no new private structures be permitted within the area other than for community commuter berthing’ and only then under ‘stringent controls’. The current application is not considered to be a community commuter structure as it would not be available to the general public. DINR has also expressed that the addition of private

structures in this area (Mapping Area 9) could greatly detract from the visual quality of this area and impede practical access along the foreshore to the sandy beach (B.Dooley DNR pers. comm. 2002).

New information is presented in the Brooklyn Estuary Processes Study that is relevant to the Crown Lands of Dangar Island. The area in front of Coolongolook Point to the south is an intertidal mudflat, mostly covered by seagrass beds (*Zosteri capricorni*) (The Ecology Lab 2003). The study also reiterates that the two beaches viz: Bradleys Beach and North Beach located to the west of the public wharf remain accessible for public recreation (WRL, 2003).

During the community consultation for Dangar Island, commuter berthing on Dangar Island was not raised as an issue. However, many people did raise the need to maintain public access to foreshores and concerns of over-development of Dangar Island.

Another aspect not considered in the Lower Hawkesbury Crown Lands Assessment is projected sea level rise in response to the enhanced greenhouse effect. This could further diminish available public beach, where development is located close to the present shoreline.

Based on a review of the Crown Lands Assessment and consideration of new information, it is recommended that the principles of the assessment remain current and applicable and that due consideration is given to the aquatic habitat surrounding Dangar Island and the impacts of future sea level rise.

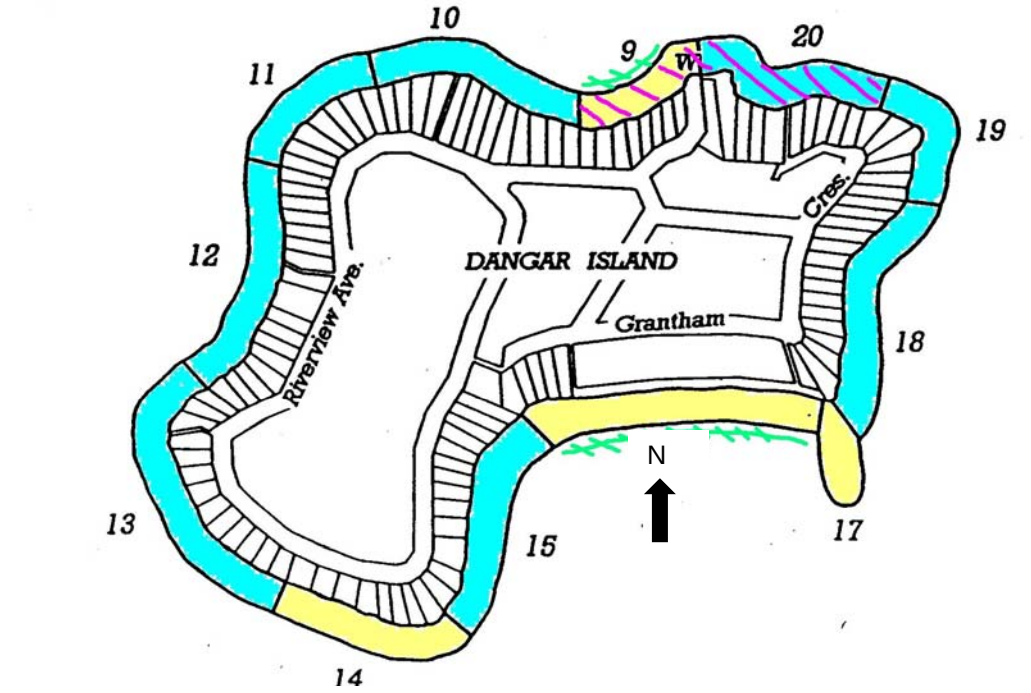

Figure 4-4 Mapping Area Specific Recomendations from the Lower Hawkesbury Crown Land Assessment

4.3.2 Assessment of Crown Land at Brooklyn

This assessment covers the land within the Sandbrook Inlet and Boat Harbour on the Hawkesbury River at Brooklyn. The assessment area was divided into mapping areas. Each mapping area was examined individually and inventories of the land's attributes and current use patterns taken and recorded on inventory sheets. The capability of the land was then determined and suitable uses for the land identified. All of the Crown Land at Brooklyn was found to have a common suitability for environmental protection and recreational activities varied from area to area.

4.4 Commonwealth Legislation

4.4.1 Environmental Protection and Biodiversity Conservation Act, 1999

Environmental impact assessments for certain activities are required under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (*EPBC Act*). The *EPBC Act* commenced on 16 July 2000 and replaced the *Environmental Protection (Impact of Proposals) Act 1974* (Cth), the Act which formerly set out requirements for environmental assessment in Federal law.

The *EPBC Act* has increased the number of activities that will be subject to environmental assessment and approval by the Commonwealth government, and has given a more important role and broader powers to the Federal Minister for the Environment (the 'Minister').

Under the *EPBC Act*, it is necessary to obtain an approval from the Minister to carry out a 'controlled action'. A controlled action is any action which:

- Is carried out by a Commonwealth government department or authority, or is carried out on Commonwealth land, and is likely to have a significant effect on the environment, or
- The action is likely to have a significant effect on a "matter of national environmental significance". The *EPBC Act* defines matters of national environmental significance as Ramsar wetlands, listed threatened species and communities, World Heritage properties, listed migratory species, the Commonwealth marine environment and nuclear actions (including uranium mining). The Commonwealth may add more matters to this list in future.

There are nine endangered and twenty-nine vulnerable species of flora and fauna listed in the EPBC Act (1999) database occurring within 5 km of Brooklyn. There are also a number of animals protected under other sections of the EPBC Act (1999) including: 3 marine birds; 5 marine species; 6 terrestrial species and 2 wetland bird species covered by the migratory provisions of the Act; and 11 birds; 21 fish and 3 reptiles covered by the marine provisions of the Act (The Ecology Lab 2003).

4.5 Important Planning documents

4.5.1 Hawkesbury Nepean Catchment Blueprint

Catchment Blueprints have been developed for all areas of New South Wales. The purpose of the Blueprints is to establish targets to improve the health of the landscape. The Blueprints were designed to provide focus and direction to individual and community initiatives, help coordinate Government investment, such as extension work and grant funding, and contribute to the implementation of legislation.

The Hawkesbury-Nepean Catchments Blueprint was developed by the former Catchment Management Committee and the Hawkesbury-Nepean Local Government Advisory Group and then progressed by the Hawkesbury-Nepean Catchment Management Board. A Catchment Management Authority has now replaced the Hawkesbury-Nepean Catchment Management Board.

Building on the Catchment Blueprint developed, the Authority will:

- Produce a Catchments Action Plan (CAP) and investment strategies targeting the areas of highest priority;
- Recommend and manage incentive programs aimed at engaging local communities in natural resource management;
- Provide landholders with the information they need to develop property vegetation plans;
- Support Landcare in the catchments including support for the indigenous community;, and
- Provide education and training in natural resource management.

A key management action from the Blueprint is to prepare and implement an Estuary Management Plan (EMP) for the Hawkesbury Estuary incorporating key objectives and actions from Brisbane Waters EMP, Pittwater EMP, Berowra Creek EMP and Brooklyn EMP.

4.5.2 Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves Plan of Management 2002

The Plan of Management was adopted in 2002 and reiterates the significance of Ku-ring-gai Chase National Park and Long Island Nature reserve as part of the National Estate. The overall strategy for the management of theses areas is to:

- Protect the national park and nature reserves from detrimental impacts of fire, weeds, feral animals, pollution, erosion and visitor use impacts through direct control and remediation works and through education of park visitors, stakeholders and neighbours;
- Protect the outstanding scenic values of the national park when viewed from both within and outside the park;
- Maintain and promote selected sites and facilities within the national park, which can cope with the high levels of visitor use;
- Limit facilities to existing developed areas of the national park or park boundaries where possible, rather than further dissecting the park with new developments; and
- Continue to limit access to the nature reserves to protect the nature conservation values for which they were dedicated.

The plan outlines policies and an action framework. Management options developed for the Brooklyn Management Study and Plan have been developed giving due consideration to the Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves Plan of Management.

4.5.3 Brisbane Water National Park Plan of Management

This plan was adopted in October 1992 in accordance with Section 75 of the National Parks and Wildlife Act, 1974. There are a number of policies within the Plan that are relevant to the Brooklyn River Estuary Management Study and Plan. These relate to catchment management in Mullet and Mooney Mooney Creeks, and Aboriginal sites and historic places. These aspects of the plan have been consulted when developing management options for areas of the estuary within or adjacent to Brisbane Waters National Park. In accordance with section 81 of the National Parks and Wildlife

Act, 1974, any operations undertaken within the Brisbane Waters National Park must be in accordance with the Plan of Management.

4.5.4 Sydney Regional Coastal Management Strategy (1998)

The area that the Sydney Regional Coastal Management Strategy covers includes the Hornsby LGA but excludes the Gosford LGA. The strategy aims to protect and conserve terrestrial and marine ecosystems in the study area. It provides a framework intended to guide management and planning. The framework presents an action implementation plan covering the key areas of:

- Water Cycle Management
- Nature Conservation
- Public Access
- Role of Government
- Climate Change
- Cultural Heritage

Each of these areas is directly relevant to the Brooklyn Estuary Management Study and Plan and has been consulted when refining the management options. The development of the Estuary Management Plan itself is an action within the framework.

4.5.5 Kangaroo Point Community Masterplan

The Kangaroo Point Community Masterplan was considered by Hornsby Council at its meeting on 16th March 2005. Council considered two options for the Masterplan, including Option A (no commuter berthing) and Option B (with commuter berthing). Council resolved to adopt Option A and this include:

- Refurbishment or reconstruction on existing footprint of existing disused two storey restaurant-uses may include a variety of prescribed commercial/community uses.
- Public toilets;
- New ramp for access between upper and lower levels in vicinity of existing disused restaurant building;
- Grassed area with picnic tables;
- Children's playground;
- Formalised public parking divided between long stay and short stay parks
- Coach parking;
- Screen planting to mask undesirable views (eg road, telecommunications facility);
- Preservation of existing heritage stone wall;
- Viewing deck;
- Heritage walk circuit;
- Interpretation signs and possibly sculptures; and

- Waste management facilities for visitor rubbish.

The views from Kangaroo Point are a largely valued element of the Masterplan have been taken into consideration in the development of management options for the Brooklyn Estuary management Plan.

4.6 Relevant Policies

4.6.1 NSW State Rivers and Estuaries Policy

The NSW Government has a policy to encourage sustainable development of the natural resources of the States' rivers, estuaries, wetlands and adjacent riverine plains. This is to reduce and where possible halt:

- Declining water quality;
- Loss of riparian vegetation;
- Damage to riverbanks and channels;
- Loss of biodiversity; and
- Declining natural flood mitigation.

The policy also aims to encourage projects and activities, which will restore the quality of the river and estuarine systems such as:

- Rehabilitating remnant habitats;
- Re-establishing vegetation buffer zones adjacent to streams and wetlands;
- Restoring wetland areas;
- Rehabilitation of estuarine foreshores; and
- Ensuring adequate stream flows to maintain aquatic and wetland habitats.

The Rivers and Estuary Policy is underpinned by 10 component policies. Two of these have direct relevance to the Brooklyn Estuary Management Plan Project. These are the Estuary Management Policy and the Wetlands Management Policy.

4.6.2 Estuary Management Policy

The Estuary Management Policy was developed in 1992. This Policy forms part of a suite of catchment management policies and provides for the assessment of all estuarine uses, the resolution of conflicts and the production of a unified and sustainable management plan for each estuary, including remedial works and the redirection of activities, where appropriate. The Policy itself is implemented through the preparation and implementation of Estuary Management Plans such as the Brooklyn Estuary Management Study and Plan.

4.6.3 NSW Coastal Policy 1997

The NSW Coastal Policy is the state governments response to the challenge of achieving a sustainable future for the NSW coastline while balancing environmental, economic, cultural and

recreational needs. The policy presently does not apply to the study area, but is likely to within the next 12 months (see notes on the Coastal Protection Act 1979).

The overriding vision of the 1997 NSW Coastal Policy is the ecological sustainability of the NSW coast and integrated coastal zone management. The policy brings together all planning and management initiatives which are occurring in relation to the coast. To give expression to this vision, nine goals have been adopted which represent a commitment to:

- Protecting, rehabilitating and improving the natural environment;
- Recognising and accommodating the natural processes of the coastal zone;
- Protecting and enhancing the aesthetic qualities of the coastal zone;
- Protecting and conserving the cultural heritage of the coastal zone;
- Providing for ecologically sustainable development and use of resources;
- Providing for ecologically sustainable human settlement in the coastal zone;
- Providing for appropriate public access and use;
- Providing information to enable effective management of the coastal zone; and
- Providing for the integrated planning and management of the coastal zone.

The Coastal Policy also contains a large number of strategic actions relating to coastal planning and management. Some of the policy's more important provisions were given stronger statutory backing by elements of the NSW Coastal Package. These included the introduction of *State Environmental Planning Policy No. 71—Coastal Protectio*n.

4.6.4 Flood Prone Land Policy

The primary objective of the NSW Governments Flood Prone Land Policy is to reduce the impacts of flooding on individual owners and occupiers of flood prone land, and to reduce private and public losses caused by flooding. The policy provides for financial assistance, technical support, emergency management and protection against liability.

Flooding has not been identified as a major issue for the Brooklyn Estuary.

4.7 Research / reports

4.7.1 Healthy Rivers Commission Reports

4.7.1.1 HRC Review of the Relationship between Healthy Oysters and Healthy Rivers

The Healthy Rivers Commission Report on the relationship between Healthy Oysters and Healthy Rivers recognises the social and economic importance of the oyster industry. The review also recognises the role of oysters as critical indicators of river health.

A key finding of the report that is relevant to the Brooklyn Estuary Management Study and Plan is that there is at present no explicit link between the aquaculture industry development plans and other land and water planning and management in NSW.

The Report contains five recommendations that the Commission considers are essential to the maintenance of healthy oyster growing catchments. These recommendations relate to all waterways where oyster cultivation for human consumption occurs or might be expected to occur in the future.

The recommendations involve:

- Determination of locations where oyster growing is a priority intended outcome and formalisation of these areas via inclusion in a statutory instrument;
- For areas where oyster growing is a priority intended outcome:
    - Directing of regional and local planning processes to achieve this outcome; (NB: this includes Estuary Management Plans)
    - Internalisation of the costs of new development to achieve this outcome;
    - Equitable cost sharing arrangements for existing land and water uses to achieve this outcome; and
- Government interaction with the oyster industry to ensure greater viability of the industry.

In relation to the development of the Brooklyn Estuary Management Study and Plan, the report notes that measures to safeguard river health to allow for oyster cultivation for human consumption will also provide river health for aquatic ecosystem protection and primary contact recreation, both typical objectives for estuarine waters.

4.7.1.2 HRC Independent enquiry into the Hawkesbury Nepean River System

Between 1997 and 1999, the NSW Healthy Rivers Commission conducted a public inquiry into the health of the Hawkesbury Nepean River system. The inquiry found that, while the many parts of the system are in good health, smaller parts of the river system are in relatively poor condition. This includes streams in and below major urban centres (such as Hornsby and Penrith), and the Hawkesbury River from Windsor to Sackville.

The report focuses on management of the whole river system and identifies key actions to achieve a healthier river. Of interest to the current studies are the recommendations for certain river wide issues. For example the issue of boating wastewater discharge is discussed.

A key recommendation of the Healthy River Commission Inquiry is the need for a system-based view of the catchment in river management. This level of management is expected to be established through the recently formed Hawkesbury Nepean Catchment Management Authority.

On 29 February 2000, the New South Wales Government made decisions in respect of the Commission's findings and recommendations in those Reports. In its decision, the Government endorsed many of the recommendations of the Commission and in other instances determined an alternative strategy for addressing the Commission's findings. A Statement of Joint Intent (SOJI) to

record the commitments of State agencies and relevant Councils and to implement the endorsed recommendations of the Commission was developed.

4.7.1.3 HRC Securing Healthy Coastal Rivers: A Strategic Perspective

Through the Healthy Rivers Commission Inquiries for individual River systems, a number of generic issues and resulting management challenges were found to be relevant for all Coastal Rivers. In summary, the common principles, that could be applied to the Brooklyn Estuary Management Study and Plan are:

- Rivers must be managed as whole systems;
- Rivers must be treated as assets with productive values to be sustained by carefully directed management and maintenance. Decisions about these must be governed by realistic assessments of their capabilities and recognition of their limitations;
- Management Plans must be more rigorous, more directive, and create obligations on the entities that possess powers and resources that can be applied to river management;
- Entities with river management responsibilities powers and resources must be accountable and answerable for the condition of rivers at the conclusion of each cycle of planning, action and assessment. The accountable entity must be answerable for the proper implementation of agreed management processes, where actual river outcomes are subject to a variety of uncontrollable external outcomes.
- Government and communities must meet their obligations within explicit partnership arrangements for river management, based on unambiguous statements of their respective roles and responsibilities.
- Well-designed strategies for managing rivers will inevitably involve an adaptive approach, given the inherent uncertainties and lack of information on many matters.

4.8 Existing initiatives

4.8.1 Hawkesbury Lower Nepean Riverbank Management Program- Extension to Brooklyn (NHT 2 Project)

This program is primarily focussed on riparian rehabilitation and weed control. In the past the program has worked with landholders to restore riverbanks and riparian vegetation. Typically, an assigned Riverbank Officer works with the property owner to devise a riverbank management plan. This is then implemented using about 50% contract labour paid for by the CMA and 50% volunteer labour supplied by the landholder. There is at least one example in the Windsor area where publicly owned land has been rehabilitated in this manner. This included a partnership with Hornsby Council.

In the past the focus has been areas around Windsor, however, areas closer to the Brooklyn Estuary have been opportunistically included. The latest NHT2 funding grant officially extends the program to Brooklyn. This program extends the successful Hawkesbury-Nepean Riverbank Management Program from Windsor to Brooklyn and the Colo River. It works with landholders to restore riverbanks and riparian vegetation.

4.8.2 River Health Strategy for the Hawkesbury River

An investment strategy prepared by the Hawkesbury Nepean Catchment Management Authority (yet to be approved) allows for NHT funds to be directed towards estuary projects. The initiative will likely involve the employment of a Community Support Officer to facilitate the distribution of funds. The priority areas for the funds will be strategies in finalised Estuary Management Plans that focus on saltmarsh rehabilitation and cleanup of rubbish throughout the estuary (including oyster leases and derelict boats).

Table 4-1 Summary of legislative requirements

Legislation or planning document	Relevant to study area	Action
Environmental Planning and Assessment Act 1979	Yes	• Is development consent required? • If yes is it-designated development? • Where development consent not required assess if significant impact on environment (Part 5) • Consider contributions plans
SEPP 62	Not relevant	No Action
SEPP 71	Currently not applicable but likely to be during the Plan implementation phase	• If Coastal zone has been declared for Sydney metrop - Would option be classified as State Significant Development, Significant Coastal Development or Development in Sensitive Coastal Locations?
SEPP 14	Some SEPP 14 Wetlands in wider catchment-unlikely to be a major consideration in this study	No action
SEPP 26	Not applicable to study area	No action
SEPP 35	Not applicable (due to SREP 20)	No action
SEPP 44	Yes- applies to entire study area, except National Parks and State Forests	Unlikely to be a major consideration for estuary management options Is option likely to impact on Koala habitat?
SREP 20	Applicable to entire study area	Refer to planning considerations and development controls for all management options to insure consistency and integration
Rivers and Foreshore Improvement Act 1948	Applicable at time of writing- due to be repealed and replaced by water management act at some unspecified future date	Determine if permit is required for management options
SREP 6	Does not apply to study area	No Action
Water Management	Provisions for approvals of controlled activities not in force at time of writing	Determine if management options would be controlled

Legislation or planning document	Relevant to study area	Action
Act 2000	but due to replace the Rivers and Foreshores Improvement Act permits at an unspecified future date	activities
Hawkesbury Nepean Catchment Blueprint	Relevant to study area – currently being incorporated to the new Catchment Action Plan	Look for opportunities for integration Ensure consistency
Crown Lands Assessment for the Lower Hawkesbury River	Relevant to area below Mean High Water Mark adjoining freehold residential lands fronting Dangar Island and Milsons passage	Ensure management options are consistent with Crown Lands Assessment recommendations.
Hornsby Shire Dangar Development Control Plan	Applies to Dangar Island	Ensure management options for Dangar Island are consistent with the prescriptive measures of the DCP
Hornsby Shire Sustainable Water Development Control Plan	Applicable to all areas covered by Hornsby LEP	Ensure consistency with prescriptive measures for management options likely to impact on water issues.
Hornsby Shire Heritage Development Control Plan	Relates to heritage items within the study area- unlikely to be a major consideration for the development of management options	Investigate if option is related to a heritage item
Hornsby Shire Brooklyn Development Control Plan	Covers Brooklyn and environs	Check each management option is consistent with the planning strategies and development controls
Sydney Regional Coastal Management Strategy	Relevant to Hornsby LGA	Implementation Plan should be reviewed for potential management options Ensure management options are consistent
Coastal Protection Act 1979	Currently not applicable but likely to be during the Plan implementation phase	Determine if part 3 of the act would apply
Local Government Act	Yes	Investigate funding options and orders and enforcement to work in with management options
Fisheries Management Act	Yes	Consider fish habitat protection plans in developing management options Assess need for permit for dredging/reclamation or

Legislation or planning document	Relevant to study area	Action
		damage to marine vegetation
Threatened Species Conservation Act 1997	Yes	Assess management options potential to harm any animal or plant that is a threatened species, population or ecological community
B*risbane Water National Park Plan of Management*	Yes	Assess management options proposed within or adjacent to the Brisbane Water National Park for consistency with Plan of Management
Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves Plan of Management	Yes	Assess management options proposed within or adjacent to the Ku-ring-gai Chase National Park and Long Island Nature Reserve for consistency with Plan of Management
Gosford DCP 89 Scenic Quality	Yes	Is the option relevant to Gosford LGA? Is development consent required? If so consider provisions of DCP 89.
HRC Report on Healthy Oysters and Healthy Rivers	Yes	No statutory obligation-

5 CURRENT LANDUSE AND FUTURE DEVELOPMENT POTENTIAL

5.1 The bed of the Brooklyn Estuary

5.1.1 Current Land Use

Oyster leases are prevalent throughout the study area from Mooney Mooney Point to Croppy Point. This includes leases within Sandbrook Inlet, Brooklyn Harbour and along Mooney Mooney and Mullet Creeks. Infrastructure including oyster depots and purification tanks are located in the eastern end of Sandbrook Inlet and at Mooney Mooney (WRL, 2003). Long timber jetties facilitate water access and provide moorings (WRL, 2003; PWD, 1988). The oyster farmers transport materials to and from oyster leases in shallow draft punts. The current outbreak of QX oyster disease is discussed in Section 6.6.4.5.

