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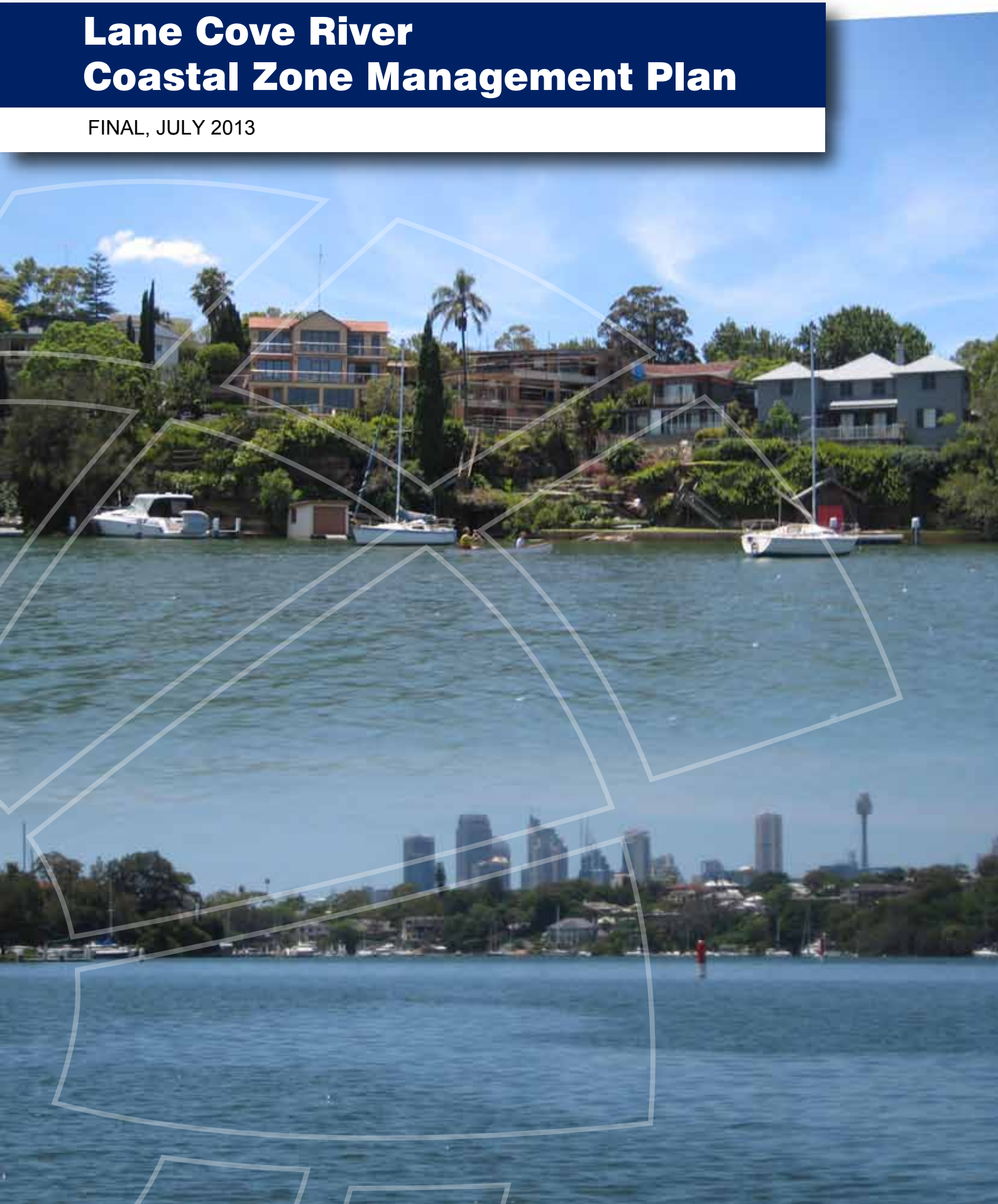
Lane Cove River Coastal Zone Management Plan

FINAL, JULY 2013



Lane Cove River Coastal Zone Management Plan

Prepared For:	Lane Cove River Estuary Management Committee (LCREMC), Hunters Hill Council, Lane Cove Council, City of Ryde, Willoughby Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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The coastal zone of NSW is a priceless natural resource, and is immensely valued from an ecological, social and economic perspective. Besides the open coast beaches and headlands, the NSW coastal zone contains over 130 estuaries that vary in size from small coastal creeks and lagoons to large lakes and rivers. Estuaries contain diverse ecosystems that form the foundation of the coastal food chain. They provide important habitats for a variety of marine and terrestrial plants and animals.

Lane Cove River is a highly valued estuary within the Sydney Metropolitan Area close to the CBD. It preserves significant ecological value and also acts as a resource for a variety of recreational pursuits. Although the estuary and its catchment have undergone considerable environmental change since European settlement in the 1790s, large sections of the estuary and its shoreline still remain as an important natural remnant in an urban setting. This association of natural and urban environments surrounding the Lane Cove River Estuary demands that special management considerations are made to ensure the long term balance and sustainability of this precious resource.

The Lane Cove River Coastal Zone Management Plan (CZMP) has been prepared by environmental consultants BMT WBM, on behalf of the Lane Cove River Estuary Management Plan Implementation Committee and Lane Cove Council (representing constituent Councils: Hunters Hill Council, Lane Cove Council, City of Ryde and Willoughby Council) and the NSW Office of Environment and Heritage (OEH). This Plan covers the entire Lane Cove River Estuary, located in the lower north shore of Sydney.

This plan builds on the existing Lane Cove River Estuary Management Plan 2004 and has been updated to include climate change assessment and a plan for Water Sensitive Urban Design measures to be promoted across the catchment.

Since the original commencement of the Estuary Management Process for the Lane Cove River, the NSW Government has introduced various reforms to coastal management, including new Guidelines for Preparation of Coastal Zone Management Plans (2010).

Previously, the NSW Government had adopted a Sea Level Rise Policy Statement, which set out benchmarks for sea level rise to be considered for future planning purposes. These benchmarks were a projected rise in sea level (relative to the 1990 mean sea level) of 0.4 metres by 2050 and 0.9 metres by 2100. The values were derived from sea level rise projections by the Intergovernmental Panel on Climate Change (IPCC 2007) and CSIRO. The derivation of these benchmarks is set out in the *Technical Note: Derivation of the NSW Government's sea level rise planning benchmarks* (Department Environment, Climate Change and Water NSW, 2009).

However, recently, as part of its stage one coastal management reforms, the NSW Government announced that Councils would have the flexibility to determine their own sea level rise projections to suit their local conditions - the Government would no longer prescribe state-wide sea level rise projections for use by Councils. Hence, the 2009 NSW Sea Level Rise Policy Statement is no longer NSW Government Policy.

A recent report *"Assessment of the science behind the NSW Government's sea level rise planning benchmarks" (2012),* prepared by NSW Chief Scientist and Engineer Mary O'Kane details the adequacy of the science informing the NSW sea level rise benchmarks adopted in the 2009 Policy Statement. This report concludes that given the current level of knowledge, the way the science was used to determine benchmarks is adequate. However, for some years to come there will be more and better models for predicting sea level rise which will be informed by more and better data enabled by rapid advances in sensing, positioning, computational and imaging technologies.[1]

The Office of Environment and Heritage (OEH) has also released guidelines on incorporating sea level rise into flood risk and coastal hazard assessment. These documents will be revised as part of the reform process. In the interim, reference to the NSW sea level rise planning benchmarks in these documents should be taken as referring to council's adopted sea level rise projections.[2]

The Lane Cove River CZMP satisfies the intent and objectives of these new reforms and initiatives taken by the NSW Government, as well as the fundamental principles originally adopted in the NSW Coastal Policy and the previous NSW Estuary Management Policy.

Actions in this plan may require approval under the Environmental Planning and Assessment Act 1979 and other legislation and should be considered as intended actions subject to these approvals. In the event of any inconsistency between a statutory instrument or development consent issued under the EP&A Act and this plan, the statutory instrument or development consent applies to the extent of the inconsistency.

Any actions, including project funding, noted in this plan for completion by or contribution from the NSW Government, its Departments or Agencies should be considered as requests for funding or action. The NSW Government will consider these requests when determining its state-wide priorities relating to coastal zone management. If any such actions are not completed in accordance with the plan, this is not to be considered a breach of Section 55L of the Coastal Protection Act 1979.

1.2 Who is this Plan for?

The primary audiences for this CZMP are Councils within the Lane Cove River Estuary catchment. Other stakeholders, including the general public, are also likely to take a keen interest in the future management of the estuary, and therefore have been considered during preparation of this Plan.

The primary purpose of the Lane Cove River Coastal Zone Management Plan is to provide strategic direction and guidance on future actions within the estuary and its catchment, which will help to achieve long term balanced environmental sustainability.

The Plan shall be used to inform other strategic documents that aim to manage and rationalise human activities and development within the catchment, such as Regional Strategies, Development Control Plans (DCPs) and Local Environmental Plans (LEPs).

The Plan also provides an opportunity for future climate change to be considered in the strategic management and planning of the estuary and surrounding sensitive coastal lands.

[1] *"Assessment of the science behind the NSW Government's sea level rise planning benchmarks", Mary O'Kane, NSW Chief Scientist and Engineer*
http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0016/26206/CSE-Report-Sea-Level-Rise-Benchmarks_.pdf
[2] *NSW OEH, Climate Change, Adapting to Climate Change, Sea Level Rise, NSW Govt. Policy*
http://www.environment.nsw.gov.au/climatechange/sealevel.htm

1.3 Coastal Management Principles

To inform strategic considerations in coastal management, including the preparation of CZMPs, Coastal Management Principles have been developed. Relevant principles should be considered in evaluating potential coastal management actions and be reflected in CZMPs (DECCW 2010).

The "Coastal Management Principles" and where these principles have been addressed or achieved within this CZMP are given in Table 1-1.

Table 1-1: Coastal Management Principles Addressed by the Lane Cove River CZMP

Principles		Addressed By
Principle 1	Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997 and the NSW Sea Level Rise Policy Statement 2009	Section 1.6.3
Principle 2	Optimise links between plans relating to the management of the coastal zone	Sections 1.4 and 1.6
Principle 3	Involve the community in decision-making and make coastal information publicly available	Section 3
Principle 4	Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach	Sections 1.3, 1.4, 4, 7
Principle 5	The priority for public expenditure is public benefit; public expenditure should cost-effectively achieve the best practical long-term outcomes	Section 8.4 and 9
Principle 6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	Sections 1.5, 6
Principle 7	Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	Section 6
Principle 8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	Section 7
Principle 9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	Sections 4.1.6 and 5
Principle 10	Support recreational activities consistent with the goals of the NSW Coastal Policy	Section 5

Under Section 733 of the Local Government Act 1993, councils are taken to have acted in 'good faith' and receive an exemption from liability where their actions were done substantially in accordance with the "coastal management principles" as given in the CZMP Guidelines. Further, intended changes to Section 117 of the Environmental Planning and Assessment Act 1979 will require the CZMP Guidelines be taken into consideration when councils prepare their local environment plans (LEPs).

1.4 NSW Estuary Management Process

Historically, the Estuary Management Process in NSW has been guided by the Estuary Management Policy (1992) and Estuary Management Manual (1992). Recently, the NSW Government released new Guidelines for Preparing Coastal Zone Management Plans (the CZMP Guidelines), which replace the Estuary Management Manual and combines the former coastal and estuary management processes. Under the new CZMP Guidelines, estuary management is required to focus on addressing risks to the health of estuaries through practical management actions. Focus is guided towards estuary health, as this is not explicitly investigated or managed through any other council or state statutory or planning process.

Fundamentally, the steps required to prepare a Coastal Zone Management Plan, in accordance with the CZMP guidelines, are:

1. Identify and discuss the planning framework relevant to management of the estuary;
2. Prioritise management objectives based on a combination of issues that need attention, and conservation of natural and social values;
3. Assess and select potential management options to achieve the objectives;
4. Detail a schedule of activities for the implementation of the best management options; and
5. Indicate responsibilities and sources of funding for implementing the best options.

Once the Plan has undergone public exhibition and has been adopted by the Councils, the recommended management options can start to be implemented, in accordance with the framework presented in the Plan.

1.5 Coastal Risk Management

A key platform of the new CZMP Guidelines is the adoption of a risk-based approach to the management of estuary health. Risk-based management of estuaries has several key advantages, including:

- all risks are assessed and compared equally, ensuring that management efforts are directed towards those areas or issues that post the greatest risk to estuary health and sustainability,
- better streamlining of the Plan with existing Council's operational plans, as the risk approach inherently requires that existing management efforts are included in the assessment of risk, rather than a duplication of actions,
- the risk approach identifies the highest priority risks, which are not currently being managed (sufficiently) through any other process, targeting management resources towards the highest priority issues,
- management options can be designed to reduce the likelihood of the risk (e.g. planning setbacks) and the consequence of the risk (e.g. emergency management works), and
- where there is a high level of community concern regarding an issue that presents a low risk, monitoring and trigger levels can be set without absorbing

funding resources unnecessarily.

1.6 Key Legislation and Other Instruments Guiding Estuary Management

The Lane Cove River Estuary and its catchment are subject to numerous environmental planning and management instruments and legislation, spanning four LGAs (each with its own planning framework, policies and plans). In addition to these instruments and statutory documents, there is also a vast array of management plans and strategies that are relevant to the Lane Cove River, ranging from overarching Commonwealth initiatives down to site specific Plans of Management.

In addition to legislated Acts of Parliament, there are two main types of Statutory Environment Planning Instruments (EPIs): Local Environmental Plans (LEPs) and State Environmental Planning Policies (SEPPs). There are also other instruments that guide management of natural resources, including the Lane Cove River.

The existing environmental planning and strategic management frameworks relevant to the Lane Cove River are summarised below.

1.6.1 State Environmental Planning Policies

There are a number of State Environmental Planning Policies (SEPPs) that may be relevant to the Lane Cove River Estuary. These include:

- SEPP 71 – Coastal Protection
- SEPP (Major Development) 2005
- SEPP (Infrastructure) 2007
- Sydney Harbour Catchment Regional Environmental Plan (2005)
- Sydney Harbour Foreshores Area Development Control Plan (2005)

Of particular note, Division 25 of SEPP (Infrastructure) 2007 refers to waterway and foreshore environmental management activities, including riparian corridor management, bank stabilization, weed management, revegetation activities, and the creation of foreshore access ways. In this regard, the relevant local Council is deemed to be the public authority, and as such, does not require development consent to undertake waterway and foreshore environmental management activities. Please refer to APPENDIX A for further notes.

The NSW Government is building a planning system focused on sustainable growth to deliver the jobs and houses we need to support our growing cities and regions. The White Paper – A new planning system for NSW and draft planning legislation were released on 16 April 2013 and were on public exhibition until 28 June 2013. This comes as a bold step in the development of a new planning system for the State and overhauls the State Planning System.

Future implementation of some of the actions in this plan may be affected by this. Further details are given in APPENDIX A.

1.6.2 Local Environmental Plans and Development Control Plans

Local Environmental Plans (LEPs) are planning instruments produced by local councils to direct the type of development in local government areas. LEPs aim to conserve the natural environment, whilst creating attractive living areas and ensuring development complies with ecologically sustainable principles. Through zoning and development controls, they allow councils to supervise the ways in which land is used by defining permissibility for different types of development across an entire LGA, as a requirement of the Environmental Planning and Assessment Act 1979. LEPs are statutory documents, meaning it is illegal to develop land contrary to that permitted by the LEP. In 2006, the NSW Government gazetted a standard instrument for preparing new LEPs so that zoning definitions were consistent across Councils.

Development Control Plans (DCPs) are non-statutory instruments that support the LEPs, by providing specific, more comprehensive guidelines for types of development, or specific areas within a local government area. DCPs contain a specific range of conditions (including visual amenity, drainage, access, pollution control, vegetation etc.) aimed at optimising land use in an environmentally sustainable manner. A list of the LEPs and DCPs relevant to the Lane Cove River Estuary are presented in Table 1-2.