Some waterfront residents within the study area are permitted to erect structures on the foreshore subject to payment of a levy. Jetty construction of this nature is carried out in accordance with the appropriate Crown Land Assessment and may be withdrawn at any time.

Public wharves are available for short term mooring and passenger access at Kangaroo Point, the Brooklyn Wharf, Dangar Island, Little Wobby Beach and Mooney Mooney (WRL, 2003). The wharf at Kangaroo Point is also used by charter and cruise boats to pick up passengers. Brooklyn wharf is used by ferries taking passengers to Dangar Island (WRL, 2003). There are floating pontoons for public use at Parsley Bay (2) and McKell Park. Public boat launching ramps are also provided at Parsley Bay, Mooney Mooney Point and Kangaroo Point.

NSW Maritime and private marinas administer a combined total of five hundred and fifty moorings located at Sandbrook Inlet, Pasley Bay, Brooklyn Harbour, Mooney Mooney, Dangar Island, Little Wobby and Cogra Bay (WRL, 2003). The majority of these are swing moorings. There are 7 marinas in the study area, comprising Dolphin Boatshed Marina, Hawkesbury River Marina, Fenwicks Marina, Brooklyn Marina, Wharf street Marina, Browns Boatyard and Sandbrook Inlet Marina

Several areas within the Brooklyn Estuary, including Brooklyn Harbour and Parsley Bay, have been dredged in the past to facilitate vessel navigation.

5.1.2 Ownership

The bed of the estuary is owned by the State of NSW. The Crown Lands Act states that it is an offence to 'clear, dig up or cultivate public land' or 'interfere with any substance, whether on or in, or forming part of, public land,' without a licence or lease granted under the Act.

5.1.3 Zoning

Gosford LEP adopts clause 31 of the Environmental Planning and Assessment Model Provisions 1980 requiring development consent for any development below high water mark. Thus, estuarine waters within council's area are normally subject to planning controls.

The Crown Lands Assessment is discussed in Section 4.3.

5.1.4 Impacts of existing Land uses

During the community consultation, some claims were made regarding the impacts of oyster leases on sedimentation rates. Any increases in sedimentation as a result of aquaculture have not been verified or quantified while anecdotal evidence suggests that the leases have no impact on sedimentation of the estuary. As farmed oysters require good water quality, they play an important role as indicators of estuary health.

The construction of jetties have been associated with a reduction in seagrass distribution due to shading (see Fisheries Habitat Protection Plan No. 2). Note that overall, the cover of seagrasses in the study area has increased in the last 16 years (refer to Section 2.5).

Moorings impact on navigation and visual amenity. They may also influence seagrass distribution through shading and dragging of mooring chains on the bed.

The impacts of marinas on the bed of the estuary may include accumulation of metals such as copper, reduced seagrass due to shading and small scale dredging, which can result in turbidity problems, the release of contaminants and further disturbance of seagrass beds.

5.1.5 Development Potential

The Crown Lands Act specifies the following principles for Crown land management:

- Environmental protection principles are to be observed in relation to the management and administration of Crown land;
- Natural resources of Crown land (including water, soil, flora, fauna and scenic quality) are to be conserved wherever possible;
- Public use and enjoyment of appropriate Crown land is to be encouraged;
- Where appropriate, multiple use of Crown land is to be encouraged;
- Where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity; and
- Crown land is to be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.

Future development potential for the bed of the estuary below high water mark could include boat ramps, jetties, marinas and reclamation. These would all require land owners' consent. Under the Crown Lands Act, a land assessment sets out recommendations for the reservation, dedication, exchange, vesting or sale of Crown land, or the granting of easements, leases or licences in respect of such land. The Crown Lands Assessment for the Lower Hawkesbury has considerable restraints on the granting of new leases for jetty construction within the study area. This assessment has been reviewed as a part of the Estuary Management Study and Plan. Please refer to Section 4.3 for further discussion.

Brooklyn Development Control Plan includes a jetty limit line for Sandbrook Inlet.

5.2 National Parks and Nature Reserve

5.2.1 Ownership

The Department of Environment and Conservation (National Parks Services) manages the National Parks and Nature Reserves, which are retained as Crown Land. The land is managed through Plans of Management, the requirements for which are set out in the National Parks and Wildlife Act, 1974 (refer to section 5.2.3).

5.2.2 Impacts of existing land uses

The National Parks areas are mostly bushland and as such are usually a positive influence on the Brooklyn Estuary. Sources of impacts from the National Parks include:

- Runoff from very large fire events, which may contribute to sedimentation;
- Runoff from paved road areas; and
- Pollution from on-site toilet, camping and picnicking activities.

The Nature Reserve areas are not likely to have any adverse impacts on the study area.

5.2.3 Development Potential

The future management of Brisbane Water National Park, Ku-ring-gai Chase National Park, Long Island Nature Reserve and Spectacle Island Nature Reserve is outlined in the relevant National Parks Plans of Management prepared for these areas. These Plans of Management are statutory documents prepared under section 81 of the National Parks and Wildlife Act 1974.

The Brisbane Water National Park Plan of Management was developed in 1992 with a planned lifespan of about ten years. Discussions with the Gosford Office of the NPWS indicate that the scale and nature of development described in the POM would not alter in the foreseeable future. The western section of the Brisbane Water National Park including the Mooney Mooney Valley and much of the plateau between Mooney Mooney and Mullet Creeks has remained undeveloped and is used by bushwalkers and sometimes pack campers. The area is less subject to hazard reduction burns as it is far enough away from development not to pose a risk. The Plan of Management allows for additional bush walking and picnicking opportunities and the possibility for small-scale campsites.

The Plan of Management for the Ku-ring-gai Chase National Park and Long Island and Spectacle Island Nature Reserves was published in May 2002.

The Ku-ring-gai Chase National Park covers 14,882 hectares and contains a range of facilities such as picnic areas, boat launching ramps, boat moorings, marinas, restaurants, campsites, visitor centres and walking tracks. Recreational use and future development will focus on existing visitor use areas.

Public access to Long Island and Spectacle Island will continue to require a permit and be for the primary purposes of conservation and research.

5.3 Gosford LGA

5.3.1 Land use

Landuse zoning is described in Section 4.1.1.2. Most of the area adjacent to the Brooklyn Estuary on the northern side of the river is National Park. The remainder includes bushland, agricultural land, urban areas and some industrial land. There are also two dams on Mooney Mooney Creek.

A comparison of the land use maps presented in the Estuary Process study report (WRL, 2003) and recent rectified aerial photography shows that since the maps were produced in the early 1980s, some land clearing has occurred (particularly in the areas presently zoned Non Urban 1a). These areas are shown in Figure 5.1.

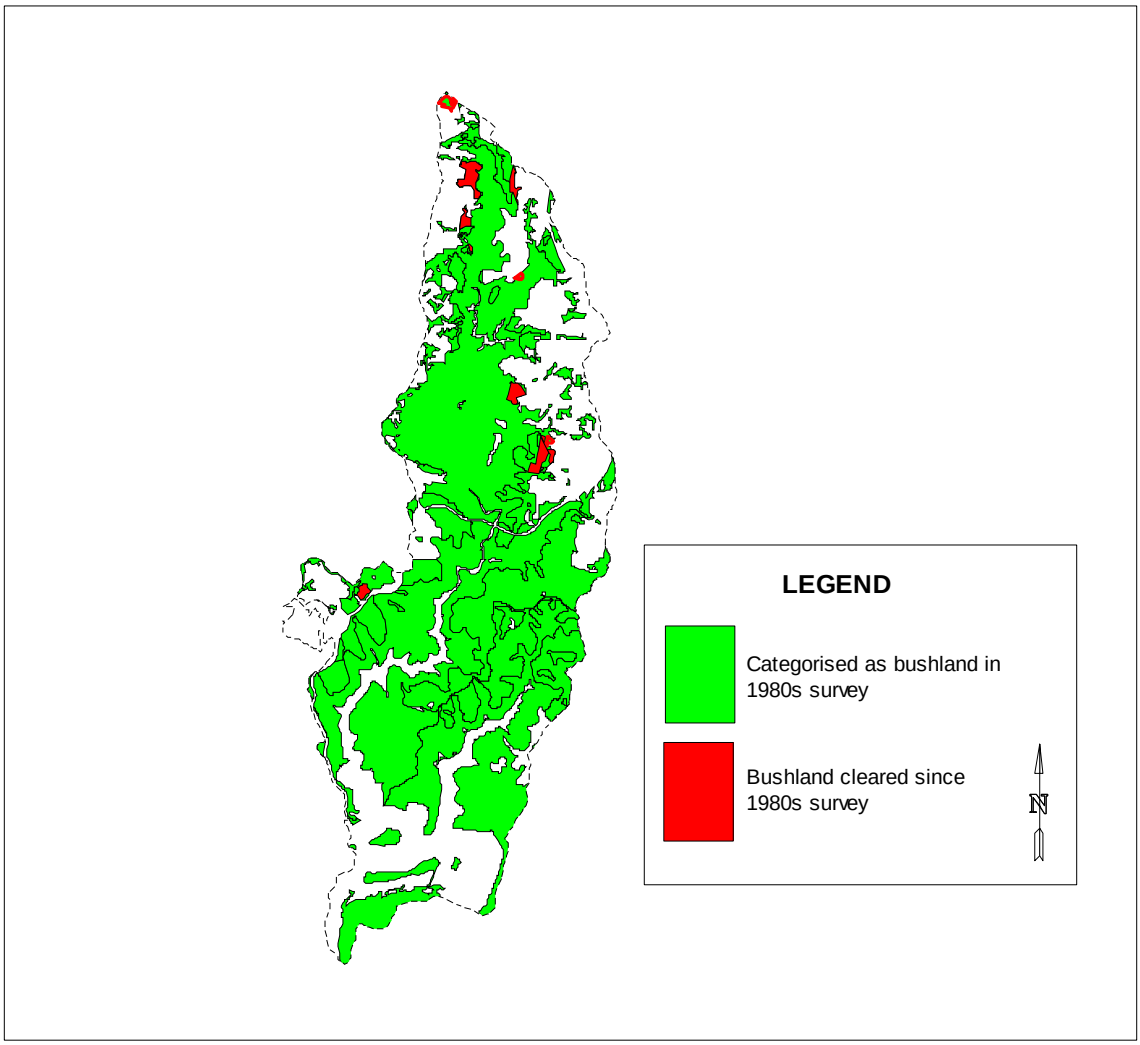

Figure 5-1 Bushland cleared since the 1980s Landuse Survey

5.3.2 Development Potential

Although some restricted development may occur in the Conservation and Scenic Protection zones, this is likely to be low key and not have a significant impact on estuarine processes. Nonetheless piecemeal impacts of cumulative small development need to be considered. Minimum lot sizes in the Environmental Conservation zones (7a) are 40 hectares and permissible developments include home occupation and a small scale bed and breakfast. Agriculture is permitted, however, extremely unlikely given the nature of the land. Construction of dams is permitted.

The areas with potential for future development are most likely those bushland areas that are zoned industrial and non urban in the upper reaches of the catchment. Development permitted without consent in the Non Urban zones includes agriculture. Agricultural and Industrial land uses have the potential to impact on estuary processes significantly compared to the current land use as bushland. There are no plans at this stage to increase the areas zoned for industrial or agricultural purposes (Bruce Ronan GCC pers comm. 2004).

5.4 Hornsby LGA

5.4.1 Land use

The zoning for the Hornsby LGA is described in section 4.1.1.1. The majority of the Hornsby LGA side of the catchment is also National Park. The developed areas are concentrated around Brooklyn and Dangar Island and consist mostly of residential and small business development.

5.4.2 Development Potential

There is little opportunity for greenfield development on the Hornsby LGA side of the Brooklyn Estuary, however, the area's proximity to the rapidly increasing population centre of Sydney means there will be increasing pressure for the intensification of existing development. There are already a number of multistorey residences replacing traditional riverside cottages. Construction includes a Sewage Treatment Plant (STP) at the 'Old Dairy Site' located at the headwaters of Seymours Creek.

6 SIGNIFICANCE, VALUES AND ISSUES OF CONCERN

6.1 National Significance of the Estuary

The national significance of the Brooklyn Estuary is demonstrated by the inclusion of Ku-ring-gai Chase National Park, Long Island and Spectacle Island and the old Hawkesbury River Rail Bridge on the Register of the National Estate. The Australian Heritage Commission has compiled this Register of places of natural, historic and indigenous significance since 1976.

Ku-ring-gai Chase National Park is listed for its aesthetic value, scientific value as a remnant of the natural environment of Sydney and for the number of Aboriginal sites it contains (NPWS 2002). Long Island is listed for the variation and distinctive characteristics of its vegetation, and Spectacle Island for its particularly diverse vegetation (NPWS 2002). The old Hawkesbury River Rail Bridge is also listed for the technical accomplishment it represents, as at the time of construction it was the largest bridge then built in Australia (Department of Environment and Heritage, 2004).

The Brooklyn Estuary may also provide habitat to fauna of national significance, listed in the Environmental Protection and Biodiversity Conservation Act 1999. The Ecology Lab (2003) identified the following three species of bird covered by the migratory provisions of the Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) that are likely to be found in the Brooklyn estuary:

- The southern giant petrel (*Marcronectes giganteus*);
- The northern giant petrel (*Macronectes halli*);and
- The shy albatross (*Thalassarche cauta*)

6.2 State Significance

From an environmental perspective, the state significance of the Brooklyn Estuary includes its role as habitat for threatened species. This includes species listed as endangered under the NSW *Threatened Species Conservation Act* 1995 found in the estuary, such as the bush-stone curlew (*Burhinus grallarius*), little tern (*Sterna albifrons*), regent honeyeater (*Xanthomyza phrygia*), Goulds petrel (*Pterodroma leucoptera*), and swift parrot (*Latahmus discolor*). Threatened Ecological Communities listed under the *Threatened Species Conservation Act* 1995 found in the study area include coastal saltmarsh..

From an economic perspective, the contribution of the Brooklyn Estuary to oyster farming in NSW is significant. The NSW oyster industry is the state's most valuable fishery (HRC, 2003). The Healthy Rivers Commission reported that the NSW industry produces about 90 million oysters worth about 30 million dollars per year at the farm gate (HRC, 2003). The Hawkesbury River is the second most significant contributor to NSW oyster production. The entire estuary contributed about 13% of the state's oyster production for the years 1995 to 2000 (HRC 2003). The recent devastating outbreak of QX disease threatens to reduce this (refer to Section 6.6.4.5).

The Koala habitat identified in SEPP 44 (refer to Section 4.1.3.4) has state significance.

6.3 Regional Significance

From a regional perspective the National Parks and Nature Reserves of the Brooklyn estuary are important components of a system of nature reserves and national parks that protect the nature conservation and heritage values of the Lower Hawkesbury River (NPWS 2000).

The estuary is highly valued as an area of natural beauty and recreational potential that is very close and accessible to Sydney.

6.4 Local Significance

The Brooklyn Estuary dominates the local community, both geographically and culturally. Whether it is for economic or lifestyle reasons, the estuary is the primary reason that most people choose to visit or live in the riverside villages of Brooklyn, Dangar Island, Wobby Beach, Mooney Mooney and Cheero Point.

The Brooklyn Estuary is locally significant in its role as a transport medium, a habitat for native animals and plants, a source of food and livelihoods, a provider of recreational opportunities and views, and a link to Aboriginal and European heritage.

6.5 Values of the Estuary

There was no shortage of information provided by community consultation participants on the values of the Brooklyn estuary. All participants were passionate about the estuary and the need to preserve its values for future generations.

The values of the Brooklyn Estuary most frequently discussed are described in the following sections.

6.5.1 Environmental Qualities

Environmental qualities were identified by the local community as the most valued aspect of the Brooklyn Estuary (WBM 2004). Within the community questionnaire, "Native animals and plants" were rated as the most valued aspect of the Brooklyn Estuary. Other environmental qualities, including National Parks, clean water, healthy fisheries, biological diversity, natural processes and overall estuarine health were also important to the community and stakeholders. It is appreciated by the community and stakeholders that a healthy and sustainable environment is critical to the social and economic viability of life on the Brooklyn Estuary.

6.5.2 Access

The ease by which the estuary can be reached by road and rail from both Sydney and the Central Coast/Newcastle Region is considered a major asset for the area. The estuary also provides the only access links between the offshore communities and the mainland (at Brooklyn).

6.5.3 Character

The peaceful riverside village atmosphere of Brooklyn and associated offshore communities is highly valued by most stakeholders. This includes the heritage values in terms of both Aboriginal and more

recent European history that are unique to the area. Many people also value the views to the waterway and National Park ridges. The uncrowded and less developed nature of the area accompanied by the diversity of river traffic is seen as an important aspect of this character. Traditions of oyster farming and fishing were also seen by some as an essential part of Brooklyn's character.

6.5.4 Recreational Opportunities

The choice of boating grounds including open water, small bays and creeks makes the Brooklyn Estuary a valued destination for the recreating public. As the community questionnaire showed, the most common activities include boating, bushwalking, fishing and picnicking (WBM, 2004). The riverside restaurants and cafes are also valued by day tourists to the area.

6.5.5 Community

Stakeholders value the nature of the community itself. This was found to be relevant from the perspective of residents who thought it was a great place to live and also from the perspective of government agencies who valued the community interest, knowledge and involvement in the estuary.

6.5.6 Income from the estuary

Income from the estuary includes oyster farming and fishing, seafood supply, tourism and the boating industry. It is interesting to note from the community questionnaire that income from the estuary, including tourism was the least valued aspect of the estuary. The targeted stakeholder consultation, however showed that aspects such as tourism and income from the estuary were highly valued by parties with an economic stake in the estuary.

The information provided by respondents on occupation was not sufficiently detailed to assess the proportion of respondents earning an income from the estuary.

6.6 Issues and Concerns

The issues raised through the consultation process (as discussed in WBM 2004) are detailed in the following sections.

The issues have been divided into separate categories which are largely inter-related and co-dependent. The issues are presented in no particular order of importance.

6.6.1 Ecosystems and Biodiversity

6.6.1.1 Data on Fisheries

A number of issues raised related to the availability of data on the fisheries of the estuary.

It was suggested that data on recreational fish takes are limited making it difficult to estimate the impacts of recreational fishing. Data concerning recreational fishing in the Brooklyn River Estuary Processes Study includes an un-referenced "best estimate" of catches from recreational fishing for the entire Hawkesbury estuary and a comment on the high compliance rates for recreational fishers

approached by Fisheries Officers. More detailed data is given for commercial fishing takes, which is based on information presented in the *NSW Commercial Fisheries Data Report* (cited in WRL, 2003).

It was also claimed that bag limits were too high. An example given was the bag limit of 20 Blue Swimmer Crabs.

The issue of the impact of prawn trawling on benthic invertebrates was also raised. Ecological studies undertaken for the Estuary Processes Study (WRL, 2003) indicated that an overall increase in mobile invertebrate numbers in the estuary over time was observed. As this was found at all sites it is most likely attributed to a recruitment episode or seasonal variation. Benthic invertebrates from the fringing mangrove areas were also sampled and no evidence was found to suggest that they were depauperate at the locations sampled.

6.6.1.2 Reduced abundances and diversity of native fauna

There is anecdotal evidence from the local community and stakeholder groups of a decline in both biodiversity and species abundance. Examples given include Blue Swimmer Crabs, cormorants and other native birds.

6.6.1.3 Estuarine Health

Many respondents to the community questionnaire are concerned about estuarine health. While there is no widely accepted and measurable definition of estuarine health, it is generally taken to mean the overall condition or wellbeing of the estuary. This includes both the occurrence of certain attributes that are deemed to be present in a healthy, sustainable resource, and the absence of conditions that result from known stresses or problems affecting the resource.

In the context of this study, ecological health includes the maintenance of:

- Ecological processes, including for example, water and nutrient flows, community structures and food webs;
- Terrestrial and aquatic biological diversity; and
- Viable populations of native species.

Indicators of ecological health for the Brooklyn Estuary could include seagrass distribution and condition, nutrient levels, faecal coliform data and higher trophic level indicator organisms, such as fish.

6.6.1.4 Increase in marine influence on biota

Changes in the distribution of aquatic biota in response to reduced environmental flows have been reported anecdotally by the community. While only qualitative data are available, basal environmental flows have important implications for many estuarine processes including deposition, re-suspension and transport of sediment.

6.6.2 Public Access and Recreational Amenity

6.6.2.1 Car parking

Car parking was one of the issues most raised by respondents to the community consultation. Many respondents stated that there was often no parking at all near the Brooklyn town centre. One frequently raised viewpoint was the frustration with those residents living upriver or those providing tourist facilities offshore, resulting in vehicles parked for long periods of time and making it difficult for day tourists to Brooklyn and other residents to obtain a parking space. This was referred to by one respondent as "doormat" use of Brooklyn.

Those living on Dangar Island also expressed some frustration with the McKell car park often being full.

There is also an issue related to loss of valuable public space along the foreshore to car parking facilities. The most cited example of this is the area at Kangaroo Point, which has scenic, heritage and recreational value to the local community.