Table 1-2: Local Government Planning Instruments

Local Environmental Plans	Development Control Plans
Hunters Hill LEP 1982 Draft Hunters Hill LEP 2012 (commencement date: 12/08/2013) Hunters Hill Village LEP 2009 Gladesville Village Centre LEP 2010	DCP 15 – Residential Development 2000 DCP 27 – Hunters Hill Village 2009 DCP 28 – Gladesville Village Centre 2010
Lane Cove LEP 2010	Lane Cove DCP 2010
City of Ryde LEP 2010	City of Ryde DCP 2010
Willoughby LEP 2012	Willoughby DCP 2006

Note: All Councils have or are currently updating their LEPs based on the Department of Planning and Infrastructure's standard template.

1.6.3 State and Commonwealth Legislation and Policies

There are a number of NSW and Commonwealth Parliamentary Acts that are relevant to the management of the Lane Cove River Estuary and catchment. Key Acts and policies are listed below:

- Coastal Protection Act 1979;
- Crown Lands Act 1989;
- Environmental Planning and Assessment Act 1979;
- Fisheries Management Act, 1994;
- Heritage Act 1977;
- Local Government Act, 1993;
- National Parks and Wildlife Act, 1974;
- NSW Coastal Policy 1997;
- Noxious Weeds Act 1993;

- Protection of the Environment Operations Act, 1997;
- Threatened Species Conservation Act, 1995;
- Water Management Act 2000.

A brief explanation of each of the above listed Acts and Policies are given in APPENDIX A:.

1.6.4 Sydney Metropolitan Catchment Action Plan 2009

The Sydney Metropolitan Catchment Action Plan (CAP) 2009 has been prepared by former Sydney Metropolitan CMA and now Hawkesbury Nepean CMA (HNCMA). The CAP sets out a 10 year strategic framework for balanced natural resource management across the rural, coastal and urban catchments of the CMA area. The CAP defines targets and direct investment of public and private resources to achieve sustainable natural resource management in line with community expectations. The HNCMA is in the process of reviewing/updating the CAP, and it will be important that the new CAP supports the aims and objectives of this CZMP.

The CAP has a key role in addressing the priorities of the NSW State Plan. The NSW State Plan Priority E4 identifies targets which will guide the implementation of the CAP to ensure better outcomes for native vegetation, biodiversity, land, rivers and coastal waterways, such as the Lane Cove River Estuary.

Within the CAP, Catchment Target CTECM1 states that "By 2016, there is an improvement in the condition of estuaries and coastal lakes". This catchment target relates directly to the aims and objectives of this Lane Cove River Estuary Coastal Zone Management Plan, while the CZMP would also contribute to Catchment Target CTW1 "By 2016 there is a net improvement in the health of modified waterways and riparian corridors and conservation of natural waterways". The CAP identifies a number of Management Targets that will contribute to improvements in the condition of estuaries. The CAP states that the most important benefit of a coordinated approach to estuary management is the rationalisation of conflicting policy and operational objectives across State and Local Government institutions, so that clear and consistent objectives and valuing of estuary health emerge. This is particularly pertinent for the Lane Cove River Estuary Coastal Zone Management Plan, which transects four different Local Government Areas.

The preparation and implementation of this Lane Cove River Estuary Coastal Zone Management Plan is evidently a critical step towards achieving the desired outcomes of the CAP. Indeed, this Coastal Zone Management Plan will help to achieve Catchment and Management Targets across the entire spectrum of Biodiversity, Water, Land and Community issues that are central to the CAP.

Table 1-3: Key CAP Management Targets Relevant to Estuary Management

Management Target	Description
MTECM1.1	By 2016 the threats posed by marine pests have been reduced
MTECM1.4	By 2016, new in-stream and foreshore structures are designed and constructed in an ecologically sensitive manner
MTECM1.5	By 2016 the condition of estuaries and coastal lake systems will be maintained or improved through development and implementation of natural resource management plans (including estuary management plans)
MTECM1.10	By 2016, the extent, condition and connectivity of estuarine vegetation is

	maintained and/or improved by facilitating the protection and rehabilitation of estuarine vegetation at high priority sites
MTW5.2	By 2012 local councils have incorporated and implemented provisions in the revised LEPs, DCPs and related codes and policies that promote WSUD and other practices that reduce the impact of stormwater on the environmental values of waterways
MTECM2.3	By 2016 active management will protect or improve key estuarine and marine habitat areas in partnership with relevant authorities and user groups
MTW1.1	By 2016 selected high priority reaches of waterways and riparian corridors are protected and rehabilitated

2 BACKGROUND

2.1 Study Area

The Lane Cove River is a tributary of Parramatta River and is located within 5 km of the Sydney Central Business District (CBD). The river's source is around Pennant Hills and Hornsby and its catchment boundary is the Pacific Highway, Pennant Hills Road, Blaxland Road, Victoria Road and Ryde Road. The study area is the estuarine reaches of the Lane Cove River, approximately 11 km upstream from the confluence of the Lane Cove River and Parramatta River, flowing from the concrete weir at Fullers Bridge (Delhi Road) to east of Greenwich Point, where it joins the Parramatta River and then Port Jackson (refer to APPENDIX H Figure 1). The estuary drains a catchment area of approximately 88km^2 and seven local government areas fall within the catchment (wholly or partially). The total area of the estuary to the high water mark is 3 km^2 and is managed by four Councils: Lane Cove, Hunters Hill, City of Ryde and Willoughby.

As the estuary is downstream of the Lane Cove National Park and is close to the Sydney CBD, it provides a valuable ecological resource as well as a recreational area for Sydney residents and visitors. Sections of the valley are richly forested and are protected within the Lane Cove National Park, an area of 598 hectares, formerly a State Recreation Area.

2.2 Planning Process

The Lane Cove River Estuary Planning Process commenced under the guidance of the former Estuary Management Manual (1992) and an Estuary Management Plan (EMP) was produced in 2004 by Patterson Britton and Partners Pty Ltd (PBP) on behalf of the Lane Cove River Estuary Management Committee.

The actions within the EMP (2004) had originated from various sources including the Lane Cove River Data Compilation Study (1997), Lane Cove River Estuary Processes Study (2000) and Lane Cove River Estuary Management Study (2002). The EMP was finalised and adopted by the Councils and the committee in 2004.

A time line of the recent and future studies that will influence the management of the Lane Cove River Estuary is included in Figure 2-1.

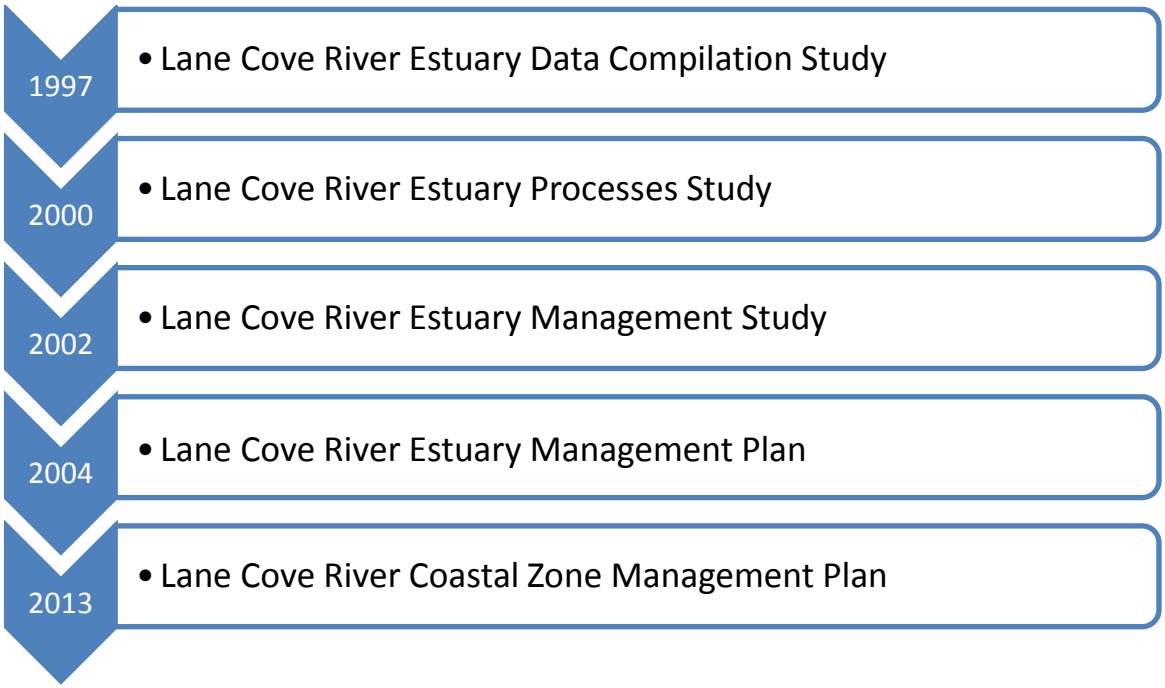

Figure 2-1: Timeline of Recent and Future Studies for Lane Cove River Estuary

2.3 Lane Cove River Estuary Processes

A comprehensive Estuary Processes Study for the Lane Cove River was carried out by Patterson Britton & Partners Pty Ltd in 2000, and forms the necessary prerequisite stage to this Coastal Zone Management Plan. It documents the key physical, chemical and biological processes occurring within the Lane Cove River Estuary (and catchment) that have an impact on the existing condition of the waterway and its future management needs and limitations.

Presented below is a summary of the previous Estuary Processes Study.

2.3.1 Estuary/Catchment Characteristics

The Lane Cove River estuary is classified as a drowned river valley estuary, characterised by an open mouth and semi-enclosed bays with sub-aqueous deltas. Being relatively deep and narrow with steep rocky sides, consequently there is little attenuation of tidal range. These features are characteristic of estuaries in the Sydney region, which exhibit an erosional topography that has been developed in massive, thick bedded sandstones that crop out as cliffs at the coast. The Lane Cove River estuary has many of these characteristics. Paleo tidal delta sands have intruded into the lower reaches from the Parramatta River, behind which, mud basins such as Woodford, Tambourine and Burns Bays have been slowly infilling. In the upper reaches, contemporary fluvial deltas such as at the mouth of Buffalo Creek are prograding over the upstream end of the mud basin. Tidal range throughout the estuary is unrestricted except in areas where intertidal fluvial deltas exist.

2.3.1.1 Land Use

The Lane Cove River catchment is dominated by low to medium density residential housing, although there are substantial pockets of open space (e.g., Blackman Park) and bushland (e.g., Lane Cove

National Park). Major commercial and light industrial centres are also located in the catchment, including those at North Ryde, Top Ryde, Eastwood, Epping, Lane Cove and Gordon.

Although the primary land-use of the catchment is urban, a substantial portion of the catchment is dominated by open space and bushland (approximately 24%). However, many of the bushland areas in the catchment are long and narrow, and are fragmented by intrusions and development. These remnants of native bushland suffer heavily from urban impacts, particularly weed invasion. Similarly, native flora and fauna species diversity and numbers suffer from urban pressures on those remaining bushland habitats, although bird species diversity and numbers are high.

2.3.1.2 Geology

The geology of the Lane Cove River catchment is dominated by Hawkesbury Sandstone overlain by a thin layer of Wianamatta Shale. However, the Lane Cove River and its tributaries have cut deeply and widely into these formations leaving only remnants of shale on ridges with sandstone found on the valley slopes down to the river. The underlying geology of the estuary is similar to the geology of the ridges that intersect the river at the land surface. This feature is characteristic of a drowned river valley estuary, in which oceanic waters have penetrated the land mass as sea level rose, infilling the valleys formed by the earlier erosion of the Hornsby Plateau. The Hornsby Plateau is made up of a series of horizontal layers of sedimentary rock formations.

2.3.1.3 Catchment Soils

Sandy soils of the Lane Cove River catchment are usually located on the valley slopes of the catchment. Patches of alluvial soils are found on the flatter areas along the Lane Cove River and its tributaries. The main soil landscape away from water bodies that form the Lane Cove estuary are the Gymea and Glenorie soils. Along the waterways the soils range from colluvial in the steeper sections, to residual and fluvial along the flatter areas adjacent to Lane Cove River.

2.3.1.4 Topography

The topography of the Lane Cove River catchment is typical of the Sydney Basin with altitudes varying from 0 to approximately 240 metres above sea level. The northern boundary of the catchment is formed by the Pacific Highway and Pennant Hills Road. The highest point in the catchment is located at the Wahroonga Reservoir and is at an elevation of 241 metres above sea level. The catchment of the lower Lane Cove River consists of an undulating floodplain deeply indented with bays into which Tannery, Tambourine and Gore Creeks drain. The floodplain is relatively narrow and is at typical elevations of 2 to 3 metres above sea level.

2.3.1.5 Estuary Bathymetry

The bathymetry of the Lane Cove River downstream of the weir can be described in terms of three distinct reaches. These reaches are:

Reach 1: Lane Cove River weir downstream to the Epping Road Bridge;

Reach 2: Epping Road Bridge downstream to the mouth of Bums Bay; and,

Reach 3: Bums Bay downstream to the Parramatta River.

The first of these reaches extends for about 2.5 kilometres downstream from the weir. The contemporary bathymetry along this reach is characterised by highly variable water depths which typically range from 5 to 9 metres below MSL. This reach of the river is typically deeper than those estuarine reaches further downstream. Nonetheless, deltaic shoals are evident from the available hydrosurvey in the mouths of Swaines and Blue Gum Creeks.

The second reach of the river extends for 5.5 kilometres below the Epping Road Bridge. Water depths along this reach are relatively constant, averaging from 3 to 4 metres below MSL. Shallow shoals also exist in the vicinity of the mouths of tributaries that drain to the estuary such as Buffalo and Kittys Creeks.

The channel thalweg along the lower reach of the estuary increases in depth with distance downstream. Hydro surveys show the thalweg depth immediately downstream of Burns Bay to be about 3 metres below MSL. These same hydro surveys indicate that the river gradually deepens until the mouth of the river where it approaches 12 metres below MSL.

2.3.2 Estuary Uses

The estuary and surrounding catchment is used widely for many recreational activities. The waterways and associated bushland are valued for their passive and active recreational uses as well as their ecological attributes. There are a number of ferry wharves, boat launching facilities, tidal swimming enclosures, boating clubs, playing fields and picnic areas located along the estuarine section of the river. The Lane Cove National Park is located adjacent to the river at Chatswood West, and extends upstream to West Pymble. The National Park is a valued feature within the estuary catchment and is used extensively for bushwalking and picnicking. Conflicts between users and pressure for improved facilities have been identified by estuary users. The major uses of the estuary are:

- Boating
- Fishing
- Swimming and Bathing
- Parks and Reserves
- Golf Courses
- Bushwalking
- Commercial Uses

2.3.3 Tidal and Fluvial Hydrodynamics

Tides along the NSW coast in the vicinity of Sydney Harbour are semi-diurnal in nature. That is, high and low tides generally occur twice each day. They are sinusoidal in shape and successive high tides differ in magnitude (known as diurnal inequality). The ocean mean spring tidal range is approximately 1.2 metres.

2.3.3.1 Tidal Planes and Tidal Range

A comparison of water levels and the timing of high and low water along the estuary indicated that tidal fluctuations are similar to those recorded at Fort Denison. Hence, the tidal planes for Fort Denison can be adopted for the majority of the Lane Cove River estuary. Fort Denison data is representative of ocean tide conditions. Hence, the estuary experiences the full tidal range

throughout, which is a defining characteristic of a drowned river valley estuary. Furthermore, the data indicates that the estuary exhibits a co-oscillating tidal regime in which the incoming tidal wave is almost fully reflected over the tidal cycle.

2.3.3.2 Tidal Discharges and Velocities

There was considerable variation in tidal flux across the width of the river, particularly on the flood tide. The variability highlights the occurrence of localised areas of higher tidal velocity up to 50% greater than in adjacent areas. This could be due to localised shoals located downstream of Butchers Block Point which cause the incoming flood tide wave to be directed into the deeper channels within the estuary. The flood and ebb tides are concentrated along the right bank of the estuary at Butchers Block Point (i.e., as viewed looking downstream). The area adjacent to the left bank near Longueville Wharf is a zone of relatively low velocity (i.e., up to 50% lower than other sections of the channel).