6.6.2.2 Dinghy Storage

Dinghy storage is an issue for commuters from Dangar Island and also those with moored boats. At present an informal arrangement exists where some Dangar Island residents and owners of moored vessels store dinghies against the natural rock wall close to the shore at Parsley Bay. Dinghy storage is also an issue at the end of Baden Powell Ave, Brooklyn. A co-op for the storage of dinghies for offshore residents is located near McKell park.

6.6.2.3 The McKell Park Proposal

Two separate Environmental Impact Statements (EIS's) have been prepared by Patterson Britton and Partners for Maintenance Dredging of Brooklyn Harbour, and Reclamation of McKell Park, Brooklyn (PBP, 2003a, 2003b). One aim of the project is to provide more parking facilities close to the public wharf.

There were a variety of issues raised through the community consultation process relating to the McKell Park proposal. Some respondents were particularly keen for the proposal to go ahead and were concerned that the present study would delay the project. Others thought that the site at McKell Park was too constrained and that a more suitable site should be located (eg Western side of causeway).

Other groups were concerned about the environmental impacts of dredging such fine sediments on water quality and disposing of these near wetland areas, in particular Endangered Ecological Wetland communities listed in the *Threatened Species Conservation Act 1995*, occurring in the vicinity..

One of the objectives developed for this Estuary Management Study is to prevent car parking from monopolising open space in the study area (refer to Section 7). If the decision is made to increase car-parking facilities, the option of using existing sites and minimising the footprint with deck style parking may be more appropriate than reclamation.

6.6.2.4 Mooring Arrangements

Issues associated with mooring arrangements have been raised from many viewpoints.

Some are concerned with the scenic impacts of Sandbrook Inlet, which they claim is cluttered with boats. It is argued that this is contrary to the values and goals espoused in SREP 20.

It was also noted that some older residents of Dangar Island would be unable to afford moorings provided by Marinas or Co-ops. These people will often moor their boats illegally at places such as near the seawall in Brooklyn Harbour. Access to boats here can be quite dangerous.

Some people believe that moorings in Parsley Bay and Sandbrook Inlet occupy areas beyond navigation marks within channels and pose a risk to navigation. NSW Maritime advised that during certain weather conditions, vessels may swing from inside mooring areas into the fairway. In this circumstance it is the responsibility of vessel operators to maintain a safe speed and avoid collision.

The current ceiling for mooring sites in Sandbrook Inlet is 280 (this was reduced from 302 in 2002) (Paul Scurry NSW Maritime, Pers. Comm.. 2005). NSW Maritime advised that, recently, they had undertaken to remove abandoned vessels in association with DEC (NPWS).

6.6.2.5 Erosion and degradation on railway land and the causeway

Significant erosion is apparent along the entire eastern side of the causeway. The area is sparsely vegetated with weed species such as lantana.

6.6.2.6 Littering

Littering from both boats and foreshore activities (including households) is an issue throughout the estuary. This includes rubbish such as bottles and food wrappings, old tyres and sticks from old oyster leases. There is reportedly a lack of garbage bins in key areas used by weekend fishermen along the foreshores.

6.6.2.7 Nature of development on Dangar Island

There is concern among the community about the robustness of the Hornsby Local Environmental Plan in upholding the values espoused in Sydney Regional Environmental Plan 20 (SREP 20). The Plan sets out general planning considerations, specific planning policies and recommended strategies. These must be taken into account in the preparation of environmental plans and also by consent authorities in assessing development applications.

Specific issues raised include the nature of development being approved on Dangar Island. An example of this is the approval of the redevelopment of Number 82 Riverview Avenue. Many residents feel that this proposal is not consistent with the landscape character outlined in SREP 20. Approval of the development is considered by some to have been dependent on a loophole in the Development Control Plan. It has been suggested that this matter needs to be addressed before further inappropriate development occurs on Dangar Island.

6.6.2.8 Noise pollution from boats

A number of residents raised the issue of noise pollution from the recreational boats.

6.6.2.9 Heritage

The heritage of the Brooklyn area is considered to be undervalued by some. This includes sites such as the abandoned rail station on the eastern end of Long Island. There are also reportedly a number of significant Aboriginal sites surrounding the Brooklyn Estuary.

6.6.2.10 Derelict Boats within Sandbrook Inlet

There are a number of boats within Sandbrook Inlet that are derelict. Some of these (approximately 5) have washed off their moorings and are derelict on either the shores of Long Island or Brooklyn. Others remain on their moorings but have clearly not been maintained for a very long time. Derelict boats pose a safety, visual and water quality impact.

NSW Maritime advised that, in conjunction with the Department of Environment and Conservation (NPWS), they are in the process of removing abandoned and derelict boats in Sandbrook Inlet and along Long Island foreshore. NSW Maritime also suggested that some of the vessels that may be perceived as derelict are in fact registered and occupying legal moorings. In these cases the vessels are generally undergoing, or are planned for, refurbishment. NSW Maritime considers that in most cases, these vessels still fit with the character of the area.

6.6.2.11 Foreshore Access

Brooklyn is very accessible by both rail and road infrastructure. However, once at Brooklyn there are limited opportunities for foreshore activities such as picnics and BBQs, fishing (from wharves, for example) and walking. This aspect was raised as an issue by many participants of the community consultation and was observable to the study team during the site visits.

6.6.2.12 Public Wharves

Public wharves are located at Kangaroo Point, Brooklyn Harbour and on Dangar Island. Disabled access is not provided at any of these facilities. This is of particular importance as many elderly and infirm visitors to the area participate in day-cruises that launch from these wharves.

The Public Wharf at Kangaroo Point is being upgraded to a floating pontoon and ramp as part of the Kangaroo Point Community Masterplan (refer to Section 4.5.5).

A proposal has been submitted to council for a commuter jetty on Dangar Island. This proposal does not meet the present recommendations of the Lower Hawkesbury River Crown Lands Assessment, but it does flag the demand for additional commuter facilities at Dangar Island. The Crown Lands Assessment has been reviewed as a part of this Estuary Management Study.

6.6.2.13 Jetty Limits in Sandbrook Inlet

A number of respondents also raised the issue of the Jetty Limits prescribed in the Brooklyn DCP. Although the DCP outlines the reason for limiting jetty length as visual amenity considerations, the

line was supposedly developed by NSW Maritime to facilitate a plan to dredge the channel and move moorings that never eventuated. This issue also interrelates with the sedimentation issues, as the jetties are presently limited by increasingly shallowing water depths.

6.6.3 Water Quality

6.6.3.1 Proposed Reticulated Sewerage System

Under recent initiatives by the NSW Government, a reticulated sewerage service has been proposed for existing urban zoned lands within Brooklyn, Dangar Island, Mooney Mooney and Cheero Point. The proposal is being considered by Sydney Water, as part of their Priority Sewerage Program (PSP), and Gosford City Council (GCC), under the Small Towns Sewerage Policy and the Country Towns Water Supply and Sewerage Program.

A number of viewpoints related to the preferred strategy for improved sewage services for Brooklyn, Dangar Island, Mooney Mooney and Cheero Point have been raised during the consultation.

Many people welcome the connection and are concerned at ongoing delays. This includes those that are currently paying for expensive pump-out services.

With over 40 Sewerage Treatment Plants (STPs) discharging into the Hawkesbury Nepean River System already (WRL, 2003), there is concern among the community regarding the impact of an additional outfall beneath the F3 Freeway Bridge. It was suggested that the estuarine system might already be close to its carrying capacity in terms of sewerage outfalls. Alternative suggestions include reusing the treated effluent in a dual reticulation system (like that at Rouse Hill) or using a different outfall site closer to the sea.

A concern was also raised that even if the latest proposal is implemented there will be places along the river such as Milsons Passage, Sunny Corner and Melvys Wharf where on-site system remain in place and continue to impact on water quality.

There was a group of respondents who felt that the existing system could be adequate, if coupled with ongoing education, regular inspections and gradual replacement with the latest onsite treatment technology.

6.6.3.2 Pump out Facilities

Many respondents raised the issue of the inaccessibility of pump out facilities for large vessels and yachts around the Brooklyn area. The Estuary Processes Study reported that pump-out facilities at Kangaroo Point and Holidays Afloat Houseboats in Brooklyn provided an easily accessible means of legal and environmentally responsible waste disposal (WRL, 2003). However, the consultation suggests that larger vessels cannot access the facility at Kangaroo Point because of clearance under the railway bridge.

There is concern about boats without any waste storage facilities discharging directly into the river. Faecal coliform data generally complied with the ANZECC guidelines for recreational water quality, although the data set was quite small (ie a maximum of 64 data points) (WRL, 2003). The Estuary

Processes Study identifies boat discharges as a potential source of pollution during holiday periods (WRL, 2003). This could include human specific pathogens, nutrients and paper waste.

The Waterways community brochure "Take charge of your discharge" states that under the Protection of the Environment Operations Act, 1997, the discharge of raw sewage into the waters of NSW is prohibited. An onboard sewage treatment system can also be used, but treated sewage cannot be discharged in areas within 500 metres of moorings, marinas, anchorages, swimming beaches or aquaculture sites.

6.6.3.3 Diesel and fuel discharges from boats

Some respondents were concerned about the impacts of diesel and fuel discharges from boats. Diesel and fuel discharges from boats may contribute pollutants such as Hydrocarbons, Carbon Monoxide, Carbon Dioxide and inorganic nitrogen. In terms of the Brooklyn Estuary the impact of hydrocarbons in the water column and sediment is of key significance. Polycyclic Aromatic Hydrocarbon compounds (PAHs) are an indicator of anthropogenic related sources of contamination (including fuel) in estuarine sediments. Sediment sampling undertaken as part of the Estuary Process Study found that while guidelines for PAHs were not exceeded, elevated levels were observed in Sandbrook Inlet and Mooney Mooney Creek (WRL, 2003).

6.6.3.4 Enforcing existing regulations and policies

Compliance with existing regulations and policies is an issue for the Brooklyn Estuary. This includes, for example, effluent discharges from boats, management of onsite sewerage systems and recreational fishing limits. Many people expressed frustration with regulatory authorities for inefficient policing and education of existing regulations and legislation.

6.6.3.5 Upstream pollution sources

The Hawkesbury River has a very large catchment area and many participants in the consultation at all levels reiterated the impact of this wider catchment on water quality and sedimentation.

6.6.3.6 People living on moored boats for extended periods

Within Sandbrook Inlet and also around Dangar Island, people are reportedly living on boats for extended periods. This poses issues for water quality, such as effluent management.

6.6.4 Sediments and sedimentation

6.6.4.1 Contaminated Sediments

Many respondents communicated concern about the contaminated sediments within Sandbrook Inlet. The Estuary Processes Study (WRL, 2003) found that while elevated levels of contaminants (copper, lead, zinc and PAHs) were reported for Sandbrook Inlet, the levels were within the guidelines for Fresh and Marine Waters (ANZECC, 2000).

Some respondents raised the issue of Tri-butyl-tin (TBT). The sedimentological studies undertaken for the Estuary Process Study did not consider TBT directly, however, tin and copper elevations are

associated with the use of both TBT based (tin) and alternative (copper) antifoul paints (Voulvoulis et al 1999). The Oyster bioaccumulation study undertaken as part of the Estuary Process Study (TEL 2002) found that copper concentrations in oysters from Sandbrook Inlet exceeded the ANZFA Standard (ANZFA 2000). Previous investigations have shown that concentrations of TBT in Sandbrook Inlet have reduced since the banning of their use (JBA Consultants 1998, cited in WRL 2003).

As the selected chemical analyses for Sandbrook Inlet were within the guideline limits, the issue at this stage may be the need to prevent further contamination or release, as opposed to rehabilitation of existing levels. Similarly, the sedimentological assessment undertaken for the Estuary Processes Study (CMG 2003) recommends that future issues of sediment contamination in the Sandbrook Inlet should be addressed in the Brooklyn Estuary Management Study and Plan.

6.6.4.2 Sedimentation of Sandbrook Inlet

Most people consulted as a part of the study consider siltation of Sandbrook Inlet a significant issue.

Sedimentation restricts access to boats and tidal waters. It is reportedly only possible to access some areas at high tide, such as Browns Boat Yard at the eastern end. The sedimentation of Sandbrook Inlet was exacerbated by the construction of the causeway in the 1880's. The Estuary Processes Study (WRL, 2003) explains the historical events that have contributed to the sedimentation of Sandbrook Inlet. This includes the building of the causeway, tunnelling for the railway link and the construction of both the Pacific Highway and F3 freeway. Early clearance of the hillsides for timber used to fire steam trains would also have been a major contributor for an extended period of time. A sedimentation rate for Sandbrook Inlet was not calculated specifically as part of the Estuary Processes Study, however PWD (1988) put the estimate at about 10-20mm/year (cited in WRL, 2003).

Observations during the field visit in June 2004 indicated that small creeks such as Seymours Creek and Saltpan Creek may represent a significant local contribution to the sedimentation of Sandbrook Inlet. This sediment is gradually scoured out of the creeks during rainfall events. This is indicated by the fanning fluvial deltas forming at the mouths of these creeks. The significance of these creeks to local siltation problems is further supported by the preservation of the deeper channel parallel to Long Island along the northern edge of Sandbrook Inlet. Sediment settling from flood flows could be expected to have equal impact throughout Sandbrook Inlet, resulting in a mostly uniform bed level.

The Estuary Processes Study (WRL, 2003) gave a conservative estimate of 70 tonnes of sediment moving through the study area from the Hawkesbury River during each tide. The estimate given for local creeks was much lower at 240 tonnes per year, however, the delivery locations were considered to result in greater volumes settling in the study area.

Council advised that the sedimentation in Seymours Creek would include that accumulated as a result of a collapse of the rail line about 10 years ago (pers. Comm., Jacqui Grove- HSC, 2004). This caused significant deposition at the mouth of Seymours Creek, which was subsequently dredged by Rail Infrastructure Corporation.

The issue of future sedimentation therefore relates mostly to local sources.

6.6.4.3 Sedimentation of Brooklyn Harbour

Sedimentation is also an issue for navigation channels within Brooklyn Harbour where the sedimentation rates have been estimated at about 80mm/yr (WRL, 2003).

6.6.4.4 Derelict Oyster Leases

Derelict oyster leases are an issue for the Brooklyn Estuary and may be exacerbated in the future. Derelict oyster leases are observed throughout the estuary including areas in Sandbrook Inlet, Mooney Mooney and Mullet Creeks. Many of the leases have not been used for a long time and pose a threat to navigation, scenic amenity and safety. From the perspective of oyster farmers, the tipping of used oyster sticks can be expensive. Experience in areas such as Wallis Lake and Georges River have shown that once businesses start to fold, farmers are unlikely to have the resources available to decommission existing leases. A discussion with Robert Moxham of Brooklyn indicated an interest in proactively and gradually removing derelict leases in a joint venture where the industry supplies labour with a subsidy for tipping fees. The EPA (now DEC) reclassified tar treated oyster farming timbers as inert solid waste in November 2002, which allows disposal as landfill at local council tips. Unfortunately, this approval has a sunset clause dated December 2006, so any moves to take advantage of the lower tipping fees need to be undertaken within the next two years.

6.6.4.5 QX Oyster Disease

QX oyster disease was first flagged as an issue in early 2004, and has since developed into a major catastrophic event for the local oyster industry. This parasitic infection to the Sydney Rock Oyster is caused by a protozoan parasite, *Marteilia sydneyi*. The life cycle of the organism is not well understood. The latest research indicates that QX is present in a dormant state in several oyster growing estuaries. However, what triggers it to go from a dormant state to an outbreak is still unknown. QX is believed to enter the body of the oysters, which are filter feeders, via the gills and lodge in the lining of the gut. Once there, QX can multiply in the stomach of the oyster, eventually starving it to death (DPI Fisheries, 2004). QX is a declared disease under the Fisheries Management (Aquaculture) Regulation 2002. An outbreak of QX disease was confirmed in areas just outside the study area in June 2004. An emergency closure of Hawkesbury River and Patonga Creek was declared on 11 June 2004. Since this time the outbreak has continued to spread through the study area and the latest updates are bleak. QX disease is a significant issue for the oyster industry and has led to the complete closure of the industry in the Georges River (HRC, 2003). A specially-bred QX-resistant Sydney rock oyster, developed by NSW DPI, will give Hawkesbury oyster farmers their best possible chance of rebuilding their Sydney rock oyster industry. This specially bred oyster has been found to be up to 70 per cent resistant to QX disease (DPI Fisheries, 2004). QX disease has also impacted on wild oysters within the estuary, which have an important role in the ecosystem function. The cause of the outbreak is, as yet, unknown. The severe drought is being considered as a possible trigger for QX – particularly the reduction in natural water flow into estuaries (DPI Fisheries, 2004).

6.6.4.6 Decline in oyster production

Many respondents expressed concern about the decline in the oyster industry. Oyster farming has historical and cultural links with the Brooklyn community. The decline in oyster production is also

seen as an indication of declining estuary health. The role of oysters as the "canary" of the estuary is discussed in HRC (2003), which describes the key threats to oysters as being QX disease (discussed above), human faecal contamination, winter mortality, runoff from acid sulphate soils, turbidity, marine bio toxins, agricultural and industrial runoff and prolonged fresh water flooding. This issue is not unique to the Brooklyn Estuary. The oyster industry has been in decline throughout NSW with the peak production of the 1970s of nearly 150,000 bags dropping to about 78,000 bags by the mid 1990s (HRC, 2003). This may be caused by a number of influences including decline in water quality, virus scares and the onset of "QX" disease.

6.6.4.7 Private development in mangrove forests

Along Mooney Mooney Creek (and possibly other areas within the estuary), the study team were alerted to areas where private residences had excavated channels through stands of mature mangroves. The channels were about 30 metres long and have been constructued illegally to facilitate small boat access between foreshore properties and Mooney Mooney Creek. Apart from the possibility of prosecution under the Fisheries Management Act 1994, this action also has the potential to impact on the local estuary function.

7 GOALS AND OBJECTIVES FOR FUTURE MANAGEMENT

A series of Goals and Objectives for the future management of the Brooklyn Estuary were developed on the basis of information received through the community and stakeholder consultation, input from the Brooklyn Estuary Management Committee and a sound appreciation of estuarine processes and human interactions. On October 11 2004 a workshop of the Brooklyn Estuary Management Committee was convened to clarify and rank the objectives. The outcomes of the Committee Workshop are included as Appendix A.

Six (6) overarching goals have been defined for the future management of the Brooklyn Estuary. These goals define the aspirations of the Community and future direction for management with respect to the environmental, social recreational and economic sustainability and viability of the estuary.

For each Goal, a series of specific objectives have been defined, which describe the requirements for specific aspects of the estuary, necessary to achieve the goals.

The goals and their related objectives for the Brooklyn Estuary are presented below. Each objective has been assigned an individual identifier, or reference, and also a rank (as either High-H, Medium-M or Low-L). The relative rank was determined through consultation with the Brooklyn Estuary Management Committee (BEMC) as discussed above.

The management objectives essentially provide the "goal posts" for which future management of the estuary should be targeted towards.

Goal 1: For the Brooklyn Estuary to contain healthy, diverse and viable ecosystems

Reference	Objective	Rank
1 -1.	Conserve, and where possible increase, the total areas of estuarine habitat (beyond natural variability)	H
1 -2.	Reduce the transport of weeds and pests throughout the estuary	H
1 -3.	Develop a better understanding of ecological indicators through monitoring and research to help guide management decisions	M
1 -4.	Re-establish native vegetation where appropriate along foreshores and to protect existing remnants on public land	M
1 -5.	Establish and maintain buffer zones between development and the foreshore	M
1 -6.	Minimise land clearing within the catchment including no new development on green field sites	M
1 -7.	Establish an appropriate regime of environmental flows	M
1 -8.	Ensure that foreshore structures are designed with intertidal habitat needs in mind	M

Goal 2: For the Brooklyn Estuary to provide opportunity for a range of ecologically and commercially sustainable estuary based industries

Reference	Objective	Rank
2 -1.	Ensure that existing and future tourism development is consistent with the character and ecological capacity of Brooklyn	H
2 -2.	Provide support to the fishing and oyster industry to help ensure their long term viability.	M
2 -3.	Provide appropriate infrastructure for the boating and tourism industry	M
2 -4.	Provide adequate parking for visitors to support the estuary based industries	M
2 -5.	Ensure boating access to existing marinas (for appropriate sized vessels)	M
2 -6.	Maintain, and, if possible improve the navigability of Sandbrook Inlet, Brooklyn Harbour, Parsley Bay and other navigation channels.	L
2 -7.	Alleviate vessel congestion in Brooklyn Harbour, Sandbrook Inlet and Parsley Bay.	L

Goal 3: For the Brooklyn Estuary to be a place of great recreational value, with minimum impacts on the natural environment

Reference	Objective	Rank
3-1	Ensure there is sufficient solid and liquid waste management facilities for the volume of users of the Brooklyn Estuary and foreshore areas	H
3-2	Ensure that public wharves and other facilities are safe and accessible to all	H
3-3	Determine the maximum number of moorings that can be sustained by the estuary	H
3-4	Provide adequate infrastructure for passive recreational activities	H
3-5	Remove derelict oyster producing infrastructure (eg racks and sticks) from the estuary.	M
3-6	Minimise noise pollution generated from boats	L
3-7	Remove abandoned and derelict vessels from the Brooklyn Estuary	L

Goal 4: For the Brooklyn Estuary to have good sediment and water quality which is compatible with oyster farming, ecosystem and human health requirements

Reference	Objective	Rank
4-1	Ensure that the water quality of the Brooklyn Estuary is considered in regional Management Plans	H
4-2	For bacterial counts to meet requirements for aquaculture (shellfish and fish) harvesting areas and ANZECC recreational water requirements	H
4-3	Assess temporal trends and variability in water and sediment quality in the estuary	H
4-4	Eliminate boat sources of pollution by providing adequate infrastructure and controls, such as pump out facilities	H
4-5	Identify, quantify and manage sources of sediment and pollutant loads to the estuary (including stormwater inputs)	H
4-6	For the potential impacts on estuarine processes to be considered when assessing proposed developments within the catchment	H
4-7	Prevent illegal permanent residency on moored boats	L

Goal 5: For the riverside village atmosphere, scenic beauty and character of the Brooklyn Estuary to be enjoyed by residents and visitors now and in the future

Reference	Objective	Rank
5 -1.	Ensure that future development is consistent with the nature, scale and scenic quality guidelines in SREP 20	H
5 -2.	Provide and maintain foreshore open space for passive recreation	H
5 -3.	Involve the local and wider community in future management and decision making	H
5 -4.	Prevent further erosion and degradation of foreshores, including the railway causeway	H
5 -5.	Prevent car parking from monopolising open space in the study area	M
5 -6.	Ensure that the Aboriginal and non-indigenous heritage and spiritual aspects of the study area can be appreciated and enjoyed by current and future generations	M
5 -7.	Investigate and plan for the mooring and car parking needs of river access only residents on a regional basis	M
5 -8.	Ensure that adequate space is provided for dinghy storage	L

Goal 6: For existing and future regulations and policies to be known, understood and adhered to by visitors and residents of the Brooklyn Estuary

Reference	Objective	Rank
6 -1.	For recreational fishers to comply with fisheries legal size and bag limits	H
6 -2.	Ensure compliance with marine/boating legislation	H
6 -3.	Better educate the community to improve compliance with legislation and policies	H
6 -4.	Ensure land use zonings are consistent with the principles of sound environmental management and the goals and objectives of this Estuary Management Plan	H
6 -5.	Ensure waterfront land owners appreciate and adhere to legislation pertaining to estuarine habitat ecosystems	M
6 -6.	Ensure all future development proposals consider the goals and objectives of this Estuary Management Plan (through the EPIC assessment)	M

8 SELECTION OF MANAGEMENT OPTIONS

A total of eighty-one management options/strategies was formulated to address the management objectives discussed in chapter 7. These strategies are listed in Appendix B. Many of these management options were developed by community members and stakeholders, and were canvassed during the consultation process.