2.3.3.3 Estuary Flushing

Tidal action in an estuary provides a flushing action during dry weather conditions. Work undertaken by Sydney Water as part of the Clean Waterways Program, established that flushing times in the lower estuary are in the range of three to seven days. Flushing times upstream of Epping Road were determined to typically be 7 to 10 days. Unfortunately, the specific reports detailing the basis for these estimates of flushing times was not available. Hence, a full presentation and discussion of the flushing potential using this data could not be presented.

The volume of water introduced on the flood tide is referred to as the tidal prism P. It can be determined by either integrating a discharge curve, or by multiplying the planar area of the waterway by the tidal range. The tidal prism for the Lane Cove River estuary was calculated to be 2.8×10^6 m^3. This was based on an estimated waterway area of 2.82 km^2.

2.3.3.4 Hydrology

Flooding potential in the Upper Lane Cove River catchment is limited because of the relatively short length of tributaries and the steepness of the catchment, which results in the quick rise and fall of stream height. Overbank flooding can occur in a 1 in 20 year recurrence flood, although a 1 in 50 year recurrence flood is required to produce widespread flooding. Flooding in the estuary and away from the creeks is generally limited to isolated areas where stormwater infrastructure cannot cope with the increased flow.

2.3.3.5 Water Balance

Water can enter the Lane Cove River system via a number of sources, including tides, local catchment runoff, and from direct rainfall on the waterway area. Based on an average annual rainfall of 1,138 mm, and a typical volumetric runoff coefficient of 0.35, the average annual catchment runoff from the Lane Cove River catchment (95 km^2) is estimated to be 38.2×10^6 m^3. The tidal prism of the Lane Cove River is approximately 2.8×10^6 m^3. As this volume enters every tide (i.e., every 12.5 hours on average), the total volume of ocean water entering the estuary is approximately $1{,}972 \times 10^6$ m^3 per year. The effective waterway area of the Lane Cove River is approximately 2.8 km^2. Therefore, the average annual volume of water entering the Lane Cove River through direct rainfall on the waterway (assuming average annual rainfall of 1,138mm) is approximately 3.2×10^6 m^3.

Based on the results of analyses presented above, the total average annual volume of water entering the Lane Cove River estuary is approximately 2,013 x 10^6 m^3.

Losses from the system include the discharge of tide and flood flows through the river entrance, as well as evaporation from the exposed water surface. Evaporation in the Lane Cove River region was estimated based on daily evaporation data for Sydney Airport obtained from the Bureau of Meteorology. Average annual evaporation from the waterway was estimated to be 600 mm per year.

Therefore, the average total volume lost due to evaporation would be approximately 1.7 x 10^6 m^3 per year. The remaining volume exits the Lane Cove River system to the Parramatta River, via the river entrance.

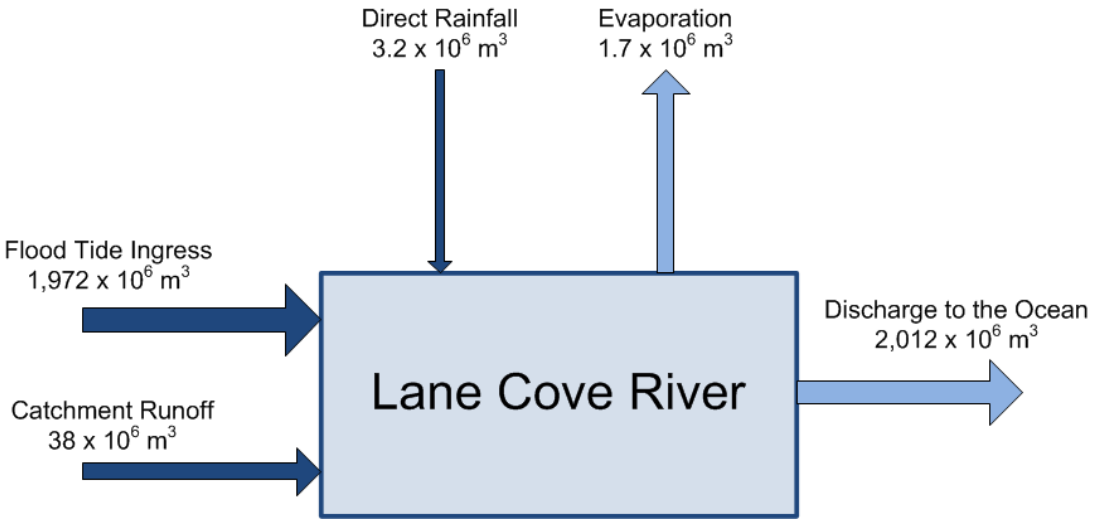

Figure 2-2: Water Balance Summary

2.3.3.6 Pollutant Export Rates

The Lane Cove River catchment comprises of a number of different land uses, all of which have different pollutant runoff characteristics. Pollutant runoff loads from the sub-catchments were determined in accordance NSW EPA guidelines (EPA, 1997) and were based on the following equation:

Pollutant Load (kg/year) = P x Cv x C x A, where, P = average annual rainfall (mm), Cv = annual average volumetric runoff coefficient (dimensionless), C = average (log-mean) event mean pollutant concentration (EMC) (mg/l) and A = sub catchment area (km^2).

The total pollutant runoff loads to the estuary for suspended solids, phosphorus, nitrogen and faecal coliform were calculated to be 264,000 kg/yr, 849 kg/yr, 12,000 kg/yr and 566 Tcfu/yr respectively. As expected, the largest and most heavily developed sub catchments, including Lane Cove Headwaters, Devlin Creek, Terrys Creek, Shrimptons Creek and Buffalo Creek, contributed the greatest pollutant runoff loads to the estuary.

2.4 Sedimentary Processes

Sediment build-up appears to be occurring particularly adjacent to the shoreline along the lower reaches of the estuary and at the mouth of tributary creeks. Hence, the estuary can be considered to be in a state of dynamic sediment settlement and deposition.

By the 1880s mudflats had formed along the banks of the Lane Cove River. Mangroves had colonised areas of the estuary where they previously had not been encountered. Elsewhere along Buffalo and Kittys Creeks, mangrove densities increased in parallel with the increased sedimentation of the tributary mouths. It was estimated that an average of 1.2 metres of sediment was deposited across the bed of the estuary.

The hydro survey comparison suggests that an average depth of 1 metre of sediment has been deposited since the catchment was cleared during the early 1800s. Further interpretation of the data suggests that between 0.3 and 0.7 metres of this infilling has been deposited since urbanisation of the catchment during the twentieth century.

Contemporary sedimentation patterns also indicate deposition within the northern embayments of the estuary, and particularly within Burns, Tambourine and Woodford Bays. These observations confirm the results of investigations completed by the University of Sydney, which showed the presence of trace metals in bed sediments of these embayments. These trace metals have origins that can only be related to the impacts of European settlement, and therefore indicate that anthropogenic influences are the most significant cause of sedimentation within these bays.

2.5 Water Quality Processes

The greater proportion of the water quality monitoring and assessment has been undertaken by Sydney Water Corporation as part of their Clean Waterways Program. This program commenced in 1991 and involved the assessment and monitoring of water quality within the receiving waters of all Sydney catchments. Water quality monitoring within the estuarine and freshwater reaches of the Lane Cove River was undertaken between 1991 and 1997.

A summary of the major water quality studies completed in the Lane Cove River catchment was prepared as part of the 'Lane Cove River Catchment Stormwater Management Plan (1999). A recent report on the water quality of the river has been completed by BMT WBM and is presented in APPENDIX G.

2.6 Biological Processes

2.6.1 Flora

Saltmarsh communities are often bounded by a seaward fringe of mangroves and by rushes on the landward side. This sequence of vegetation is particularly evident in the Lane Cove River estuary between the mouth of Stringybark Creek and Blackman Park. Other saltmarsh communities are located in Woodford Bay, near Mowbray Park, Ferdinand Street Reserve, Hunters Hill High School and at the mouths of Gore, Brickmakers, Buffalo, Tambourine and Stringybark Creeks. Based on aerial photographs, there is about 8.9 ha of saltmarsh in the Lane Cove River estuary. However,

anecdotal reports indicate that the areal extent of saltmarsh within the estuary has been declining due to sedimentation and mangrove colonisation of intertidal areas.

The Grey Mangrove (*Avicennia marina*) can be found along several reaches of the lower Lane Cove River. Significant stands exist within Tambourine Bay and between Brickmakers, Buffalo and Kittys Creeks, as well as along both banks of the river between the Epping Road and Delhi Road bridges. The River Mangrove (*Aegiceras corniculatum*) also occurs along the shoreline of the upper estuary, but it is generally less abundant than its larger counterpart (though no less important).

Sydney Sandstone Gully Forest (closed forest) is the predominant riparian vegetation community found along the tributaries of the estuary. Notwithstanding, isolated, but substantial patches of the Coastal Swamp Forest Complex, Open Scrub and Estuarine Complex also exist along the Lane Cove River. The riparian vegetation along many of the estuary tributaries is typically dominated by Open Forest Woodland Complex (e.g., Stringybark, Gore and Buffalo Creeks).

2.6.2 Fauna

Apart from fish studies undertaken in the 1970s and 1980s, the aquatic fauna of the Lane Cove River estuary is relatively unstudied. Some macroinvertebrate sampling has been undertaken by all four Councils. Native freshwater species of fish in the river include the Australian Bass, Australian Smelt, Coxs Gudgeon, Long-finned Eel, Native Minnow, Short-finned Eel and Striped Gudgeon (Lane Cove River CMC, 1998). It should be noted that many of the native fish species listed require access to freshwater habitats during their lifecycle. Accordingly, a fishway was constructed in 1999 to allow fish passage past the Fullers Weir.

Based on the available data, the native fauna of the Lane Cove River estuary includes mammals (predominantly possums and bats), reptiles (lizards, snakes and turtles), amphibians (frogs), insects and spiders, and birds. Introduced species including rats, feral cats, rabbits and foxes are also present and often compete with native fauna for resources or act as predators, resulting in increased pressures.

3 STAKEHOLDER CONSULTATION

3.1 Estuary Management Committee (EMC) Workshop

A committee workshop was conducted on 05/03/2012 at Lane Cove Council. The list of attendees included:

Jacqui Vollmer - Hunters Hill Council

Susan Butler - Lane Cove Council

Sam Cappelli - City of Ryde

Angelo Berios - Willoughby Council

Gus Pelosi - NSW Office of Environment and Heritage (OEH)

Lesley Diver - HNCMA

Dr Philip Haines, Reid Butler, Smita Jha - BMT WBM Pty Ltd

During the meeting, every action outlined in the existing EMP 2004 was discussed to determine how and the extent to which an action was implemented, the effectiveness of the action, and outstanding issues or improvements to the action which could be made. Where an action was not implemented, the reasons for this, the future need for the action and possible improvements to aid its implementation were determined.

A risk assessment workshop was undertaken on the same day following the EMP 2004 review Please refer to Table 6-8 for details.

Some risks, identified during their internal risk assessments, were subsequently brought forward by the Councils and the Committee members, which have been included in this risk assessment process. Once a risk was considered still relevant, a rating of the potential impact and the frequency of the risk was determined by the committee and an overall risk rating assigned.

3.2 Community Workshop

A community workshop was held at Lane Cove Council on 14/08/2012 to inform the community about the status of project, the aims and actions identified and to get their view on the proposed actions. A feedback form was distributed to all the community members and they were asked to score the listed actions and provide their comments. The community score for the all actions has been included in the actions prioritisation in Table 8-2.

The community concerns related to the Lane Cove River estuary and how they have been addressed in this Plan are given in Table 12-3. The ranking of actions are presented in Table 12-4 in APPENDIX C.

3.3 Community Feedback on Draft Lane Cove River CZMP

The Draft Lane Cove River Coastal Zone Management Plan (CZMP) was on public exhibition from 13 May 2013 until 24 June 2013 and members of the public were invited to give their opinion on the Plan

The comments received and how they have been addressed in the Plan is given in APPENDIX F.

4 REVIEW OF LANE COVE RIVER ESTUARY MANAGEMENT PLAN 2004

The Lane Cove River Estuary Management Plan (EMP 2004) was prepared by Patterson Britton and Partners Pty Ltd (PBP) in 2004 for Lane Cove, Hunters Hill, City of Ryde and Willoughby Councils. The plan provided a list of strategic measures that could be implemented across the area in order to meet objectives determined through consultation with key stakeholders.

This section reviews the implementation status of the strategies mentioned in the Lane Cove River EMP 2004.

4.1 Implementation Status of Strategies

The Lane Cove River Estuary Management Plan (EMP) was finalised in 2004. Each of the management objectives, which directly addressed each of the estuary's issues, have been listed below, along with a description of how, and if, the objective of the EMP 2004 was achieved based on the completeness and performance of strategies, and recommendations for further action. These are summarized in Table 4-1 at the end of this section.

4.1.1 Objective 1: Minimise Impact of Development and Human Activities

Objective partly achieved.

Two out of the four strategies to achieve this objective are considered complete and two are partially complete and are ongoing.

Regarding strategy 1, Lane Cove Council LEP (2010) is based on the comprehensive LEP (2010) template which is currently being reviewed. Hunters Hill Council's LEP has been reviewed, gazetted and consolidated DCP is currently being prepared to be adopted by the Council before August 12 2013. The NSW Department of Planning and Infrastructure (DoP) has issued the S65 certificate for City of Ryde's draft comprehensive LEP, community exhibition has been completed and the Council is currently reviewing submissions. Willoughby Council's LEP (2012) is also based on the comprehensive DCP template.

Regarding strategy 2, Sydney Harbour Catchment REP and DCP were developed by the Department of Planning in 2005. Hunters Hill Council has a foreshore building line control (mostly 10-15 metres above high water mark) for all relevant properties. Lane Cove Council has the controls for some properties only as mapped in the LEP 2009. The Willoughby LEP (2012) includes foreshore building line requirements for the property known as 170 Epping Road, Lane Cove North. City of Ryde has a foreshore building line clause in the DCP 2010 but has no specific controls in its DCP or LEP.

Lane Cove River Estuary Community Education Kit was prepared by T Issues Consultancy and Terra Cordis in 2009 for all four Councils involved. This kit aims to increase awareness in the community, achieve reduction in polluting behaviour, increase conservation behaviour, promote positive feelings for the unique environment and encourage use of the estuary for low impact, ecologically sustainable

recreation. An estuary map illustrating the Lane Cove River boat trips has been prepared by Patterson Britton and Partners for Lane Cove and Hunters Hill Councils.

An aboriginal sites report has been completed by the Northern Sydney Aboriginal Heritage Office for all estuary Councils. Lane Cove, City of Ryde and Willoughby Councils are partners in the Northern Sydney Aboriginal Heritage Office.

Recommendations:

- Await finalization of all LEPs and monitor the effectiveness over time,
- Provide guidance on updated DCPs and LEPs which are stricter on development controls, particularly during construction,
- Establish consistent foreshore building line controls across all Councils.

4.1.2 Objective 2: Improve Water Quality

Objective partly achieved.

Some local schools have been participating in "Streamwatch" program, a water monitoring program formerly run by Sydney Water and now Australian Museum.

Strategy 6 has almost been complete which included a study on landfill at Blackman Park, Lane Cove done by Coffey environments. Porters Creek, City of Ryde is under OEH management system and reporting requirements. Monthly water quality testing and reporting are to comply with the management plan.

The water quality review shows some reduction in faecal contamination of swimming pools since the Northside Storage Tunnel (NST) was commissioned in 2001. SewerFix abatement strategies are currently being designed to reduce overflows from Gloucester Avenue, upstream of the Lane Cove River estaury.