It is not possible to include all of these options in the Final Management Plan. Firstly, a large number of options would become unmanageable and the resources required to implement would be unobtainable. Secondly, some of the options suggested conflict with certain high priority objectives.

To determine which options should be included in the Plan, a multi criteria decision-making process was adopted to compare and prioritise the 81 options initially formulated.

Preferred options were determined by consideration of the following criteria:

- Effectiveness of the options in addressing the specific management issues;
- Acceptance of the options by the community and stakeholders;
- The number of specific objectives addressed by each individual management option; and
- Ensuring all specific objectives were addressed by at least one of the management options.

The aim of the multi criteria matrix is to identify those options/strategies that address multiple objectives, are widely acceptable, and are affordable. The methodology used to achieve this is described below.

The options and strategies have been numbered according to the primary goal they address. The codes are:

- WQ for options/strategies that primarily relate to Water Quality
- FL for options/strategies that primarily relate to the management of Foreshore Land
- E for options/strategies that primarily relate to Ecology
- FC for options/ strategies that primarily relate to Foreshore Carparking
- WU for options/strategies that primarily relate to Waterway Usage
- R for options/strategies that primarily relate to the Implementation of Regulations
- DN for options/ strategies that primarily relate to Dredging and Navigation
- T for options/ strategies that primarily relate to Tourism
- H for options/ strategies that primarily relate to Heritage

8.1 The Multi Criteria Assessment Matrix

A matrix was developed that cross reference suggested management options/strategies with management objectives. This matrix is presented as Figure 8.1.

8.1.1 Objectives score

The matrix was used to indicate whether each management option/strategy contributed (YY), indirectly contributed (Y) or conflicted (N) with each of the management objectives. At the end of each row a score was automatically calculated for each of the strategies/options. This score was achieved by giving objectives ranked High, Medium or low a score of 3, 2 or 1, respectively. Actions that indirectly contributed to meeting the objectives, received a 0.5 score. Actions that conflicted with an objective received a score of negative 1. The scores were then tallied to an "Objectives score" for each of the management options/strategies. The "objectives score" for each option was coloured dark grey (for strategies/options with a score of 10 or higher), light grey (for actions with a positive score less than 10) or black (for actions with a negative score).

8.1.2 The acceptability score

An acceptability score was also assigned to each of the options. A score of 1 was given to actions that were mostly unfavoured by the committee review. Actions that received both negative and positive feedback received a score of 2 and actions that were mostly favoured received a score of three. Again formatting was used to colour the "acceptability score" dark grey (for actions with a score of three), light grey (for actions with a score of 2) or black (for the score of 1).

8.1.3 The budget score

Options and strategies were categorised as having a high, medium or low cost. High, medium and low costs were given a score of 3,2 or 1, respectively. The "budget score" was coloured dark grey (for actions with a score of three), light grey (for actions with a score of 2) or black (for the score of 1).

8.1.4 All objectives check

At the bottom of each of the objectives columns a score was automatically tallied for each of the objectives. This was used as a checklist to ensure that all the high and medium level objectives were being addressed. Like the other parameters described above, the tallies were coloured dark grey (for objectives addressed by more than 5 strategies/options), light grey (for objectives that were addressed by between 0 and 5 strategies/options) or black (for objectives that were not met by any of the strategies/options, or that were conflicted by more objectives than they were met by.

SELECTION OF MANAGEMENT OPTIONS

TABLE 8-1 The Multi Criteria Assessment Matrix

		GOALS →	Healthy Ecosystems								Sustain. Industries							Recreation							Water quality for ecosystems, industry and recreation							Character maintained							Reg implement.						Objectives Score	Acceptability Score	Cost Score	Rank
		Priority	H	H	M	M	M	M	M	M	H	M	M	M	M	L	L	H	H	H	H	M	L	L	H	H	H	H	H	H	L	H	H	H	H	M	M	M	H	H	H	H	M	M				
		Weighting	3	3	2	2	2	2	2	2	3	2	2	2	2	1	1	3	3	3	3	2	1	1	3	3	3	3	3	3	1	3	3	3	3	2	2	2	1	3	3	3	3	2	2				
		OPTIONS	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	6.1	6.2	6.3	6.4	6.5	6.6				
Foreshore Carparks	FC1	Overnight accommodation providers to supply private parking / Contributions to public parking - DCP									Y		YY	YY																		YY	YY			YY		Y									14	3	3	3
	FC2	Parking zones with time limits									YY		YY	YY																		YY	YY			YY											15	3	2	10
	FC3	Public carpark near Saltpan Reserve with associated commuter berthing						N					YY	YY							Y												YY				YY									8	2	1	61
	FC4	Investigate deck parking options for Saltpan Reserve, Mckell Park, Parsley Bay						N					YY	YY							Y											N					YY									2	1	1	72
	FC5	Time limited weekend parking in Baden Powell Ave									Y		YY	YY							Y															YY									8	2	2	43
Foreshore Land	FL1	Upgrade Public jetties, wharves, rubbish bins, toilets at Mckell Park, Kangaroo Point and Saltpan reserve											YY					YY	YY		YY					Y		Y				N	YY												13	3	1	32
	FL2	Investigate opportunities to integrate with Hawkesbury Nepean Riverbank management Program	YY	YY		YY	Y																									YY			Y										13	3	2	11
	FL3	Discuss with RIC railway rehab.	YY	YY		YY	Y											Y														YY	Y		YY										17	3	3	1
	FL4	Prepare brochure "living on the Brooklyn Estuary" for foreshore landholders	YY	Y		YY	YY	Y				Y																							YY						YY			18	3	2	3
	FL5	Fill the western side of causeway	N			N					N	N	YY				Y															N	YY												-7	1	1	67
	FL6	Promote plant list for council foreshore projects		YY		YY	Y																																					6	3	3	10
	FL7	Continue Bushcare program in the area.		YY		YY	Y																												YY									9	2	2	33
	FL8	Instigate a program for the removal of rubbish from the riparian zones																Y															YY		YY						Y		Y			9	2	3	18
	FL9	Prepare a development control plan for new foreshore structures to include intertidal habitat								YY		Y	Y																Y															Y	6	2	3	28
	FL10	Develop rehabilitation plans for any saltmarsh communities degraded by noxious weeds.		YY		YY	Y					Y																							YY									10	2	2	30
Dredging and Navigation	DN 1	Dredge Parsley Bay	N			N							YY			YY			Y																	N									-4	2	1	61
	DN 2	Dredge Sandbrook Inlet	N										YY		YY	YY			YY																										4	2	1	57
	DN 3	Redesign Brooklyn Harbour											YY			YY	YY		YY		YY												Y		Y										12	3	2	10
	DN 4	Support and expedite the Mckell Park Proposal	N			N	N				N			YY																			N		N										-14	1	1	59
	DN 5	Move commuter boating facility from Mckell Park to Parsley Bay												YY			YY																												3	2	3	29
	DN 6	Adopt no dredging policy	YY										N		N	N																													1	1	3	53
	DN 7	Ensure that sediment and erosion controls are in place at all development sites.	YY													YY													YY						Y								Y	Y	10	3	3	5
	DN 8	Ensure that the Water Sensitive Development Control Plan and the Best Management Practices continue to be implemented.	YY																						YY																			YY	8	2	2	31
	DN 9	Monitor sediment quality			YY																						YY		YY																8	2	1	47
	DN 10	Determine the sources of heavy metal contamination.			YY																				Y		YY		YY																9	2	2	28
	DN 11	Monitor sediment quality in association with any dredging proposal – before, during and after dredging.			YY																						YY		YY																8	2	3	22
	DN 12	Sea level rise and climate change should be considered.			YY																																								2	2	3	29
Ecology	E1	Develop an est. health monitoring program	Y		YY						YY	YY													Y	Y	YY						YY					Y		YY					20	3	2	2
	E2	Monitor recreational fishing			YY						YY	YY									Y																	Y	Y	YY					13	3	2	7
	E3	Modify recreational bag limits									YY	YY																																5	1	3	41
	E4	Prepare a management plan for saltmarsh near the old dairy site	YY	Y																	YY																								7	2	3	22
	E5	Review zonings (Gosford 7) ability to protect ecol. and WQ					Y				YY														Y							YY			Y								YY		12	3	3	2
	E6	Baseline fish stock study			YY							YY																																	4	1	2	43
	E7	Clearly mark seagrass beds in Sandbrook Inlet to prevent damage.	YY									Y																											Y	YY					8	2	3	19
	E8	Mark seagrass beds on boating maps and undertake an education program to promote protection of these areas.	YY								YY	Y									YY																	Y	YY					14	2	2	15
	E9	Ensure that all seagrass, saltmarsh and mangrove areas are clearly mapped in the HSC and GCC GIS systems.	YY		YY	Y				Y		Y									YY				Y				Y									Y						14	2	2	15
	E10	Implement an ecological monitoring program in the Brooklyn Estuary	Y		YY							YY															YY												Y						8	2	2	22

SELECTION OF MANAGEMENT OPTIONS

TABLE 8-1 The Multi Criteria Assessment Matrix

		GOALS →	Healthy Ecosystems								Sustain. Industries							Recreation							Water quality for ecosystems, industry and recreation							Character maintained								Reg implement.						Objectives Score	Acceptability Score	Cost Score	Rank
		Priority	H	H	M	M	M	M	M	M	H	M	M	M	M	L	L	H	H	H	H	M	L	L	H	H	H	H	H	H	L	H	H	H	H	M	M	M	L	H	H	H	H	M	M				
		Weighting	3	3	2	2	2	2	2	2	3	2	2	2	2	1	1	3	3	3	3	2	1	1	3	3	3	3	3	3	1	3	3	3	3	2	2	2	1	3	3	3	3	2	2				
		OPTIONS	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	6.1	6.2	6.3	6.4	6.5	6.6				
	E11	Monitor the health of estuarine communities including but not limited to seagrass beds, saltmarsh, mangroves, mudflats and rocky shores.	YY		YY					Y		Y																																		7	2	2	25
	E12	Undertake an environmental flows investigation for the Mooney Mooney Creek which quantifies the changes to the hydraulic regime and how this I managed.			YY				Y		Y	Y													Y		Y			Y																8	2	2	22
Tourism	T1	Include old dairy site and adjacent wetland into NP	YY			YY		YY																																					7	1	2	35
	T2	Encourage passive recreation-Improve foreshore access									YY										YY											YY	YY												12	3	2	6
	T3	Develop small scale boat hire opportunities									Y										YY											YY													7	2	2	23
	T4	Regular forum between tourism industry and community									YY										Y											YY													7	2	2	23
	T5	Provide better signage for access to the National Park/Great North Walk.											YY								YY												Y								YY				9	2	3	12
	T6	Ensure adequacy of all infrastructure before approving new tourism developments.											YY															Y				YY													6	2	2	26
Regulations Implemented	R1	Investigate physical and scenic impacts of boats on SI- limit numbers									YY																					YY													6	2	2	26
	R2	Review effectiveness of Hornsby LEP and DCPs					YY				YY														YY							YY											YY	YY	16	3	3	1
	R3	Community education boat discharges and pump out facilities																								Y																YY				4	3	3	8
	R4	Enhance onsite sewage treatment system management program																Y								YY	YY																			7	1	3	20
	R5	Audit compliance with sediment/erosion regs on building sites	YY												YY														YY						Y								Y	Y	10	3	3	2
	R6	Investigate mangrove offences under FMA by residents	YY																																								YY		5	3	3	5
	R7	Develop and target (EPIC) decision making framework for planners	Y								YY														Y					YY					Y									YY	11	3	3	1
	R8	Actively target CMA to consider Brooklyn in CAP						Y	Y		YY														Y	Y			Y	Y					Y										10	3	3	1
	R9	Develop models to assist in the consideration of cumulative impacts for each development application																							YY					YY														YY	8	3	2	7
Waterway	WU1	More channel markers for the entrance to Sandbrook Inlet											YY																																	2	2	2	19
	WU2	Convert all Waterways managed moorings to commercial facilities																		N																										-3	1	2	22
	WU3	Redevelop Mooney Ramp											YY			YY																														3	3	2	12
	WU4	Prepare a mooring management plan													Y	YY				YY												YY														8	1	2	18
	WU5	Oyster Lease decommission plan										YY	Y				Y					YY																					Y				7	3	1	14
	WU6	Prohibit people from permanently living onboard boats																		Y						YY		YY			YY														8	2	3	8
	WU7	Revise jetty limits in SI	N							N		YY		Y																	N														-6	2	3	16
Water Quality	WQ1	Barge with portable toilets for use during peak holiday times									Y	YY					YY									YY		YY																	12	3	1	8
	WQ2	Creek rehabilitation and sediment control plans for tributaries to SI	Y			Y	Y	Y			Y														Y		YY		YY	Y				Y										14	3	2	1
	WQ3	Install a public pump out facility in Brooklyn Harbour									Y	YY					YY									YY		YY																	12	3	2	1
	WQ4	Discuss with Sydney Water alternatives to the preferred option for the sewering of Brooklyn such as a dual reticulation system, reuse options or alternative discharge sites										YY					Y								YY	YY																			9	2	3	4
	WQ5	Further investigation of the implications of allowing some level of tidal flushing through the causeway.							Y	Y						Y										Y				Y															5	3	3	1
	WQ6	Ensure that the RTA and RIC implement stormwater controls from major infrastructure (F3, Main Northern Rail line, Pacific Highway).	YY			Y	Y	Y				Y			Y										YY				YY			Y			Y										16	2	2	1
	WQ7	Continue to enforce the POEO Act in relation to water pollution.															YY									YY																			6	2	3	3
	WQ8	Ensure all DEC pollution licences are adequate															YY									YY																			6	2	2	8
	WQ9	Continue education to reduce water pollution and improve water quality.															YY									YY																	YY		9	2	2	3
	WQ10	Monitor pre and post installation of the proposed sewage outfall at the road bridge to determine impacts			YY												Y									Y																			4	2	1	7

SELECTION OF MANAGEMENT OPTIONS

TABLE 8-1 The Multi Criteria Assessment Matrix

		GOALS	Healthy Ecosystems								Sustain. Industries							Recreation							Water quality for ecosystems, industry and recreation							Character maintained							Reg implement.						Objectives Score	Acceptability Score	Cost Score	Rank
		Priority	H	H	M	M	M	M	M	M	H	M	M	M	M	L	L	H	H	H	H	M	L	L	H	H	H	H	H	H	L	H	H	H	H	M	M	M	L	H	H	H	H	M	M				
		Weighting	3	3	2	2	2	2	2	2	3	2	2	2	2	1	1	3	3	3	3	2	1	1	3	3	3	3	3	3	1	3	3	3	3	2	2	2	1	3	3	3	3	2	2				
		OPTIONS	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	6.1	6.2	6.3	6.4	6.5	6.6				
	WQ11	Implement a program to determine the ecological impact of the installation of the STP outfall.			YY					Y	YY	Y						Y							YY	Y	YY		Y																	16	2	2	1
	WQ12	Continue and improve existing water quality monitoring programs.			YY																					Y	YY		Y																	7	2	2	4
	WQ13	Undertake specific monitoring to determine the impacts from marinas and industrial areas (Somersby).			YY													YY							YY		YY		YY																	14	2	2	1
	WQ14	Undertake further oyster bioaccumulation studies with appropriate spatial and temporal variation.			YY							YY															YY																			7	2	2	3
Heritage	H1	Conduct Aboriginal sites assessment									YY																				YY					YY											8	2	2	1
	H2	Conduct post European heritage assessment									YY																				YY					YY											8	2	2	1
		Total for Objective	12	6	16	5.5	5	1	1	3	15	14	17	7	0.5	5	5	11	3.5	0.5	11	1	0	0	11	12	12	4	8.5	6	1	11	7.5	1	7.5	3	2	2.5	0	1	2	9	2	3.5	5.5				

8.1.5 Preferred Strategy Selection

The preferred strategy was selected by averaging the objectives score, acceptability score and budget score (expressed as percentages). Options that scored over 70% were selected. This left six high and medium level objectives unaddressed. Therefore another eleven options/strategies were added to the preferred strategies list to meet these objectives. Where management strategies/options were closely related, they were hybridised. This bought the total number of management options to 32 . This is considered a good number to ensure manageability for plan implementation.

The preferred management strategy is related to the original list of management issues and prioritised management objectives in . Details of each strategy is provided in Section 9.

It is important to note that some of the suggested options that were not short listed for the preferred strategy are already being implemented beyond the scope of the current study. This includes modifying recreational fishing bag limits, which are being revised to reduce bag limits and increase minimum sizes, across the state. Discussion papers are soon to be released by DPI for public comment.

Table 8-1 Cross reference of issues, objectives and managment strategies

Issue	Objective/s	Strategies
Lack of Data on Fisheries	• Develop a better understanding of ecological indicators through monitoring and research to help guide management decisions	• Develop an Estuary Health monitoring program • Monitor recreational fishing
Reduced abundances and diversity of native flora and fauna	• Conserve, and where possible increase, the total areas of estuarine habitat (beyond natural variability) • Develop a better understanding of ecological indicators through monitoring and research to help guide management decisions • Reduce the transport of weeds and pests through the estuary • Re-establish native vegetation where appropriate along foreshores and to protect existing remnants on public land • Minimise land clearing in the catchment including no new development on Greenfield sites	• Develop an estuary health monitoring program • Prepare a brochure “living on the Brooklyn Estuary • Ensure all seagrass, saltmarsh and mangrove areas are mapped accurately in HSC and GCC GIS systems • Identify Significant seagrass beds on boating charts and by buoys and undertake an education program to promote the protection of these areas
Estuarine Health	• To conserve, and where possible increase, the total areas of estuarine habitat (beyond natural variability) • Develop a better understanding of ecological indicators through monitoring and research to help guide management decisions • Reduce the transport of weeds and pests through the estuary	• Develop a catchment model • Develop an estuary health monitoring program • Prepare a brochure “living on the Brooklyn Estuary • Continue and improve community education programs regarding water pollution including boat discharges • Investigate opportunities for allowing some flushing under the causeway • Monitor sediment quality and determine sources of sediment contamination
Increased in marine influence on biota	• Develop a better understanding of ecological indicators through monitoring and research to help guide management decisions • Establish appropriate regime of environmental flows	• Develop a catchment model • Develop an estuary health monitoring program • Undertake an environmental flws investigation for tributaries to the Brooklyn Estuary
Car parking	• Provide adequate infrastructure for the boating and tourism industry • Provide adequate parking for visitors to support the estuary based industries	• Hornsby and Gosford Councils to consider developing a DCP requiring new overnight accommodation developments including up river developments to provide sufficient parking for guests or to contribute to council run public parking facilities through Section 94 of the EP&A Act • Public carpark facilities in Saltpan Reserve • Introduce time limited parking zones
Dinghy Storage	• Ensure adequate space is provided for dinghy storage • Investigate and plan for the mooring and car parking needs of river access only residents on a regional basis	• Public carpark facilities in Saltpan Reserve
The Mckell Park Proposal	• Provide adequate infrastructure for the boating and tourism industry • Provide adequate parking for visitors to support the estuary based industries • Establish and maintain buffer zones between development and the foreshore • Ensure that foreshore structures are designed with intertidal habitat needs in mind • Ensure that future development is consistent with the nature, scale and scenic quality guidelines in SREP 20 • Prevent car parking from monopolising open space in the study area	• Public carpark facilities in Saltpan Reserve
Mooring arrangements	• Determine the maximum number of moorings that can be sustained by the estuary • Remove abandoned and derelict vessels from the Brooklyn Estuary • Prevent illegal permanent residency on moored boats • Ensure that future development is consistent with the nature, scale and scenic quality guidelines in SREP 20 • Alleviate vessel congestion in Brooklyn Harbour, Sandbrook Inlet and Parsley Bay	• Review effectiveness of existing planning frameworks to protect estuary values • Review mooring limits to ensure consistency with estuary capacity • Redesign Brooklyn Harbour
Erosion and degradation on railway land and the causeway	• Reduce the transport of weeds and pests through the estuary • Conserve and where possible • Conserve, and where possible increase, the total areas of estuarine habitat (beyond natural variability) • Reduce the transport of weeds and pests throughout the estuary	• Rehabilitate public foreshore land through programs such as Bushcare, the Hawkesbury Nepean Riverbank Management Program and by promoting the Hornsby Council Plant list • Prepare and implement creek rehabilitation plans for tributaries of the Brooklyn Estuary