Some recent sampling results for faecal coliforms and enterococci are available for the harbour swimming sites at Tambourine Bay, Woolwich Baths and Woodford Bay. The beach suitability grade for Tambourine Bay is "poor" indicating microbial water quality is influenced by faecal pollution, usually triggered by rainfall, with potential faecal contamination from stormwater, sewer chokes and sewage overflows in the Lane Cove River catchment. The beach suitability grade for Woolwich Baths is "fair" indicating microbial water quality is occasionally susceptible to faecal pollution, usually triggered by rainfall, with potential faecal contamination from river discharge, stormwater and sewage overflows in the Lane Cove River catchment. The beach suitability grade for Woodford Bay is "good" indicating microbial water quality is suitable for swimming most of the time but the water may be susceptible to pollution from several potential sources of faecal contamination including sewage overflows in the Lane Cove River.[3]

Sydney Water's SewerFix consultation workshops were completed in 2010 with local community groups and Council officers from each LGA. The aim was to develop knowledge of best management of wet weather sewerage overflows and identify preferred strategies to reduce overflow frequency and environmental impacts and to protect public health. During this planning phase the focus was on

[3] *The Harbourwatch Program, NSW OEH, State of the Beaches 2010-11 Report for Sydney Estuarine Beaches* http://www.environment.nsw.gov.au/beach/ar1011/index1011.htm

one of the worst area - Gloucester Avenue on Lane Cove River.[4] Wet weather monitoring was not funded but dry weather monitoring has been ongoing at City of Ryde.

Lane Cove Council and City of Ryde have committed to the Sydney Harbour Water Quality Improvement Plan (SHWQIP) which is Hawkesbury-Nepean Catchment Management Authority's (HNCMA) project. This Plan aims to develop a catchment wide approach to improving the quality of Sydney Harbour. A technical report, Sydney Harbour Catchment Water Quality Improvement Plan (Data Compilation and Review), has been prepared by Water Research Laboratory, University of New South Wales in July 2011 for HNCMA.

Although strategy 9 (determine and adopt water quality parameters for all reaches of the estuary consistent with the Interim Environmental Objectives of NSW Water Reforms) was not funded for the whole estuary, Willoughby Council developed a Technical Standard for Water Quality within its DCP (2004) with an objective to minimise water pollution from new developments.

Strategy 10 was not funded, however, separate to this task, Willoughby and Lane Cove (along with North Sydney and Mosman) Councils developed a water quality plan with consistent parameters in 2009. This plan is not specific to Lane Cove River.

City of Ryde has implemented a biological and chemical water quality monitoring program targeting five main creek systems (including Buffalo Creek, Terry's Creek, Shrimptons Creek and Porters Creek). The program began in September 2004 and was delivered over 7 years, finishing in 2011. Sampling occurred each year during the months of spring and autumn. City of Ryde is also part of a separate macro-biological monitoring program being conducted in the Middle Harbour and Lane Cove River Catchments since 2001 involving Willoughby, North Sydney, Lane Cove, Hunters Hill, Kuringai and City of Ryde. Biological sampling is undertaken to monitor the diversity and abundance of aquatic macro invertebrates in creeks.

During the construction of the Epping to Chatswood Rail Link, environmental reports were submitted to Councils on a 6 monthly basis. This project has now been completed.

Strategies 12, 13 and 14 were not funded. Strategy 15 has been commenced and is considered complete for this review.

Various catchment based projects including Gore Creek and Stringybark Creek projects have been started in Lane Cove.

Strategy 18 was not funded and hence is considered to be removed from the action plan.

Regarding strategy 19, Hunters Hill Stormwater Management Action Plan (SWMAP) has been prepared by Storm Consulting in November 2011 for Hunters Hill Council. The SWMAP includes investigations into existing stormwater treatment measures, including their location, maintenance and effectiveness in the treatment of pollutants. In addition, it provides an Action Plan to assist with achieving the goals within the Council's 2008 Sustainability Plan.

Repairs to the Northern Suburbs Ocean Outfall System (NSOOS) were carried out as a part of Sydney Water's $560 million SewerFix Program to protect public health and the environment. It

[4] *Hunters Hill Trust Journal, Nov 2010, Vol. 48*
http://huntershilltrust.org.au/wp-content/uploads/2011/03/Vol-48-No-2-November-2010-3.pdf

includes the Avoid Fail program, which aims to improve the overall performance of the wastewater system by ensuring large wastewater systems do not fail in their operation and cause overflows.

Work to repair sections of the NSOOS is completed at Greenwich, Lane Cove, Cremorne and Manly. The work involved crews entering the NSOOS via maintenance holes to clean decayed concrete from the pipe's roof and walls, replace corroded joints and repair the internal structure of the maintenance hole. A coating was then applied to protect the roof and walls of the pipe. This will ensure the structural reliability of the NSOOS for many years to come.[5]

All Councils are involved in foreshore rehabilitation, erosion controls and gross pollutant traps which all contribute towards improved water quality.

Hunter's Hill Council has adopted a 10 year stormwater improvement program. This program includes funding specifically for the treatment of stormwater outlets, which open into the Lane Cove and Parramatta Rivers. All works that involve modifications to stormwater systems at the rivers will include some form of treatment to improve discharge water quality.

All the Councils have been conducting macro invertebrate testing. Samples taken at these sites are analysed by independent laboratories and the results produced in terms of a SIGNAL and AusRivaS index. The scores from these indexes help scientists to assess the environmental stress being experienced by the waterways. These sites give Council an indication of the conditions of receiving waterways and help to show how well actions being taken to improve water quality are performing. The results of these testing are given in Table 7-1.

Lane Cove Council completed an audit of its stormwater network in 2008/09. There were two main parts to the audit. The first was to physically locate and survey the network so it can be accurately represented on the GIS. Secondly, a condition assessment of the system was undertaken for inclusion into Council's asset management system. This information will be used to establish long term maintenance and upgrade program for the system.

City of Ryde is focussed on reducing stormwater pollution and increasing water quality through a variety of catchment and asset projects. Creek rehabilitation and bio-retention systems at Santa Rosa Park on Shrimptons Creek and the provision of a stormwater quality improvement device and constructed wetlands on Buffalo Creek are other examples of projects undertaken by City of Ryde to better manage the local stormwater catchment.

Recommendations:

- Sewage Pumping Stations near the river's edge may be impacted by sea level rise. Hence, investigate the level of risk,
- Water quality targets to be developed as a part of this review for all Councils,
- Ensure future reporting through SoE or the other central database is consistent and relevant to Lane Cove River Estuary,
- Continue monitoring programs for each Council and collate data on an estuary wide basis, using SoE reporting framework,
- There is a lack of inflow water monitoring. This data gap limits the accuracy of

[5] *The NSOOS is northern Sydney's largest wastewater system and runs from Blacktown to North Head Wastewater Treatment Plant in Manly.*
http://www.sydneywater.com.au/MajorProjects/North/NSOOS/oldindex.cfm

Lane Cove River catchment inflows to determine the effectiveness of management actions, as no calibration data will be available. Hence, installation of flow/level gauging on the Lane Cove River should be investigated,[6]

- Review GPT locations for future implementation. The existing stormwater treatment devices should be maintained at regular intervals to increase the overall effectiveness.

4.1.3 Objective 3: Education/Raising Community Awareness

Objective achieved.

A report, Lane Cove River Estuary Education Kit has been prepared by T Issues and Terra Cordis in 2009 for Lane Cove, Hunters Hill, City of Ryde and Willoughby City Councils. This Kit provides a range of education material and processes designed to provide Council staff with all that they need to deliver education that impacts on the community's connection with, and protection of the River.

City of Ryde and Hunters Hill Councils recently completed the Catchment Connections project funded by the NSW Environmental Trust. It is a three year project which aims to improve the water quality of local creeks, preserve and enhance remnant bushland areas, improve local biodiversity, some water sensitive urban design (WSUD) initiatives and increase community involvement in Bushcare activities. Catchment Connections covers over 2,000 hectares (20 km^2) across the Terrys Creek, Mars Creek, Shrimptons Creek and Buffalo Creek catchments, which are all tributaries of the Lane Cove River.

The final year of the project saw the implementation of a range of educational initiatives which have engaged thousands of stakeholders (10,150 people from 650 organisations) through workshops, nature walks, public lectures, a home advisory service and events such as tours, a festival and a staff seminar. Stakeholders ranged from school children to major global corporations.