Issue	Objective/s	Strategies
Littering	• Ensure there is sufficient solid and liquid waste management facilities for the volume of users of the Brooklyn Estuary and foreshore areas.	• Prepare a brochure “living on the Brooklyn Estuary • Initiate a program of rubbish removal from riparian areas
Nature and scale of development	• Ensure that future development is consistent with the nature, scale and scenic quality guidelines in SREP 20 • Ensure land use zonings are consistent with policies of sound environmental management and the goals and objectives of this EMP • Ensure that existing and future tourism development is consistent with the character and ecological capacity of Brooklyn • Ensure all future development proposals consider the goals and objectives of this EMP (EPIC)	• Review effectiveness of existing planning frameworks to protect estuary values • Promote the EPIC framework for use by Council Planners when assessing development applications • Encourage passive recreation by providing better signage for access to board walks, the National Parks Trails and the great north walk
Noise Pollution from boats	• Ensure compliance with marine/ boating legislation • Minimise noise pollution generated from boats	•
Heritage	• Ensure that the Aboriginal and non-indigenous heritage and spiritual aspects of the study area can be appreciated and enjoyed by current and future generations	• Review effectiveness of existing planning frameworks to protect estuary values • Liaise with metropolitan LALC and other relevant Aboriginal groups to assess if current level of p[rotection of Aboriginal sites is appropriate and develop opportunities for educational programs
Derelict Boats within Sandbrook Inlet	• Remove abandoned and derelict vessels from the Brooklyn Estuary	• Initiate a program of rubbish removal from riparian areas
Foreshore Access	• Provide and maintain foreshore open space for passive recreation	• Encourage passive recreation by providing better signage for access to board walks, the National Parks Trails and the great north walk
Public Wharves	• Ensure that public wharves and other facilities are safe and accessible to all • Provide adequate infrastructure for passive recreational activities	• Upgrade public jetties, wharves and waste facilities at McKell Park, Parsley Bay, Kangaroo Point and Saltpan Reserve • Redesign Brooklyn Harbour
Jetty Limits in Sandbrook Inlet	• Ensure land use zonings are consistent with policies of sound environmental management and the goals and objectives of this EMP	• Review effectiveness of existing planning frameworks to protect estuary values
Proposed reticulated Sewerage System	• Ensure that the water quality of the Brooklyn Estuary is considered in regional management plans	• Monitor the ecological impact of the proposed STP outfall – before, during and after construction • Continue discussions with Sydney Water regarding alternatives to the preferred option for management of sewage at Brooklyn
Pump out facilities	• Eliminate boat sources of pollution by providing adequate infrastructure and controls, such as pump out facilities	• Further investigate and then implement options for pump out facilities accessible to larger vessels east of the railbridge
Diesel and fuel discharges from boats	• Eliminate boat sources of pollution by providing adequate infrastructure and controls, such as pump out facilities	• Continue and improve community education programs regarding water pollution including boat discharges
Enforcing existing regulations and policies	• Better educate the community to improve compliance with legislation and policies • Ensure waterfront land owners appreciate and adhere to legislation pertaining to estuarine habitat ecosystems • For recreational fishers to comply with fisheries legal size and bag limits	• Prepare a brochure “living on the Brooklyn Estuary • Review effectiveness of existing planning frameworks to protect estuary values • Enhance current program of auditing sediment and erosion controls at all development sites • Continue and improve community education programs regarding water pollution including boat discharges
Upstream pollution sources	• Ensure that the water quality of the Brooklyn Estuary is considered in regional management plans	• Develop a catchment model • Develop and estuary health monitoring program • Investigate opportunities for allowing some flushing under the causeway • Monitor sediment quality and determine sources of sediment contamination • Liaise further with CMA to integrate with the CAPs and other strategies
People living on moored boats for extended periods	• Prevent illegal residency on moored boats	• Continue and improve community education programs regarding water pollution including boat discharges
Contaminated sediments	• Assess temporal trends and variability in water and sediment quality in the estuary	• Develop a catchment model • Monitor sediment quality and determine sources of sediment contamination
Sedimentation of Sandbrook Inlet	• Identify, quantify and manage sources of sediment and pollutant loads to the estuary • Ensure boating access to existing marinas (for appropriate sized vessels)	• Develop a catchment model • Develop and estuary health monitoring program • Enhance current program of auditing sediment and erosion controls at all development sites • Prepare and implement creek rehabilitation plans for tributaries of the Brooklyn Estuary

Issue	Objective/s	Strategies
		• Enure that road and rail infrastructure within the catchment has sufficient stormwater management controls • Investigate opportunities for allowing some flushing under the causeway • Periodic maintenance dredging of Sandbrook Inlet and Brooklyn Harbour
Sedimentation of Brooklyn Harbour	• Maintain and if possible improve the navigability of Sandbrook Inlet, Brooklyn Harbour, Parsley Bay and other navigation channels	• Develop a catchment model • Develop and estuary health monitoring program • Enhance current program of auditing sediment and erosion controls at all development sites • Redesign Brooklyn Harbour • Periodic maintenance dredging of Sandbrook Inlet and Brooklyn Harbour
Derelict Oyster Leases	• Remove derelict oyster producing infrastructure (racks and sticks) from the estuary	• Develop and implement disused oyster lease decommissioning plans
QX Oyster Disease	• Provide support to the fishing and oyster industry to help ensure their long term viability	•
Decline in Oyster Production / commercial fishing	• Provide support to the fishing and oyster industry to help ensure their long term viability	• Develop an Estuary Health monitoring program • Monitor recreational fishing • Ensure all seagrass, saltmarsh and mangrove areas are mapped accurately in HSC and GCC GIS systems • Identify Significant seagrass beds on boating charts and by buoys and undertake an education program to promote the protection of these areas
Private development in mangrove forests	• Ensure waterfront land owners appreciate and adhere to legislation pertaining to estuarine habitat ecosystem	• Prepare a brochure “living on the Brooklyn Estuary
ALL	• For the potential impacts on estuarine processes to be considered when assessing proposed development within the catchment	• Develop a catchment model • Develop and estuary health monitoring program • Promote the EPIC framework for use by Council Planners when assessing development applications

9 DETAILED DESCRIPTIONS OF PREFERRED OPTIONS

Outlined within this chapter is information relating to the preferred options/strategies to be implemented in the Brooklyn Estuary Management Plan. The information is presented in the form of individual sheets, which can be used as reference material when the strategies are implemented in the future.

9.1 Develop a catchment model

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 1.3
- 2.2
- 4.1
- 4.2
- 4.3
- 5.3
- 6.3

Specific management objectives potentially conflicted

None

What does this involve?

This option should be closely integrated with the estuary health monitoring program described in Section 9.2. A numerical catchment and receiving water model should be developed, to identify areas where ecological health may be vulnerable. This will trigger specific monitoring programs targeted at filling data gaps. New data collected will then be used for future model calibration and verification.

The model could be modified and extended into the future to assist in the identification of point sources and to assess scenarios for pollutant inputs (for example sewage management for river settlements) and broad scale landuse changes. Initially the model would be used to assist in the development of the monitoring strategy but later could be used as a tool for assessing future strategic landuse management options.

Resourcing and responsibilities

Hornsby and Gosford Councils

Cost Estimate

Set up costs of $100,000

Environmental Impacts

Nil

9.2 E1 Develop an Estuary Health Monitoring Program

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 1.3
- 2.1
- 2.2
- 4.1
- 4.2
- 4.3
- 5.3
- 6.1
- 6.3

Specific management objectives potentially conflicted

None

What does this involve?

Many respondents to the community and stakeholder consultation were concerned about estuarine health. While there is no widely accepted and measurable definition of estuarine health, it is taken to mean the overall condition or wellbeing of the estuary.

Indicators of ecological health for the Brooklyn Estuary could include seagrass distribution and condition, nutrient levels, faecal coliform data and higher trophic level indicator organisms, such as fish.

The idea is for the estuary health monitoring program to involve a number of different users of the estuary. In this way it will also act as an education and communication tool. The program would need to be flexible enough to evolve as further information on the estuary comes to light. For example, this may include new information on fish stocks, environmental flows or a change in the way that sewage is managed. The Coastal CRC have designed and successfully implemented a similar environmental health monitoring program for the Moreton Bay Estuary in Queensland (see http://www.coastal.crc.org.au/ehmp/.)

In the longer term, the program could be extended to the whole Hawkesbury River and it is recommended that this be considered as an option for the Catchment Action Plan currently being developed by the CMA as well as the Estuary Wide Estuary Management Plan currently being considered by DNR.It is recommended that this option be facilitated through the appointment of a full time River Keeper. The River Keeper would have a range of responsibilities including community education. There may be the opportunity to have the position partially funded through the NSW Maritime program.

Resourcing and responsibilities

The lead agencies for the program would be Hornsby and Gosford Councils with input from relevant government agencies. Community and industry input should be sort across the entire study area. Potential monitoring parameters and participants could include:

- Marina and boating industry reporting shoaling patterns;
- Commercial fishermen reporting fish and by catch records (already included in monthly returns-although specific to the whole estuary);
- Community or Council representatives collecting water samples for nutrient and bacterial laboratory testing;
- Community or Council representatives monitoring boat usage;
- Scientific investigations into trophic structure;
- Community representatives counting recreational fishermen and surveying catches;
- Community representatives or Commercial fishermen recording seagrass areas using GPS;
- Remote and opportunistic monitoring such as water quality and chlorophyll a probes on ferries or commercial fishing vessels;
- Oyster farmers reporting on existing water quality and oyster flesh monitoring; and
- Community representatives recording the occurrence of nuisance algae.

Findings from the monitoring programs could lead to detailed investigations carried out through universities and support agencies.

Cost estimate

$50,000 for pilot program. Annual maintenance cost of $20 000 for reporting (excluding laboratory analysis and samples).

Spatial extent

The program should be designed to cover the entire study area, with scope to move into the rest of the Hawkesbury River Estuary in the future. It is important that areas in the upper reaches of Mooney and Mullet Creeks are also included.

Environmental Impacts

Provided the program is implemented appropriately, there should be no negative environmental impacts.

9.3 Employ a River Keeper for the lower Hawkesbury Estuary

Implementation timeframe

Immediate

Pre-requisite strategies

None

Specific management objectives addressed

- 1.1
- 1.3
- 1.8
- 4.2
- 4.4
- 4.7
- 5.3
- 5.5
- 6.1
- 6.2
- 6.3
- 6.5

Specific management objectives potentially conflicted

None

What does this involve?

The River Keeper will provide assistance to the Councils through pollution and water quality monitoring, prevention and identification of foreshore run-off and siltation, compliance surveillance and community education. Assistance to NSW Maritime will involve specific boating related programs and reviews in conjunction with existing Boating Service Officers

Resourcing and responsibilities

Costs will be shared by NSW Maritime, Gosford, Hornsby and Pittwater Councils and the CMA. The River Keeper position will be administered by NSW Maritime.

Cost estimate

$25,000 set up costs, $30,000 annual costs (For the Brooklyn Estuary portion of the costs)

Spatial extent

This option would apply to the entire estuary.

Environmental Impacts

The River Keeper should have a net positive benefit on the estuary.

9.4 FL4 Prepare a brochure "living on the Brooklyn Estuary" and distribute to foreshore land owners

Implementation timeframe

Immediate

Pre-requisite strategies

None

Specific management objectives addressed

- 1.1
- 1.2
- 1.4
- 1.5
- 1.6
- 2.2
- 5.4
- 6.3
- 6.5

Specific management objectives potentially conflicted

None

What does this involve?

There is a lot of legislation, policy and planing instruments that cover the zone within 40 metres of the waters edge. Through community consultation and site visits it is apparent that not all of these are being adhered to by households on the estuary. Given the complexity of this information and the number of agencies with responsibility for this area, it is possible that many estuary side dwellers are not aware of their specific responsibilities. This strategy involves the development of a concise summary of regulations, responsibilities and other helpful information for those living on the estuary. The document could also be distributed to visitors in the area.

Another useful means for distributing this style of information would be through an interactive website. Council has advised that the Hornsby LGA is recognised by ABS as the highest internet users in Australia (Peter Coad HSC, pers comm.. 2005). The information could sit within the Water Catchments part of the existing HSC website. Alternatively, the existing website for this project could be taken over by council and used to disseminate any information relevant to the Brooklyn Estuary, with links from the Council site.

Resourcing and responsibilities

Hornsby and Gosford Councils with technical input from DNR

Cost estimate

$20,000 plus the cost of distribution.

Spatial extent

This option would apply to all privately owned foreshore land

Environmental Impacts

The brochure should have a net positive benefit on the estuary.

9.5 R2 Review effectiveness of existing planning frameworks such as Hornsby and Gosford LEPs and DCPs to protect the estuary values (combination of strategies E5 and R2)

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.5
- 2.1
- 4.1
- 5.1
- 6.4
- 6.6

Specific management objectives potentially conflicted

Nil

What does this involve?

Identified areas for future development potential under existing planning instruments include:

- Bushland zoned non-urban in the Gosford LGA
- Bushland zoned for Industrial in the Gosford LGA
- Land zone for environmental protection in the Gosford LGA
- Intensification of Residential development in Hornsby LGA

This strategy would include an audit of the types of developments that are being approved for these areas and an assessment of the existing planning documents in ensuring such development fits with the goals for the area described in Sydney Regional Environmental Plan 20 and does not impact significantly on the natural processes of the Brooklyn Estuary. Reference should be made to the EPIC framework for considerations of future development on existing estuary processes. EPIC is included as Appendix C. This option will be most effective if the EPIC Framework is compulsory.

Where appropriate, the catchment model described in Section 9.1 could be used to indicate areas of vulnerability where land use change is required.

Further to the Hornsby Council Waterways Review, this strategy aims to address impacts of existing and future development on existing environmental, social and economic values of the estuary..

Resourcing and responsibilities

To be undertaken jointly by Hornsby and Gosford Council.

Cost estimate

In house costs to Council

Spatial extent

Entire catchment including sites in both Gosford and Hornsby Councils.

Environmental Impacts

Any impacts on the environment from this strategy would be positive as a result of more stringent environmental controls.

9.6 DN 7 Enhance current program of auditing sediment and erosion controls at all development sites (combination of strategies DN7 and R5)

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 2.6
- 4.5
- 4.6
- 5.4
- 6.5
- 6.6

Specific management objectives potentially conflicted

None

What does this involve?

Within the local catchment, there is likely to be significant sources of sediment being washed into the estuary. This includes inputs from development and rail and road projects.

In the Hornsby LGA, Council officers audit and enforce development consent conditions pertaining to sediment and erosion control, on construction and development sites throughout the Shire. The Sustainable Water DCP contains guidance on consent conditions for new developments. An audit could be undertaken of a selection of 30 randomly picked current developments. If the DCP is found to be insufficiently implemented, council planners could be invited to a briefing on the DCP. Tools and checklists use by planners could then be modified to ensure future implementation. In addition, the requirements of the DCP could be included in consent requirements for future development applications. This would open avenues for corrective action. The audit should then be repeated after 12 months to ensure corrective actions have been effective.

Within the Gosford LGA, there is development potential within the bushland zoned industrial and non urban. Ensuring that there is sufficient sediment control for development of these areas will ensure greater protection for the Brooklyn Estuary. A similar audit to that described for Hornsby should be carried out.

Resourcing and responsibilities

Councils through existing programs

Cost estimate

Minimal

Spatial extent

Study Catchment

Environmental Impacts

Only positive, as ensuring no unnecessary sediment inputs from future development.

9.7 FL2 Rehabilitate public foreshore land through programs such as Bushcare, the Hawkesbury Nepean Riverbank Management Program and by promoting the Hornsby Council plant list (Hybrid of options FL2, FL3 and FL6)

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 1.2
- 1.4
- 1.5
- 5.1
- 5.4

Specific management objectives potentially conflicted

Nil

What does this involve?

Areas identified throughout the study as being in need of rehabilitation included Seymour Creek, areas along Mooney Mooney and Mullet Creeks, the railway causeway, Dangar Island and areas of railway land at the eastern end of Long Island.

The Hawkesbury Nepean Riverbank Management Program is primarily focussed on riparian rehabilitation and weed control. In the past the program has worked with landholders to restore riverbanks and riparian vegetation. Typically, an assigned Riverbank Officer works with the property owner to devise a riverbank management plan. This is then implemented using about 50% contract labour paid for by the CMA and 50% volunteer labour supplied by the landholder. There is at least one example in the Windsor area where publicly owned land has been rehabilitated in this manner. This included a partnership with Hornsby Council.

In the past the focus has been areas near Windsor, however, areas closer to the Brooklyn Estuary have been opportunistically included. The latest NHT2 funding grant officially extends the program to Brooklyn (Paul Bennet Hawkesbury Nepean CMA pers. comm. 2005). Preliminary discussions with Paul Bennet indicate that there would be opportunity for the CMA to form partnerships with either

Council or state government (RIC) to plan and implement riverbank management plans in the Brooklyn Estuary.

The bushcare volunteer program has been operating for 15 years in the Hornsby LGA. Volunteers undertake bush regeneration regularly and also attend training annually which incorporates water and catchment education. The program should be supported.

Hornsby Council have developed a booklet outlining indigenous plants suitable for use.

Resourcing and responsibilities

Hornsby Council would be the lead agency with partnerships and funding sort from Gosford Council, the CMA and RIC.

This strategy would also benefit from coordination through the proposed River Keeper position.

Cost estimate

Minimal for initial negotiations, then up to $100,000 for implementation of riverbank and rehabilitation works.

Spatial extent

Foreshore land throughout the estuary.

Environmental Impacts

Site specific environmental management plans should be developed for each project to ensure that stockpiling does not result in pollution of the waterway.

9.8 R 7 Promote the EPIC framework for use by Council Planners when assessing development applications

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 2.1
- 4.1
- 4.6
- 5.4
- 6.6

Specific management objectives potentially conflicted

None

What does this involve?

The Estuary Processes and Issues Checklist (EPIC) is a tool prepared as a part of this Estuary Management Study, that has been designed to assist the Brooklyn Estuary Management Committee (BEMC) and Council planning staff assess the likely impacts of future proposals on the processes and valued aspects of the Brooklyn Estuary. It could be used to consider future development proposals, management strategies and other activities proposed within or around the estuary.

EPIC has four key areas: **Contaminant inputs**; **Waterway encroachment; Social issues,** and **Biological impacts.** Once the Brooklyn Estuary Management Plan (BEMP) has been developed**,** a fifth key area will be added to assess the impacts of proposed development or activities on the goals, objectives and actions outlined in the BEMP. As with any information presented on the estuary, there will be overlap and interrelation between the categories presented.

EPIC is based on the technical information presented in the Brooklyn Estuary Processes Study (WRL, 2003), the information collected during the community consultation and the knowledge and experience of the study team.

EPIC has been designed as a checklist style document, using plain English to give a basic level of understanding of potential impacts. It is hoped that the simple nature of the document will allow a rapid method for assessing proposals against known processes, issues and values.

In order to be effective, EPIC should sit within a new or existing development control plan (DCP).

Resourcing and responsibilities

BEMC to encourage and promote use by planners of both Hornsby and Gosford Council.

Cost estimate

Minimal

Spatial extent

Not applicable

Environmental Impacts

Adoption of the EPIC framework will ensure that the estuary processes and issues are considered when assessing future development applications and therefore, inadvertent exacerbation of issues or degradation of the natural environment should be avoided.

9.9 R 3 Continue and improve community education programs regarding water pollution including boat discharges

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.1
- 4.2
- 6.3

Specific management objectives potentially conflicted

Nil

What does this involve?

Hornsby Council already has a number of environmental education initiatives relevant to the Brooklyn Estuary. These include

- Schools education program that included utilising a Stormwater Activity Model (SAM), this was funded by the NSW Stormwater Trust.
- Online State of the Environment Reporting and an interactive water quality map. Available at www.hornsby.nsw.gov.au/environment
- Quarterly newsletters mailed to all rate payers and bush care volunteers, which often contain articles relevant to environmental issues with education messages.
- Participation in the Brooklyn Spring Fairwhich included displays, face-to-face interaction and information dissemination.
- Signage is erected in strategic locations as interpretive education for visitors and locals
- Environmental brochures available in the Council Offices

Preliminary discussions with the Catchment Education Officer at Hornsby Council indicate a desire to move from information dissemination to greater public participation. This should also move to focus on the integrated nature of processes and issues, rather than focussing on specific individual issues. Council has also expressed the need to develop a logo and image for the education program to compete with the other various information being presented to the community.

Gosford Council had an extensive education program following the winning of funds through the Stormwater Trust. This included a media and schools campaign under the Banner “Use your Brain-

not the Drain" and an education program aimed at an industrial estate within the Brooklyn Catchment area. The Industrial program involved a follow up visit 6 months later that demonstrated significant improvement in the management of runoff on the site. There are no education campaigns focussing on water quality running in the LGA due to a lack of funds.

This strategy would involve:

- Development of a marketing strategy complete with a "corporate image" to raise the profile of environmental information among the plethora of other information being presented to the community;
- There may be an opportunity to set up an estuary research and education facility at Brooklyn Park or the former restaurant that is discussed in the Kangaroo Point Community Plan of Management;
- There is also potential to integrate this option with the suggested Environmental Health Monitoring Program; and
- Implementation would be greatly enhanced through the service of the proposed River Keeper.

Resourcing and responsibilities

Both Councils with some input from NSW Maritime regarding pumpout and boat discharge issues

Cost estimate

$20,000-$30,000 per year.

Spatial extent

Entire study area.

Environmental Impacts

The environmental impacts are expected to be positive.

9.10 WQ 11 Monitor the ecological impact of the proposed STP outfall-before, during and after construction

Implementation timeframe

Immediately and continuing

Pre-requisite strategies

None. It would be beneficial to incorporate this with strategy WQ4 Discuss with Sydney Water Alternatives to the preferred STP option.

Specific management objectives addressed

- 1.3
- 1.8
- 2.1
- 2.2
- 3.1
- 4.1
- 4.2
- 4.3
- 4.5

Specific management objectives potentially conflicted

None

What does this involve?

A monitoring program should be established to determine the environmental impacts of the proposed STP discharge and to compare this to predicted impacts. Without a time series of baseline data it will be difficult to establish between natural variability and the impacts of the proposed works. In order to obtain as much pre-construction data as possible, this program should be established immediately. Monitoring sites should be set up throughout the estuary both upstream and downstream of the proposed outfall location. Sites should also be established to monitor any beneficial impacts associated with removal of existing onsite systems. Parameters measured should include some form of faecal indicator (for example faecal coliforms, sterols, antibiotics, enterococci), nutrients, salinity, temperature, turbidity, chlorophyll-a, BOD, COD and DO.

Resourcing and responsibilities

This strategy should be implemented by Sydney Water as part of their environmental obligations to ensure that the proposed works donot degrade the existing environment and to ensure that the works

are meeting the project objectives of improving water quality within the Brooklyn Estuary and wider Hawkesbury River environs.

Cost estimate

$20,000-$30,000 per year.

Spatial extent

The monitoring should include both near field, far field and control locations.

Environmental Impacts

The monitoring itself is not expected to impact on the environment. The availability of pre and post project monitoring data will assist in demonstrating the impacts of the STP outfall on the estuary and will allow mitigating measures to be developed, if necessary.

9.11 WQ 4 Continue discussions with Sydney Water regarding alternatives to the preferred option for management of sewage at Brooklyn

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.2
- 3.1
- 4.1
- 4.2

Specific management objectives potentially conflicted

Nil

What does this involve?

The Committee should continue to have an advocacy role in natural resource management in the Brooklyn Estuary Catchment. Currently, the preferred option for the future management of wastewater for the townships of Brooklyn, Dangar Island, Mooney Mooney and Cheero Point included the following key elements:

- A new sewage treatment plant on the 'old dairy site' at Brooklyn;
- Effluent discharge to the river (the outfall is likely to be at the second pylon on the south side of the Peats Ferry Road Bridge);
- Sealed sewerage reticulation network for Brooklyn and Dangar Island, including sewage pumping stations;
- Sealed sewerage reticulation network for Cheero Point and Mooney Mooney, including sewage pumping station at south Mooney Mooney;
- Inclusion of sewage from the Peat Island facility and decommissioning of the existing Peat Island treatment plant (or upgrading of the plant to meet performance requirements by the Department of Environment and Conservation (formerly EPA)).

This issue has significant importance among those consulted. Some alternatives raised during the consultation included:

- A dual reticulation system to recycle high quality reusable water for gardens, washing machines and toilet flushing (such a system operates at Rouse Hill); and

- An alternative outfall site closer to the ocean.

Resourcing and responsibilities

The Brooklyn Estuary Management Committee or Hornsby Council.

Cost estimate

Minimal costs to discuss with Sydney Water.

Spatial extent

Not applicable

Environmental Impacts

This strategy has potential for significant environmental benefit both in terms of reduced pollutants entering the estuary and a reduction in extraction of freshwater from other systems for water that would have been used for flushing, washing clothes and gardening.

9.12 E9 Ensure all seagrass, saltmarsh and mangrove areas are mapped accurately in HSC and GSC GIS systems

Implementation timeframe

Immediate

Pre-requisite strategies

None

Specific management objectives addressed

- 1.1
- 1.3
- 1.4
- 1.8
- 2.2
- 3.4
- 4.1
- 4.6
- 6.3

Specific management objectives potentially conflicted

None

What does this involve?

This strategy would involve a review of all the GIS layers and estuarine vegetation maps presented in the Brooklyn Estuary Processes Study and comparison with Councils GIS layers. Liaise with NSW DPI (Fisheries) to establish if more recent mapping has been undertaken. Review of the latest air photos and some new ground truthing would also need to be undertaken. GIS layers based on the maximum area mapped between the existing layers could then be developed. A separate layer could define where mangrove, saltmarsh or seagrass has been lost or expanded.

Resourcing and responsibilities

Councils with support and advice from DPI Fisheries.

Cost estimate

$20,000

Spatial extent

Entire study area to the extent of estuarine vegetation

Environmental Impacts

This strategy is not expected to have any detrimental impact on the environment. Ensuring that all estuarine vegetation is mapped should be beneficial to conservation efforts.

9.13 WU5 Develop and implement a disused oyster lease decommissioning plan

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.2
- 2.3
- 3.1
- 3.5
- 6.2

Specific management objectives potentially conflicted

None

What does this involve?

Derelict oyster leases are located throughout the estuary including areas in Sandbrook Inlet, Mooney Mooney and Mullet Creeks. Many of the leases have not been used for a long time and pose a threat to navigation, scenic amenity and safety. Representatives of the Oyster Industry have indicated that a key constraint in cleaning up derelict leases is the cost. Particularly the tipping fees. A disused oyster lease decommissioning plan should be prepared with input from the oyster industry, DEC (EPA), Council, Maritime Authority and the CMA. It should identify areas for remediation and relative priorities of work. Options may include provision of labour from the oyster industry with reduced tipping fees and other finds provided by the CMA.

Following remediation, oyster leases would be surrendered by the lessees.

Resourcing and responsibilities

Primary responsibility with DPI Fisheries with assistance from the oyster industry, the CMA and Councils.

NHT funds may be available through the Catchment Investment Strategy. The Catchment Investment Strategy has not yet been finalised but includes an allocation for Estuary Projects (from Estuary Management Plans) with a focus on clean up of rubbish (including oyster sticks).

Cost estimate

$25,000 to prepare the plan. Implementation will be in excess of $100,000.

Spatial extent

Derelict oyster lease areas in Sandbrook Inlet, Brooklyn Harbour, Mooney Mooney and Mullet Creeks.

Environmental Impacts

There may be some short term environmental impacts on the estuary from the oyster lease cleanup. This would include disturbance of contaminated sediments, loss of roosting habitat for waterbirds such as cormorants, and dislodged fragments of oyster sticks being released into the waterway. In the long term remediation of derelict leases should have a net positive influence on the environment, particularly scenic and recreational aspects.

9.14 WQ 1 Further investigate and then implement options for pump out facilities accessible to larger vessels east of the rail bridge

Implementation timeframe

Short-Medium

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.2
- 2.3
- 3.1
- 4.2
- 4.4

Specific management objectives potentially conflicted

What does this involve?

The Kangaroo Point Pump out Facility is not accessible to larger boats that do not fit under the railway bridge. The BEMC recently commissioned a study to evaluate the costs, benefits and operational aspects of four land based pump out facilities and two mobile barge-based pump out service options for addressing the issue (Taylor and Hincks, 2005). The land based options considered were: The outer breakwater wall at Parsley Bay

- Near Brooklyn Baths
- Hawkesbury River Marina
- The Rail-Corp owned land at the eastern end of Long Island.

The two mobile barge options considered were:

- A full time mobile pump out service operating from the rail bridge at Brooklyn to Broken Bay
- A part time mobile boat service operating 4 days a week from the rail bridge to Broken Bay

The appraisal recommended that the option of a land based facility near the Brooklyn Baths was the most economically viable solution. There would be environmental and social implications of this, which are yet to be adequately considered. The economic evaluation also identified a range of other unknowns such as the availability of state government funding for pump out services.

The present option therefore involves further investigations focussing on the key recommendations of the economic evaluation report (Taylor and Hincks, 2005). These are:

- Investigate the availability and conditions of funding from NSW Maritime and other state government agencies;
- Undertake a more thorough investigation of the existing Myall Lakes mobile pump out operation;
- Assess the feasibility of using a mobile pump-out barge to collect wastewater from riverside developments;
- Liaise with Sydney Water to ensure that sufficient transport and treatment capacity is included in the Brooklyn Sewerage Scheme design to receive and process wastewater from future pump out facilities; and
- Assess the capacity of the proposed new treatment works to treat estimated quantities of highly saline water associated with wastewater holding tanks on board boats that flush with seawater.

In addition to this, an assessment of environmental and social impacts should be undertaken.

Once the preferred option is identified and approved, it should be implemented.

Resourcing and responsibilities

Hornsby Council and NSW Maritime (and Gosford City Council if the mobile pump out option was designed to service down to Brisbane Water)

Cost estimate

Further investigations up to $50,000. Implementation costs in excess of $300,000 with annual maintenance and operation costs of up to $300,000

Spatial extent

The main focus of this option is east of the rail bridge, although there may be benefits for the whole estuary.

Environmental Impacts

Reduced input of sewage and rubbish from recreational vessels. There would be some risk from spillage however this is expected to be minimal.

9.15 FC 1 F Investigate and manage the car parking implications of overnight accommodation in the river settlements

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.1
- 2.3
- 2.4
- 5.1
- 5.2
- 5.5
- 5.7

Specific management objectives potentially conflicted

None

What does this involve?

Hornsby Council is currently investigating the issue of short term rental accommodation in upstream areas. In considering this and other issues related to up river tourist development, this option involves the preparation of a DCP. The DCP should apply to any new development applications related to the provision of accommodation in the key locations accessed by the township of Brooklyn. The proponent should be required to demonstrate that they can provide sufficient parking for a "full house". As an alternative, and depending on the future provision of parking facilities in the Brooklyn area, the DCP could allow proponents to pay an equivalent contributions fee through Section 94 of the EP&A Act. This would require modification of Councils existing Section 94 Developer Contributions Plan.

This task could be carried out as an extension to the Tourism Review currently being undertaken by Hornsby Council, provided that its scope can include the Gosford LGA

Resourcing and responsibilities

Hornsby Council in association with NSW Maritime and Gosford Council.

Cost estimate

Minimal if prepared by Council staff.

Spatial extent

Would need to cover all development applications for river based and land based developments within the study area, or that need to be accessed through the study area.

Environmental Impacts

The DCP would minimise the future demands on existing limited public car parking facilities, including general street parking

9.16 E2 Monitor recreational fishing in the Brooklyn Estuary

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.3
- 2.1
- 2.2
- 6.1
- 6.2
- 6.3

Specific management objectives potentially conflicted

Nil

What does this involve?

Ecological consultants should be engaged to undertake this study. Methodologies used could include site audits or diary based system of a selected sample of fishers. Results could be used to help design the Estuary Health Monitoring Program (Strategy E1).

Management of fish stocks in the Brooklyn Estuary should be implemented as part of a total estuary program. Monthly returns on commercial fish takes also need to be considered. For this reason, the study should be undertaken in consultation with the Catchment Management Authority and opportunities to extend the scope to the rest of the Hawkesbury Estuary.

Resourcing and responsibilities

Preliminary discussions with Bryan van der Walt of DPI (Fisheries) indicate that some funding for a study of this nature could be made available through monies collected for fishing licence fees. This money is held in the Recreational Fishing trust. Applications to source these funds can be made by councils, fishing clubs and other organisations. Committees of anglers consider and advise on expenditure priorities from the Trust. Proposals for this funding must demonstrate benefit for recreational fishing. In the past, many research-based proposals, similar to the strategy discussed here, have received funding. The Expenditure Committees consider applications for large grants (>$5000) on an annual basis.Additional funds could be available through Envirofund or Envirotrust.

Cost estimate

$30,000-50,000

Spatial extent

Would cover recreational fishing throughout the Brooklyn Estuary

Environmental Impacts

Collection of data on recreational fishing would have no impacts on the environment. The data, however, is expected to show whether recreational fishing is or is not impacting detrimentally on the environment. If so, appropriate management strategies could be considered by DPI (Fisheries).

9.17 WQ2 Prepare and implement creek rehabilitation plans for tributaries of the Brooklyn Estuary

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 1.4
- 1.5
- 1.6
- 2.2
- 4.1
- 4.3
- 4.5
- 4.6
- 5.4

Specific management objectives potentially conflicted

None

What does this involve?

Local sources of sediment contribute significantly to overall sedimentation issues in Sandbrook Inlet. A proactive effort in managing the causes of sediment runoff in the tributaries of Sandbrook Inlet would reduce the demand for dredging in the future. The rehabilitation plans would likely include revegetation of banks and riparian areas, removal of the sand slug from Seymour Creek (from the rail line collapse in the 1990's), identifying sources of sediment and preventing them from reaching the streams, artificial erosion control measures and other sediment control devices.

Other tributaries to the Brooklyn Estuary such as Mullet Creek and Mooney Mooney Creek would also need to be considered. The sub catchment of Mooney Mooney Creek covers about 75% of the Brooklyn Estuary catchment and contains two dams and an industrial area.

Rehabilitation plans for all tributaries could also incorporate filtering of storm flows through artificial wetlands and fringing vegetation. The plans should be integrated with the other plans in the area, including the National Parks Plan of Management, Estuary Management Plan and the Catchment Action Plan.

Resourcing and responsibilities

This would be the primary responsibility of Hornsby Shire Council. However funding may be available from the RTA or RIC to implement strategies related to road and rail runoff issues. Funding for saltmarsh rehabilitation for these creeks may be available through the CMA's latest NHT grants once the Investment Strategy is finalised.

Cost estimate

$20,000-$30,000 for preparing plans and then upwards of $100,000 for implementation.

Spatial extent

All creeks draining into the Brooklyn Estuary.

Environmental Impacts

The strategy would have a number of positive benefits for the environment including a reduction in erosion and sedimentation and improvement to riparian vegetation.

9.18 WQ 6 Ensure that road and rail infrastructure within the catchment has sufficient stormwater management controls

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.1
- 1.4
- 1.5
- 1.6
- 2.2
- 2.6
- 4.1
- 4.5
- 4.6
- 5.4

Specific management objectives potentially conflicted

Nil

What does this involve?

Major sedimentation events have been associated with road and rail projects in the past. This includes the building of the causeway, tunnelling for the railway link and the construction of both the Pacific Highway and F3 freeway. Significant deposition of sediment occurred in Seymours Creek as a result of a collapse of the rail line about 10 years ago (Jacqui Grove- HSC, pers. Comm. 2004). This caused a large sediment fan at the mouth of Seymours Creek, which was subsequently dredged by Rail Infrastructure Corporation. Sediment continues to be washed from the creek and into Sandbrook Inlet during significant rainfall events which is likely to still have originated from this previous event, as sediment is slowly transported through the creek and into the estuary. Given the potential for these large scale projects to impact on the estuary, it is important that future operation/development/maintenance and upgrades of this nature have sufficient stormwater and sediment control practices in place.

This strategy would involve discussions with the RTA and RIC to assess /audit the existing controls on road and rail infrastructure, and upgrade these controls if they are found to potentially impact on the Brooklyn Estuary. The strategy should include consideration of emergency response plans for addressing spills.

Resourcing and responsibilities

RTA and RIC.

Cost estimate

$10,000-$20,000 for initial assessment and audit of existing controls and practices.

Spatial extent

The major rail and road infrastructure in the catchment is shown in Figure 9-1

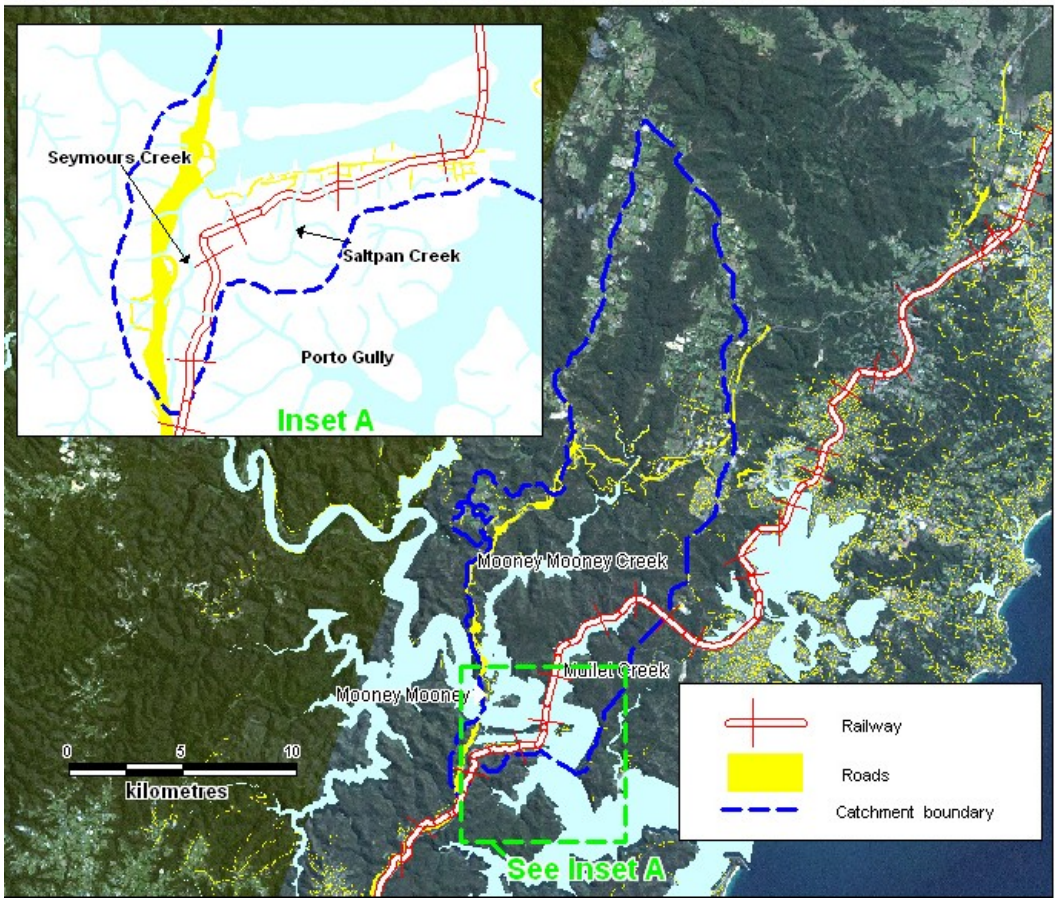

Figure 9-1 Locations of major road and rail infrastructure in Brooklyn Estuary Catchment. Inset shows tributaries to Sandbrook Inlet

Environmental Impacts

Ensuring that there are adequate controls on runoff from road and rail infrastructure in the future will minimise the potential for additional sediment and pollutant inputs to the Brooklyn Estuary and particularly Sandbrook Inlet, which is less able to accommodate such inputs.

9.19 FL 8 Initiate a program for the removal of rubbish (including wrecked boats) from riparian areas

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 3.1
- 5.2
- 5.4
- 6.3
- 6.5

Specific management objectives potentially conflicted

Nil

What does this involve?

This strategy presents another opportunity to work with the Hawkesbury Nepean CMA. The CMA have identified rubbish removal as one of two key strategies in their Catchment Investment Strategy. A clean up program could focus on larger items such as wrecked boats and dumped construction materials, with input and assistance from Industry. Volunteers from the general public could also be encouraged to assist in the clean up of dumped tires, plastics, food wrappings and other dumped materials. This option would probably best be applied on a Catchment wide basis and may even be able to coordinate with Clean Up Australia Day activities.

The derelict and wrecked boats in the study area (for example washed up on Long Island) should also be removed. NSW Maritime and the Department of Environment and Conservation (DEC) have already recently removed one vessel from this area.

Resourcing and responsibilities

NSW Maritime, The Department of Environment and Conservation (NPWS) and the Department of Lands

Cost estimate

Minimal if mostly volunteer labour. Removal of derelict boats could be an expensive exercise. There is the possibility of CMA based funding, as this has been identified as a priority area.

Spatial extent

Whole Estuary

Environmental Impacts

The impact on the environment would be positive. Particularly in relation to scenic amenity.

9.20 E8 Identify significant seagrass beds on boating charts and by buoys and undertake an education program to promote the protection of these areas (Hybrid of options E7 and E8)

Implementation timeframe

Short term

Pre-requisite strategies

Strategy E9

Specific management objectives addressed

- 1.1
- 2.1
- 2.2
- 3.4
- 6.2
- 6.3

Specific management objectives potentially conflicted

None

What does this involve?

Using the newly mapped seagrass areas from strategy E9, seagrass areas would be included on NSW Maritime boating charts, which may be viewed online at www.maritime.nsw.gov.au/maps.html or purchased from maritime NSW. The maps include a range of safety and regulatory information, but do not show seagrass areas. The charts should indicate that seagrass beds can be damaged by anchoring and through propeller wash, and that these areas should be avoided by the general boating public. Significant areas of seagrass should also be identified in the field by markers/buoys that inform boaters of the presence of seagrass. This strategy should also include promotion of DPI Fisheries information on seagrass areas, their significance and the regulations that protect them.

Resourcing and responsibilities

Council in consultation with NSW Maritime and DPI (Fisheries).

Cost estimate

$10,000

Spatial extent

All significant beds in the Brooklyn Estuary should be mapped. Those presented in the Estuary Processes Study (WRL, 2003) are mapped in Figure 9-2

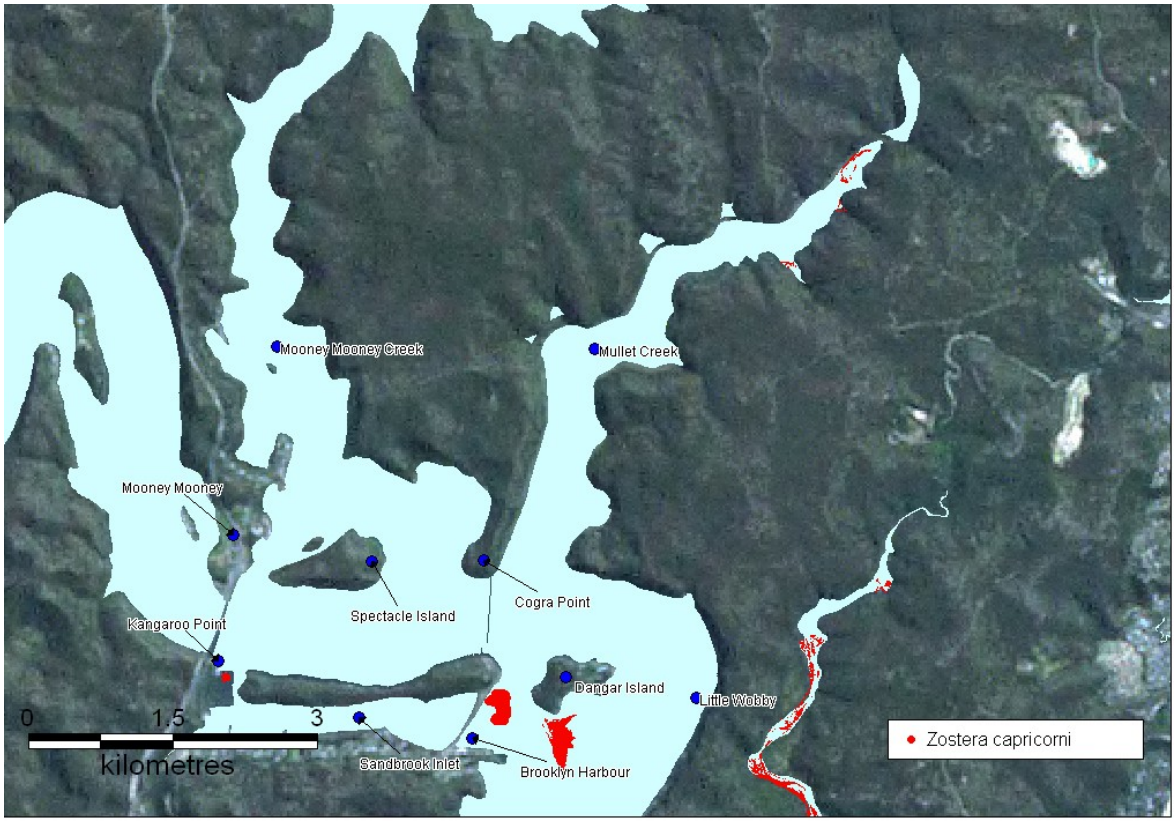

Figure 9-2 Seagrass areas mapped by WRL (2003)

Environmental Impacts

This option is not expected to have any detrimental impacts on the environment. It is hoped that promotion of seagrass areas will result in their conservation. Buoys and markers may detract from the scenic amenity of the area.

9.21 FC3 Public carpark facilities in Saltpan Reserve and/or McKell Park with associated nearby opportunities for small craft berthing for offshore residents

Implementation timeframe

Short term

Pre-requisite strategies

Specific management objectives addressed

- 2.3
- 2.4
- 3.4
- 5.2
- 5.7

Specific management objectives potentially conflicted

- 1.6

What does this involve?

The Saltpan Reserve is Crown Land and zoned Open Space A, under the Hornsby LEP. Some discussion about the conversion of the area into a commuter parking facility has already been undertaken between Council, commuters, local residents and some marina owners. The use of the area as a carpark is not consistent with the current Crown Lands Assessment, which reserves the area for public recreation. In order for a car park to be developed on the site Council would need to purchase the land or lease it at market value (Jason Rawling HSC pers comm. 2005). A carpark would be permitted under the Hornsby LEP. Preliminary investigations undertaken by Hornsby Council suggest that the current needs in terms of commuter parking for offshore residents in the lower Hawkesbury is for 50 car parks. This would most suitably be located at the back of the site. This option appears to be more favoured than parking facilities located at Kangaroo Point. The option would also require negotiations with marina owners to provide berthing facilities for commuter vessels used by the offshore residents.

The Saltpan reserve car park may be a multi level structure. In order to minimise the footprint, and subject to demand some sections of the car park could be made secure to better protect vehicles and assets held by offshore residents.

Opportunities also exist for improving/expanding public car parking facilities in McKell Park. At present, expansion of the existing car parking area is being considered by reclamation of Brooklyn Harbour. A possible alternative is the construction of an upper deck to allow two levels of car parking on the present site and extents. Similar to possible parking facilities at Saltpan Reserve, sections of the McKell Park could be secured and used exclusively by offshore residents, while other sections could be used by day trippers and people accessing the services of Brooklyn Harbour. This

alternative would allow for expansion of carparking facilities, but without the need for dredging and reclamation of Brooklyn Harbour.

Resourcing and responsibilities

Hornsby Council would be the lead agency with assistance from DOP.

Cost estimate

Capital costs would depend on scope and size of car parking facilities provided.

Spatial extent

Saltpan Reserve and or McKell Park.

Environmental Impacts

Conversion of Saltpan Reserve into a car park would result in the permanent loss of an existing open space area in the Brooklyn Township. As there is not a lot of open space in the Brooklyn area, this would be a significant loss. Minimisation of the loss could be achieved by adopting a multi-level car parking facility.

At McKell Park, proposed facilities would be sited on an existing car park and as such would not reduce existing open space. However, being located on the immediate foreshore of Brooklyn Harbour, an elevated level car park may have a visual impact from the water.

9.22 WQ 5 Investigate opportunities for allowing some flushing under the Causeway

Implementation timeframe

Short term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.8
- 2.1
- 2.6
- 4.2
- 4.6

Specific management objectives potentially conflicted

Nil

What does this involve?

Although modelling carried out for the Estuary Processes Study (WRL, 2003) suggested that opening the causeway would not have significant water quality benefits for Sandbrook Inlet, the option was suggested by over a quarter of the community questionnaire respondents. At this stage, RIC appear to be in the planning phase of the Sydney to Newcastle rail upgrade. Although the opportunity to open the causeway as a part of this upgrade is slim, this is a unique opportunity to present the case.

Discussions should be held with RIC regarding the possibilities for construction of culverts under the existing infrastructure on the causeway. Culverts may be limited in size and location depending on the current proposals for the rail upgrade.

Resourcing and responsibilities

Hornsby Council and DNR

Cost estimate

Minimal cost for liaison. Works may cost upwards of $50,000.

Spatial extent

The causeway between Brooklyn and Long Island

Environmental Impacts

Detrimental environmental impacts may include the loss of seagrass beds and associated benthic assemblages, release of contaminated sediments, decline in water quality for the Brooklyn Harbour.

9.23 FC2 Introduce time limited parking zones

Implementation timeframe

Medium term

Pre-requisite strategies

This strategy should be undertaken following implementation of FC3.

Specific management objectives addressed

- 2.1
- 2.3
- 2.4
- 3.4
- 5.1
- 5.2
- 5.5

Specific management objectives potentially conflicted

Nil

What does this involve?

A number of alternate options for implementing a parking zone strategy have been suggested through the community and stakeholder consultation. Most agree that the parking zones should be split between short and long time-limited car parking in Brooklyn to allow short-term day visitors to access cafes and the waterfront.

Resourcing and responsibilities

Hornsby Council would be the leading authority.

Cost estimate

The cost estimate will vary depending on the approach taken (eg ticket vending machines, enforcement). There is potential for recapturing some costs through the use of ticket vending machines/meters and fines.

Spatial extent

McKell Park, Parsley Bay and streets of Brooklyn.

Environmental Impacts

There are not expected to be any detrimental environmental impacts as a result of the implementation of this option, however there may be some social backlash if visitors and residents have to start paying for parking.

9.24 DN 9 Monitor Sediment Quality and determine sources of sediment contamination (Hybrid of DN9 and DN10)

Implementation timeframe

Short to medium term

Pre-requisite strategies

This option is closely related to option WQ13

Specific management objectives addressed

- 1.3
- 4.1
- 4.3
- 4.5

Specific management objectives potentially conflicted

Nil

What does this involve?

The Estuary Processes Study (WRL, 2003) found:

- Slightly elevated concentrations of mercury, copper, lead and zinc were recorded within the surface sediments of Sandbrook Inlet;
- Slightly elevated concentrations of a few metals including mercury, cadmium and lead in surface sediments adjacent to Spectacle Island, downstream of the road bridges; and
- PAHs were elevated in Sandbrook Inlet.

No trace metals were at concentrations that warrant significant concern. Sources of these trace levels of contamination were not identified. There is a desire to establish the sources of this contamination before they reach levels that may impact on ecosystems.

The main avenue for identification of heavy metal sources will be via sediment and water quality monitoring. Extensive sampling would be required to provide any indication of possible locations of contaminant input. With regard to long term impacts on ecosystem health, reference could be made to other locations where metals contamination is much more significant than within the study area (such as the southern end of Pittwater). More contaminated areas would provide a much greater opportunity for assessing general impacts of the contaminants on ecosystem health.

Resourcing and responsibilities

Lead agency would be Gosford and Hornsby Councils with support from DNR and the CMA, especially in respect to any concurrent monitoring in Pittwater.

Cost estimate

Upwards of $50,000

Spatial extent

This option should consider the entire study area with a particular focus on marinas in Sandbrook Inlet and Brooklyn Harbour and industrial areas in Somersby. The industrial area and the marinas are shown in Figure 9-3

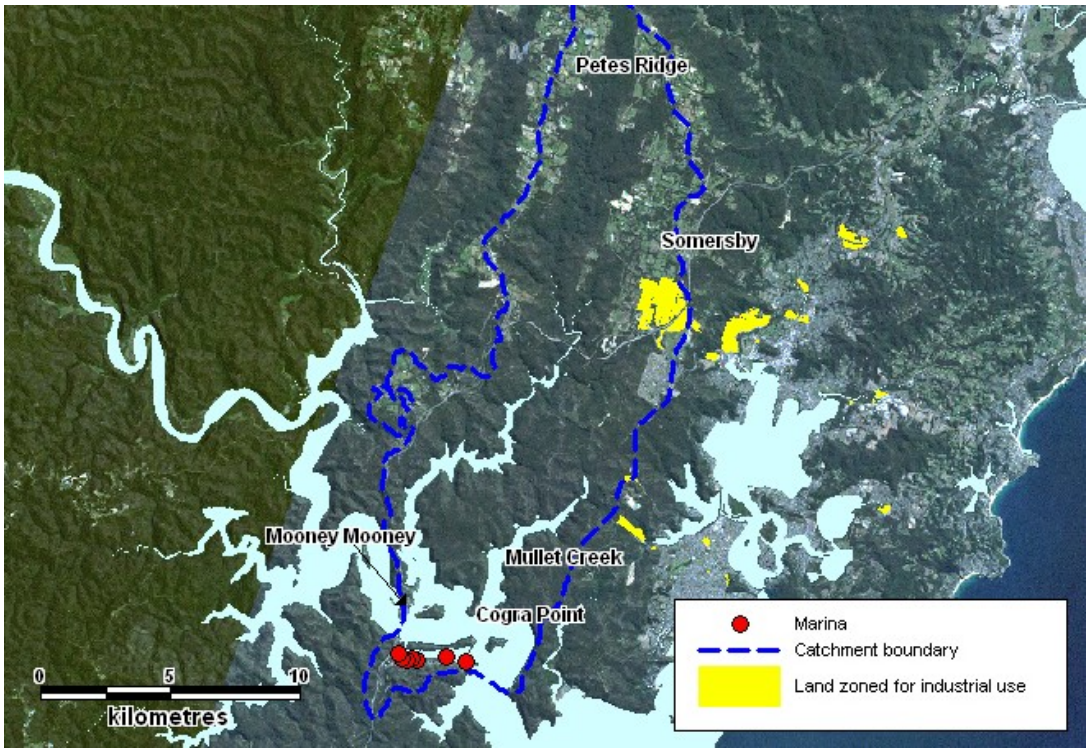

Figure 9-3 Industry and marinas in the Brooklyn Estuary Catchment

Environmental Impacts

There would not be any detrimental impacts on the environment from implementing this option

9.25 FL1 Upgrade public jetties, wharves and waste facilities at McKell Park, Brooklyn Park, Parsley Bay, Kangaroo Point and Saltpan Reserve

Implementation timeframe

Medium term

Pre-requisite strategies

None

Specific management objectives addressed

- 2.3
- 3.1
- 3.2
- 3.4
- 4.2
- 4.4
- 5.2

Specific management objectives potentially conflicted

- 5.1

What does this involve?

The Kangaroo Point Masterplan adopted by Council at its meeting on 16 March 2005 includes includes provisions for upgrading the foreshore facilities in the vicinity of Kangaroo Point. This strategy would involve reviewing existing masterplans for the remaining public foreshore space not considered in the Kangaroo Point Master plan. The review should ensure consistency with this EMP and that there are plans for adequate facilities, including, rubbish bins and toilets. Include upgrading wharves and jetties to allow disabled access.

The plans should then be implemented prioritising the upgrading of wharves and jetties to allow disabled access and to encourage passive recreation (for example wharf based fishing, sitting etc)

Resourcing and responsibilities

Hornsby Council would be the lead agency in implementing this strategy. Fifty percent funding could be obtained from the state government through the Estuary Management Program.

Cost estimate

$200 000

Spatial extent

McKell Park, Brooklyn Park, Kangaroo Point, Parsley Bay and Saltpan Reserve are indicated in Figure 9-4. Note that Kangaroo Point is currently zoned as Business- Aquatic Service Centre.

Figure 9-4 Foreshore Land for zoned for public recreation

Environmental Impacts

The provision of additional facilities is likely to attract more visitors to the parks. However, the nature of the improvements are likely to encourage passive recreational uses with lower environmental impacts. Provision of waste facilities such as rubbish bins and toilets are likely to have a net positive impact on the environment.

9.26 E12 Undertake an environmental flows investigation for tributaries to the Brooklyn Estuary

Implementation timeframe

Medium term

Pre-requisite strategies

None

Specific management objectives addressed

- 1.3
- 1.7
- 2.1
- 2.2
- 4.1
- 4.3
- 4.6

Specific management objectives potentially conflicted

None

What does this involve?

Mooney Mooney and Mullet Creek catchments cover an estimated 75% and 15% of the total catchment area, respectively. A desktop study into extraction from Mooney Mooney and Mullet Creeks should be undertaken. The review should include establishing extraction rates, existing scientific information on impacts of reduced environmental flows for estuarine areas and a discussion of implications for the water quality, flushing and ecology of the Brooklyn Estuary. The study should also include consultation with the Gosford and Wyong Councils' water department to identify opportunities to modify flows for environmental benefit. Where possible the findings of the study should be integrated with the catchment model.

Resourcing and responsibilities

Lead agency Gosford City Council with technical advice from DNR.

Cost estimate

$20, 000

Spatial extent

Implications for the entire estuary with a focus on the Mooney Mooney Creek.

Environmental Impacts

This strategy is not expected to have any detrimental impacts on the environment.

9.27 WU 4 Review mooring limits to ensure consistency with estuary capacity

Implementation timeframe

Medium term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.6
- 2.7
- 3.3
- 5.1

Specific management objectives potentially conflicted

What does this involve?

NSW Maritime regulates moorings on the Brooklyn Estuary. A ceiling of 302 mooring sites in Sandbrook Inlet was established in 1997. In 2002 this number was reduced to 280. There is also a vessel length restriction to a maximum of 10 metres for new mooring applicants for Sandbrook Inlet (Paul Scurry, NSW Maritime pers. Comm.. 2005). This option would involve discussions between the BEMC, NSW Maritime, DPI (Fisheries) and Council to establish an upper limit to mooring numbers that is consistent with estuary capacity and meets the goals of the Estuary Management Plan.

Resourcing and responsibilities

NSW Maritime with support from the BEMC and Hornsby Council

Cost estimate

Minimal

Spatial extent

Sandbrook Inlet and Brooklyn Harbour

Environmental Impacts

This option will have a net benefit for recreational and scenic amenity as well as seagrass distribution and flow on ecological processes.

9.28 H1 Liaise with Metropolitan LALC and other relevant Aboriginal groups to assess if current level of protection of Aboriginal sites is appropriate and develop opportunities for educational programs

Implementation timeframe

Medium term

Pre-requisite strategies

None

Specific management objectives addressed

- 2.1
- 5.1
- 5.6

Specific management objectives potentially conflicted

None

What does this involve?

It is an offence to knowingly destroy, deface or damage, or knowingly cause or permit the destruction, defacement or damage of an Aboriginal Relic or Aboriginal Place without the written consent of the DEC (NPWS). It is also an offence to disturb land for the purpose of discovering or removing Relics without a permit from the DEC (NPWS). Non-compliance with the conditions of any consent or permit is an offence. The *National Parks and Wildlife Act 1994* provides for prosecution and the imposition of fines and/or imprisonment for offences.

If significant sites are not included on the National Parks Register, there is a risk that they may be unknowingly destroyed. The Brooklyn Estuary and surrounds was a very important site for Aboriginal people. European invasion has resulted in destruction of the connection and culture associated with this area. It is possible that sites of significance remain, and are not included on the register.

This strategy could be part of the responsibility of the River Keeper and would involve regular consultation with representatives of the aboriginal community to assess if the level of protection to existing sites is adequate and to identify opportunities for educational programs. Any identified opportunities for educational programs should be integrated with those described in Section 9.9.

Resourcing and responsibilities

DEC (National Parks), the proposed River Keeper, Metropolitan LALCand Councils.

Cost estimate

$50,000

Spatial extent

Entire study catchment focussing on estuary side areas.

Environmental Impacts

This strategy is not expected to result in detrimental impacts. This may be one of the last opportunities to recognise and protect areas with evidence or significance to the original inhabitants.

9.29 R 8 Liaise further with CMA to integrate with the Catchment Action Plan and other strategies

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 1.6
- 1.7
- 2.1
- 4.1
- 4.2
- 4.5
- 4.6

Specific management objectives potentially conflicted

Nil

What does this involve?

As discussed earlier in this document, a Catchment Blueprint has been prepared for the Hawkesbury Catchment. The future CMA Catchment Action Plan, which will guide future works and actions in the Hawkesbury Nepean Catchment, will build on this Blueprint. One key management action listed in the Blueprint is for the development and implementation of an Estuary Management Plan for the entire Hawkesbury estuary including the Brooklyn, Pittwater, Brisbane Water and Berowra Plans.

The current strategy should also aim to target the wider Hawkesbury and minimise catchment pollutant inputs and reduced environmental flows that are impacting on the Brookyn Estuary. A discussion paper could be developed based on information in the EPS and EMS outlining all impacts from broader catchment and suggested strategies to minimise these impacts.

Direct consultation with specific members of staff of the CMA was undertaken in designing some of the management strategies discussed in this document and a number of opportunities to integrate with existing programs were identified. This includes;

- Rehabilitation works under the Hawkesbury Nepean Rivercare project
- Oyster lease and other rubbish clean up through Catchment Investment Funds
- Saltmarsh rehabilitation through the Catchment Investment strategy Funds

Opportunities to work with the CMA may be increased through open communication. A CMA representative, such as Kerry Bru could be kept in formed of BEMC meetings and the implementation of the Brookyn Estuary Management Plan.

Resourcing and responsibilities

This strategy could be undertaken by the Brooklyn Estuary Management Committee.

Cost estimate

Minimal

Spatial extent

Not applicable

Environmental Impacts

None

9.30 DN 3 Redesign Brooklyn Harbour

Implementation timeframe

Immediate

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.3
- 2.6
- 2.7
- 3.2
- 3.4
- 5.2
- 5.4

Specific management objectives potentially conflicted

- 1.1
- 1.4

What does this involve?

Brooklyn Harbour is highly congested during busy times such as weekends and public holidays. The harbour could benefit from a redesign, with the existing land based footprint. A design should be prepared in consultation with existing users and businesses. The Brooklyn DCP should then be updated accordingly.

Resourcing and responsibilities

NSW Maritime, DNR and DOP in consultation with Hornsby Council

Cost estimate

$30,000-$50,000

Spatial extent

Brooklyn Harbour. Congested nature of the Harbour is illustrated in Figure 9-5

Figure 9-5 Brooklyn Harbour

Environmental Impacts

There are a number of potential environmental impacts including the potential mobilisation of pollutants if sediments are disturbed.

9.31 DN 2 Periodic Maintenance dredging of Sandbrook Inlet and Brooklyn Harbour

Implementation timeframe

Medium term

Pre-requisite strategies

Nil

Specific management objectives addressed

- 2.3
- 2.5
- 2.6
- 3.2

Specific management objectives potentially conflicted

- 1.1
- 1.4
- 5.4

What does this involve?

A maintenance-dredging plan for these two areas should be prepared outlining depth triggers for dredging exercises. This plan should be designed so that a monitoring program has a first trigger that starts the application process. This will allow a lead time for environmental assessments before navigation is impacted. In this area maintenance dredging requires the preparation of an EIS as SEPP 35 is superseded by SREP 20. This option should be accompanied by proactive strategies such as WQ2, to prevent sedimentation, where possible. The plan also needs to develop long term disposal options.

Resourcing and responsibilities

Hornsby Shire Council.

Cost estimate

$60,000

Spatial extent

Sandbrook Inlet and Brooklyn Harbour

Environmental Impacts

Environmental Impacts of dredging are significant include the direct destruction of benthic invertebrates, seagrass and other bottom dwelling organisms, turbidity which may impact on seagrasses and saltmarsh, the release of contaminants from sediments, increased infilling rates, visual and noise impacts.

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WBM Oceanics Australia 2004(b) Brooklyn Estuary Management Study and Plan – Issues and Options Discussion Paper: Background Reading for the Brooklyn Estuary Management Committee Workshop

WRL 2003 Brooklyn Estuary Processes Study

APPENDIX A: RANKING OF MANAGEMENT OBJECTIVES

The following table outlines the final management objectives agreed to by the Brooklyn Estuary Management Committee. The final rank of High, Medium or Low was based on a democratic rank by the Brooklyn Estuary Management Committee during a workshop in October 2004.

Suggested Goal	Suggested Objective	Democratic Rank (H, M, L)	Final Rank
1. For the Brooklyn Estuary to contain healthy, diverse and viable ecosystems	1. To conserve, and where possible increase, the total areas of estuarine habitat (beyond natural variability)	H12 M3 L2	H
	2. To reduce the transport of weeds and pests throughout the estuary	H11 M3 L3	H
	3. To develop a better understanding of ecological indicators through monitoring and research to help guide management decisions	H4 M12 L1	M
	4. To re-establish native vegetation where appropriate along foreshores and to protect existing remnants on public land	H6 M8 L3	M
	5. To establish and maintain buffer zones between development and the foreshore	H2 M11 L1	M
	6. Minimisation of land clearing within the catchment including no new development on green field sites	H4 M13 L0	M
	7. To establish an appropriate regime of environmental flows	H3 M8 L6	M
	8. To ensure that foreshore structures are designed with intertidal habitat needs in mind	H5 M8 L1	M
2. For the Brooklyn Estuary to provide opportunity for a range of ecologically and commercially sustainable estuary based industries	9. To ensure that existing and future tourism development is consistent with the character and ecological capacity of Brooklyn	H15 M1 L1	H
	10. To provide support to the fishing and oyster industry to help ensure their long term viability.	H7 M10 L0	M
	11. To provide adequate infrastructure for the boating and tourism industry	H7 M7 L3	M
	12. To ensure that there is access to facilities for all	H4 M10 L3	M
	13. To provide adequate parking for visitors to support the estuary based industries	H6 M5 L6	M
	14. To ensure that marinas can be accessed by boat (for appropriate sized vessels) through an ongoing monitoring and dredging program	H4 M5 L8	M*
	15. To maintain and improve the navigability of Sandbrook Inlet, Brooklyn Harbour, Parsley Bay and o ther navigation channels.	H4 M1 L11	L
	16. To alleviate vessel congestion of Brooklyn Harbour, Sandbrook Inlet and Parsley Bay.	H1 M7 L8	L

	17. To ensure that the Brooklyn DCP is consistent with existing infrastructure	H1 M6 L10	L
3. For the Brooklyn Estuary to be a place of great recreational value, with minimum impacts on physical, chemical and biological environments	18. Ensure there is sufficient solid and liquid waste management for the volume of users of the Brooklyn Estuary and associated foreshore open space	H17 M0 L0	H
	19. To ensure that public wharves are safe and accessible to all	H14 M3 L0	H
	20. To develop absolute limits on number of moorings	H10 M7 L0	H
	21. To provide adequate infrastructure for passive recreational activities	H12 M5 L0	H
	22. To ensure that there is not a legacy of derelict oyster leases left for future generations to clean up.	H0 M12 L5	M
	23. To manage noise pollution from recreational boaters	H 0 M0 L17	L
	24. To remove abandoned vessels from the Brooklyn Estuary	H0 M5 L11	L
4. For the Brooklyn Estuary to have good sediment and water quality compatible with oyster farming, ecosystem and human health requirements	25. To ensure that the water quality of the Brooklyn estuary is considered in regional management Plans	H11 M6 L0	H
	26. For bacterial counts to meet water quality requirements for aquaculture (shellfish and fish) harvesting areas and ANZECC recreational water requirements	H17 M0 L0	H
	27. To monitor water and sediment quality to see how it is changing over time	H11 M6 L0	H
	28. To eliminate boat sources of pollution by providing adequate infrastructure and controls such as pump out facilities	H15 M2 L0	H
	29. Ensure adequate environmental flow rates in Mooney Mooney Creek and Mullet Creek	H14 M3 L0	H
	30. To identify, quantify and manage sources of sediment and pollutant loads coming into the estuary (including stormwater inputs)	H14 M3 L0	H
	31. For the impacts on estuarine processes to be considered in the assessment of proposed developments within the catchment	H13 M4 L0	H
	32. To significantly reduce nutrient and pollutant loads entering the estuary from the local catchment	H12 M2 L0	H
	33. To minimise the release of contaminants from sediment in Sandbrook Inlet and Brooklyn Harbour	H3 M8 L5	M
	34. To prevent illegal permanent residency on moored boats	H0 M1 L16	L
5. For the riverside village atmosphere, scenic beauty and	35. To ensure that future development is consistent with the nature, scale and scenic quality guidelines in SREP 20	H10 M5 L0	H
	36. To provide and maintain foreshore open space for passive recreation	H12 M4 L0	H

character of the Brooklyn Estuary to be enjoyed by residents and visitors now and in the future	37. To involve the local and wider community in future management and decision making	H12 M2 L1	H
	38. To prevent further erosion and degradation of foreshores, including the railway causeway	H12 M4 L0	H
	39. To prevent car parking from monopolising open space in the study area	H9 M5 L1	M
	40. To ensure that the Aboriginal and non-indigenous heritage and spiritual aspects of the study area can be appreciated and enjoyed by future generations	H4 M10 L2	M
	41. To investigate and plan for the mooring and car parking needs of river access only residents on a regional basis	H7 M7 L2	M
	42. To ensure that adequate space is provided for dinghy storage and access to moorings	H1 M5 L9	L
6. For existing and future regulations and policies to be known, understood and adhered to by visitors and residents of the Brooklyn Estuary	43. For recreational fishers to comply with fisheries legal size and bag limits	H10 M4 L1	H
	44. To ensure compliance with marine legislation	H12 M3 L0	H
	45. To conduct programs to better educate the community and to foster compliance with legislation and policies	H10 M5 L0	H
	46. To ensure that zonings are consistent with the estuary management plan (Dangar Island Example)	H13 M2 L0	H
	47. Ensure waterfront land owners adhere to legislation pertaining to estuarine habitat ecosystems	H8 M5 L3	M
	48. Ensure all future development proposals are assessed to consider statutory and non-statutory planning controls such as SREP 20, and the Estuary Management Plan (through the EPIC assessment)	H9 M5 L1	M

*This objective was on the border of being a low or medium ranked objective. For this report it has been interpreted as a medium level objective, meaning that at least one management strategy has been developed to meet it.

APPENDIX B: POSSIBLE MANAGEMENT OPTIONS

Options related to foreshore car parks
1. Hold discussions between Councils, Waterways and other stakeholders about requiring overnight accommodation providers without road access supplying adequate private parking for their clients at Brooklyn and elsewhere. If feasible include this in a Development Control Plan.
2. Develop parking zones with varying time restrictions. This will be aimed at supporting businesses in Brookyn and ensuring it is not crowded with cars from people travelling upriver.
3. Construction of a public car park in Saltpan Reserve accompanied by commuter berthing. Discuss opportunities for provision of commeuter berthing facilities with existing marina operators.
4. Deck carparking in Saltpan reserve, McKell Park, Parsley Bay.
5. Weekend time limited carparking in Baden Powell St associated with people accessing their boats in Sandbrook Inlet.
Options related to foreshore land
4. Upgrade Public foreshore facilities (wharves and toilets) at existing access points such as McKell Park, Kangaroo Point, Brooklyn Park and Saltpan Reserve. Integrate with Kangaroo Point Masterplan.
5. Investigate opportunities to integrate with the Hawkesbury Nepean Riverbank Management Revegetation Program recently expanded to Brooklyn and Colo River. Incorporate opportunities to reduce foreshore erosion in the Upper reaches of Mooney Mooney Creek.
6. Ensure boat speed limits area maintained and enforced to reduce foreshore erosion.
7. Ensure noxious weeds programs are fully implemented in the catchment and the riparian zones
8. Iaise with the Railways authority (RIC) on the need for rehabilitating railway land including the causeway
9. Prepare a brochure “Living on the Brooklyn Estuary” to advise residents on the importance of mangrove and saltmarsh areas and other riparian vegetation communities. Include legislative requirements.
10. Fill part of the heavily shoaled western side of the causeway in Sandbrook Inlet and use for open space and overflow car parking
11. Continue Bushcare program in the area.
12. Instigate a program for the removal of rubbish from the riparian zones
13. Prepare a development control plan for new foreshore structures to include intertidal habitat
14. Develop rehabilitation plans for any saltmarsh communities degraded by noxious weeds.
Options related to dredging and navigation
15. Dredge Parsley Bay to improve navigation for trailer landed vessels
16. Dredge Sandbrook Inlet to improve navigation in main channel areas

17. Redesign Brooklyn Harbour to improve access and amenity of foreshore infrastructure and services
18. Support and expedite the McKell Park Improvement Works Proposal
19. Move some or all commuter boating facilities from McKell Park to Parsley Bay
20. Adopt a total ban on all dredging within the estuary
21. Ensure that sediment and erosion controls are in place at all development sites. Also ensure that any breaches to these requirements are enforced.
22. Monitor sediment quality
23. Determine the sources of heavy metal contamination.
24. Monitor sediment quality in association with any dredging proposal – before, during and after dredging.
25. Plan for sea level rise and climate change
Options related to ecology
26. Develop an ecological health monitoring program that utilises the community and other regular users of the estuary
27. Undertake a monitoring program to establish actual fish takes and compliance levels for recreational fishers in the Brooklyn Estuary
28. Develop a Fishery Management Plan for the Hawkesbury Estuary noting that the Brooklyn Estuary is a subset of this area.
29. Conserve and protect flora and fauna in public and private ownership through appropriate zoning measures and development controls. Amend planning instruments where necessary.
30. Investigate with Department of Primary Industries (Fisheries) the opportunity to modify recreational bag limits for some species in the Brooklyn Estuary
31. Prepare a management plan for the salt marsh and mangrove communities in the study area.
32. Undertake a review of the appropriateness of zonings (eg Gosford 7a, 6a and 1a) to protect ecological and water quality aspects of the estuary
33. Undertake an independent assessment of fish stocks to act as a baseline for future studies
34. Construct a boardwalk with interpretative signs from the old dairy site to Kangaroo Point
35. Clearly mark seagrass beds in Sandbrook Inlet to prevent damage.
36. Mark seagrass beds on boating maps and undertaken education program to promote protection of these areas.
37. Ensure that all seagrass, saltmarsh and mangrove areas are clearly mapped in the HSC and GCC GIS
38. Implement an ecological monitoring program in the Brooklyn Estuary
39. Monitor the health of estuarine communities including but not limited to seagrass beds, saltmarsh, mangroves, mudflats and rocky shores.

40. Undertake an environmental flows investigation for the Mooney Mooney Creek which quantifies the changes to the hydraulic regime and how this is managed
Options related to tourism and recreation in Brooklyn
41. Include old dairy site and adjacent salt marsh/mangrove wetland and/or other council owned land into Ku-ring-gai Chase National Park
42. Encourage passive recreation by improving foreshore access, including jetties and walkways
43. Develop small scale boat hire and other estuary based tourism opportunities closer to the train station to encourage users travelling by public transport
44. Develop a regular forum between representatives of the tourism industry and the local community to help steer tourist development in Brooklyn
45. Provide better signage for access to the National Park/Great North Walk.
46. Ensure adequacy of supporting infrastructure before approving new tourism developments.
Options related to regulations, policy and legislation
47. Undertake an investigation of the physical and visual impacts of boats moored on Sandbrook Inlet to establish acceptable limits to boat numbers
48. Review effectiveness of Hornsby LEP and associated DCPs in implementing the values espoused in SREP 20. Also include the values and strategies detailed in the HRC (1998) report into the Hawkesbury-Nepean River.
49. Improve safety/security of moored boats.
50. Removal of existing rubbish from foreshores and education/compliance programs to reduce further rubbish dumping.
51. Ensure all commercial, industrial practices and oyster depots etc comply with best environmental management practices.
52. Undertake an extensive community education program about NSW marine legislation.
53. Enhance current program of education, regular inspection and prosecution for managing on site sewage treatment systems
54. Audit compliance with sediment/erosion regulations on building sites
55. Investigate offences under the Fisheries Management Act by residents with properties backing onto mangrove forests
56. Target the EPIC Decision Making Framework for use by Council Planners in decision making
57. Actively target the CMA to consider impacts on the Brooklyn Estuary by the broader Hawkesbury Nepean Catchment
58. Ensure that the Water Sensitive Development Control Plan and the Best Management Practices continue to be implemented.
59. Develop models to assist in the consideration of cumulative impacts for each development application.
Options related to water space

60. Install more channel markers for the entrance to Sandbrook Inlet
61. Redevelop Mooney Mooney Point boat ramp and actively encourage its use an alternative to Parsley Bay and McKell Park for commuters and some recreational users
62. Prepare and implement a mooring management plan, which outlines more efficient mooring practices (eg. Fore and aft) and the identification and removal of derelict/abandoned boats
63. Prepare and implement an oyster lease decommissioning plan between NSW DPI (Fisheries), Councils, DEC (EPA) and the Oyster Industry
64. Enforce existing regulations prohibiting people from living permanently upon moored boats
65. Revise jetty limits in Sandbrook Inlet, considering sedimentation and future plans
Options related to Water Quality
66. Hire or purchase a barge with portable toilets for use during peak holiday times (integrate with current Cost benefit study for future pumpout facilities)
67. Develop and implement creek rehabilitation and sediment control plans for Saltpan Creek, Seymour Creek and Mooney Mooney Creek
68. Install a public pump out facility in Brooklyn Harbour, consider the location on railway land on the norh eastern end of the causeway. Integrate with outcomes of the cost benefit study for future pumput facilities"
69. Discuss with Sydney Water alternatives to the *preferred* option for the sewering of Brooklyn such as a dual reticulation system, reuse options or alternative discharge sites
70. Further investigation of possibility for allowing some level of tidal flushing through the causeway.
71. Ensure that the RTA and RIC implement stormwater controls from major infrastructure (F3, Main Northern Rail line, Pacific Highway),
72. Continue to enforce the POEO Act in relation to water pollution.
73. Ensure all DEC pollution licences are adequate
74. Continue and enhance education to reduce water pollution and improve water quality.
75. Monitor pre and post installation of the proposed sewage outfall at the road bridge to determine impacts
76. Implement a program to determine the ecological impact of the installation of the STP outfall.
77. Continue and improve existing water quality monitoring programs.
78. Undertake specific monitoring to determine the impacts from marinas and industrial areas (Somersby).
79. Undertake further oyster bioaccumulation studies with appropriate spatial and temporal variation.
Options related to heritage management
80. Conduct a formal aboriginal sites assessment around the Brooklyn Estuary to identify and record areas of cultural significance
81. Assess further historical significance of European heritage sites around the waterway

APPENDIX C: THE DRAFT EPIC FRAMEWORK

Estuary Processes and Issues Checklist

Draft for Committee review and discussion – August 2004

The Estuary Processes and Issues Checklist (EPIC) is a tool designed to assist the Brooklyn Estuary Management Committee (BEMC) and Council planning staff assess the likely impacts of future proposals on the processes and valued aspects of the Brooklyn Estuary. It could be used to consider future development proposals, management strategies and other activities proposed within or around the estuary.

EPIC has four key areas: **Contaminant inputs**; **Waterway encroachment; Social issues,** and **Biological impacts.** Once the Brooklyn Estuary Management Plan (BEMP) has been developed**,** a fifth key area will be added to assess the impacts of proposed development or activities on the goals, objectives and actions outlined in the BEMP. As with any information presented on the estuary, there will be overlap and interrelation between the categories presented.

EPIC is based on the technical information presented in the Brooklyn Estuary Processes Study, the information collected during the community consultation and the knowledge and experience of the study team.

EPIC has been designed as a checklist style document, using plain English to give a basic level of understanding of potential impacts. It is hoped that the simple nature of the document will allow a rapid method for assessing proposals against known processes, issues and values.

This version of the document is a preliminary draft of the EPIC tool with some examples for Committee review and discussion.

Step 1: Assess Contaminant Inputs

Criteria	Examples	Impact	Assessment	Action Required
Does the proposal involve a change in land use, or a significant change in development footprint (including land-based and water-based developments)?	• Low density housing to medium or high density housing • Small cottage to large house • Open water to marina development • Subdivision of single or multiple lots	If yes, then the proposal may increase the overall pollutant loads to the estuary, including TN, TP, sediments, metals etc	The proposal should provide information on predicted pollutant generation (including surface runoff) and present mitigative measures, such as WSUD, buffer strips etc, to ensure that there is no net increase in pollutant loads to the receiving waters	
Does the proposal involve industrial or commercial activities?	• Marinas • Oyster farming • Tourist development	If yes, then there is a potential for additional pollutants to be discharged to the estuary associated with these activities, including metals, petro-chemicals and litter	The proposal should provide information on the likely pollutant generation from the proposed activities and methods proposed to mitigate these pollutant to ensure that they are not released to the estuary	
Does the proposal incorporate appropriate sediment erosion and control measures for construction?	• Sediment basins • Filter strips • Silt curtains / booms	If no, then additional sedimentation of the receiving waters may result	The proposal should provide details of how sediment erosion is to be controlled on-site during construction so that there is no release of sediment to the downstream receiving water	
Is the activity likely to increase human	• Boat based tourism	The proposal may result in the	The proposal should outline	

waste (treated or otherwise) being discharged into the estuary?	• STPs • Onsite treatment systems	introduction of human specific viruses, bacteria and other disease causing pathogens into the estuary. This would increase the chance of recreational users becoming ill.	waste treatment and disposal options which comply with EPA, Waterways and ANZECC standards.	
If the proposal encourages increased visitation, does it incorporate appropriate waste management facilities such as rubbish and recycling bins?	• Tourist developments • Picnic areas • Jetties	If no, then littering of the foreshore and waterways may result	The proposal should provide details of the likely volumes of waste generated and a waste management plan to ensure that littering of the estuary foreshores and waterway does not occur.	
	• Dredging • Reclamation	If yes, the development may result in changes to tidal dynamics, which could affect sedimentation, scouring, aquatic ecology and water quality.	The proposal should provide details of the likely impacts on flow sediment transport, water quality and ecological processes.	
Does the proposal involve disturbance of bed sediments?	• Dredging • Pile driving	If yes, then contaminants contained within the sediments may be released to the water	The proposal should provide details of the physical and geochemical characteristics of the sediment, the potential for contaminant release, and proposed mitigation measures to prevent associated impacts on the waterway	

Step 2 Consider Waterway encroachments

Criteria	Examples	Impact	Assessment	Action Required
Does the proposal involve reclamation of existing waterways?	• Seaward encroachment of foreshore	If yes, then the proposal may affect the tidal flushing patterns of the estuary, which may affect water quality and sedimentation patterns.	The proposal should include details of the existing tidal circulation patterns and flushing times and outline the likely impact on the surrounding waters. It should also outline measures to ensure no detrimental impacts on estuary water quality.	
Does the proposal involve the construction of physical structures within the waterway?	• Wharves • Pontoons • Marina	If yes then the proposal may affect the sediment deposition and transport patterns within the estuary	The proposal should include details of sediment transport mechanisms, the likely influence of the proposed structure and mitigative measures to ensure that existing sedimentation issues are not exacerbated	
Will the proposal result in an increase in the number of vessels within Sandbrook Inlet or Brooklyn Harbour?	• Marina • Boat hire • Additional Moorings	If yes then the proposal may exacerbate existing issues with waterway congestion in areas used for navigation and recreation.	The proposal should include details of known navigation channels and recreational areas. It should also contain details of times and numbers of boats using these areas to demonstrate no impact on existing congestion problems.	

Step 3: Consider Social issues

Criteria	Examples	Impact	Assessment	Action Required
Will the proposal increase demand for foreshore car parks?	• Boat based tourism • Water access only tourist developments • Boat ramp facilities	If yes, then the proposal may exacerbate existing parking issues for Brooklyn.	The proposal should include sufficient parking allocation for a "full house"	
Is the proposal likely to result in a change in the management and use of foreshore land?	• Marina • Private development • Car parks	If yes, then the proposal may hinder foreshore access to the general public	The proposal should outline strategies to ensure ongoing access to foreshore land	
Does the proposal involve a significant change to the existing visual characteristics of the development site?	• Open water to marina or moorings • Low profile single storey house to multilevel dwelling	If yes, the activity may interfere with the visual amenity experienced by those on or near the estuary	The proposal should consider visual impacts.	
Will the proposal encroach on land currently used for dinghy storage or commuter berthing?	• Reclamation • Marina	If yes then the activity may impact on *water access only* residents, such as those from Dangar Island	The proposal should consider alternate dinghy storage and commuter berthing facilities.	
Will the activity encroach on an area of potential historical significance?	• Car park • Private development	If yes, the development may interfere with future opportunities to enjoy the heritage aspects of Brooklyn	The proposal should consider the heritage significance of the development site and provide details on measures to ensure that heritage items are retained and preserved.	
Will the proposal involve activities that will generate higher than	• Construction activities • Recreational boating	The proposal may impact on the values of peace and	The proposal should include an assessment of the likely noise	

background noise levels?	activities	tranquillity of the estuary	generated and measures to ensure that that noise pollution is minimised	
Does the proposal include ongoing regulation of the general public?	• On site sewage treatment • Moorings	If yes, it is possible that these regulations will not be adhered to.	The proposal should include an implementation schedule including both education and compliance monitoring.	

Step 4: Assess likely biological impacts

Criteria	Examples	Impact	Assessment	Action Required
Does the proposal encroach into areas currently vegetated by seagrasses, salt marsh or mangroves?	• Wharves • Marina • Dredging • Reclamation • Boating	If yes, then the proposal may result in the loss of important habitat areas.	The proposal should include details of existing salt marsh, seagrass and mangrove areas that will be disturbed and outline mitigation and rehabilitation measures.	
Will the proposal result in the introduction of animals or plants from outside the area into the estuary	• Landscaping • Aquaculture • Boating	If yes, then the proposal could possibly result in the introduction of invasive species or disease into the estuary?	The proposal should consider the use of indigenous plants for rehabilitation and landscaping aspects. In the case of the introduction of aquatic animals or plants, the proposal should demonstrate that the risk of disease introduction has been addressed.	
Does the proposal encourage the harvesting of wild species	• Commercial fin fishing • Recreational fishing based tourism	If yes then the proposal may impact on food chain and ecosystem dynamics	The proposal should demonstrate that impacts on wild stocks and harvesting rates will be adequately monitored	
Does the proposal involve the removal of existing vegetation	• Clearing of trees and shrubs for construction or access	If yes the proposal may result in the loss of native plants and animals.	The proposal should outline specific trees to be removed and rehabilitation plans for revegetation if appropriate.	