The River to River Corridors Project is a 3 year NSW Environmental Trust Grant project between City of Ryde and Hunters Hill Council. The aim of the project is to protect and restore existing habitat and plant new habitat to reconnect two key wildlife corridors that link the Lane Cove and Parramatta Rivers. This will assist native wildlife to move through and survive in the local landscape. The project involves community engagement in corridor plantings in both public and private lands i.e. encouraging corridor residents to plant in their gardens.

All schools in the Hunters Hill LGA were offered free environmental education workshops in 2010-2011 under the Catchment Chronicles program. Students learnt about the impacts of littering, dumping weeds in the environment, excessive use of fertilisers and chemicals and benefits of reducing stormwater and recycling waste. It was a one-off program as part of Keep Australia Beautiful. Saint Ignatius' College, Riverview holds a "Catchment Day" every year inviting schools in the Lane Cove River catchment area to participate in a series of short environmental activities.

Lane Cove Council runs a boat trip along the estuary each Spring during which specialist speakers talk about the history, geography and biology of the estuary.

[6] *Sydney Harbour Catchment Water Quality Improvement Plan: Data Compilation and Review 2011, prepared by Water Research Laboratory, UNSW*

4.1.4 Objective 4: Improve Navigation and Reduce Channel Sedimentation

Objective partly achieved.

Strategies 23 and 25 were not funded as Burns Bay mouth was not dredged. Strategy 24 is considered complete.

City of Ryde has a request for Erosion and Sediment Control Plan (ESCP) which must be prepared for construction sites between 250 and 2500 m^2 (area of disturbed land) and approved prior to any Construction Certificate being issued to undertake development on a property involving the disturbance or placement of soil on the land.

Willoughby Council has developed Technical Standard for Sediment and Erosion Control within its DCP. Lane Cove Council DCP has Erosion and Sediment Control plan requirements in the Stormwater Management section.

Hunters Hill Council has soil erosion and sediment control guidelines but no technical plans are required for construction sites.

The majority of actions relating to this risk have been implemented. This has reduced the level of risk associated with catchment sourced pollutants, so long as the measures devised to address this risk continue to be implemented. However, there is an opportunity to further reduce the risk of catchment sourced pollution, by enhancing and expanding upon activities currently undertaken.

Recommendations:

- Ensure continuous inspection, maintenance and upgrade of the stormwater treatment network, particularly at outlets to the waterway, to provide the highest level of pollutant removal (such as for nutrients, oils and other contaminants, in addition to litter and sediment).
- Ensure all DCP reviews incorporate a high standard of environment protection for the estuary.

4.1.5 Objectives 5, 6: Protect Estuary Fringing Flora, Aquatic Flora and Fauna

Objectives partly achieved.

The Lane Cove River Estuary Saltmarsh Mapping project was completed by Applied Ecology in April 2010. This included a Saltmarsh Site Assessment Report, Saltmarsh Planning Manual and Saltmarsh Monitoring Manual. The aim of this report is to provide an overview and advice on planning for healthy saltmarsh communities into the future. The report, prepared with funding sourced through the NSW Government's Estuary Management Program, covers planning for rehabilitation, legislative requirements, and management of threatening process.

City of Ryde has mapped riparian zones for two waterways namely Buffalo Creek and Shrimpton's Creek and has future plans to map all remaining riparian zones in the catchment. City of Ryde is currently reviewing vegetation communities with the NSW OEH.

Hunters Hill Council mapped vegetation at Boronia Park, Buffalo Creek and Ferdinand Street reserve in 2010.

NSW DPI completed a study on occurrence of freshwater macrophytes in the Lane Cove River catchment area in 2009 in conjunction with the HNCMA and NSW Maritime.

A longer, lower fishway was built at Lane Cove weir which allows greater utilization by fish. The original fishway, built on the upstream side of the weir, was only accessible at the top of the tidal cycle when water covered a step in one of the weir's culverts. The new fishway is now accessible for half the tidal cycle, which makes it easier for fish to move into 30 km of upstream habitat. Work is continuing to improve the upstream (older) section of the fishway to further improve conditions for fish. NSW DPI, HNCMA and OEH, collaborated on the project with funding from CMA's Waterways Health Strategy and NSW DPI's Bringing Back the Fish project.[7]

In 2009, Lane Cove Council mapped the vegetation communities of all bushland reserves including the riparian corridors and foreshores. Lane Cove Council carried out enhancement of fish habitat by the rehabilitation of saltmarsh & mangrove communities in 2011 at Warraroon Reserve, Tambourine Bay. The actions in this project came from recommendations from two studies carried out in 2010, the Saltmarsh Report by Applied Ecology, which was part of a joint project between four LGAs along the Lane Cove River, and a second report by University of Technology, Sydney. Both studies recommended that bush regeneration, revegetation and stormwater control were required to protect and enhance the wetland habitats in Warraroon Reserve.

Recommendations:

- Continue bush regeneration programs across all councils,
- Flag areas potentially at risk due to Sea Level Rise,
- Allow land for migration of riparian vegetation,
- Prioritise restoration of estuarine vegetation where there is potential for retreat of the estuarine vegetation,
- Appropriate educational signage around the estuary foreshores,
- Encourage and assist preservation and revegetation of private foreshore areas.

4.1.6 Objective 7: Recreation

Objective considered complete.

Out of the three strategies recommended in the EMP, two have been fully completed (30, 32) and one is underway (31). A report, Assessing Public Health Needs for Recreational Users, was completed by Gondwana Consulting in 2011. This report assessed the adequacy of recreational facilities for foreshore and waterway users along the lower (11 km) section of the Lane Cove River Estuary. This project included an assessment of existing facilities, gap analysis, users surveys, focus groups, and strategies for the provision of additional facilities where required. The upgrading of Burns Bay boat ramp is underway.

The Actions from this report, relevant to this CZMP, are presented in APPENDIX E Table 12-6.

[7] *Newstreams No. 21, August 2009*
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/299022/Newstreams-21.pdf

4.2 Summary of EMP 2004 Review

Of the 33 actions (strategies) outlined in the existing EMP 2004, 11 have been implemented fully and 12 have been partially implemented with some still ongoing. Only 8 actions were not implemented, of which 6 are no longer relevant. The status of 2 actions could not be verified. In some cases the implementation of the action has resolved the problem, and no further work is required. More often, however, the actions require on-going commitment and maintenance.

Despite implementation of many of the proposed actions, some issues still pose a threat to the health and sustainability of Lane Cove River. Further, new aspects to some issues have become apparent. Even though all the issues have not been resolved, it is expected that the previous EMP 2004 has contributed to reducing the rate of degradation of the estuary over the past 8 – 10 years.

The development of the EMP 2004 also had broader long term benefits in facilitating the four councils to work together and jointly fund projects that address regional issues.

Table 4-1: Summary of Completeness of Actions in the EMP 2004

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
1. Coordinate DCP's/LEP's across the catchment (Lane Cove, Hunters Hill, Willoughby and Ryde LGAs) to ensure consistent planning and decision-making, particularly in areas adjacent to the estuary.	1. Identify and compile land-use management policy components across all Council LEPs that are relevant and specific to activities within the Lane Cove River estuary. 2. Review these land-use policies and development control measures and resolve inconsistencies. 3. Rationalise policies / development controls and combine to form a single DCP applicable to development within the estuarine catchment of the Lane Cove River. 4. Present Estuarine Catchment Development DCP to Committee and then to Councils for review/agreement. 5. Assuming acceptance, adopt the DCP and incorporate reference to it within revised LEPs.	LEPs based on DCP template, comprehensive DCP developed	LCC LEP 2010 based on template, comprehensive LCC DCP adopted 2010, currently being reviewed.	LEP has been reviewed and gazetted and consolidated DCP is currently being prepared to be adopted by Council before August 12, 2013.	City of Ryde Draft LEP has been exhibited and is awaiting Council consideration of submission before referring back to DoP.	WLEP 2012 is based on template.	
2. Develop controls for building and construction activities within 75 metres of the estuary shoreline/high water mark.	1. Develop detailed mapping of land-uses along estuary shoreline and ground-truth. 2. Break estuary shoreline into zones as a function of land-use. 3. Identify controls on activities within 75 metres of the estuary shoreline aimed at protecting the estuary from adverse human impacts (e.g. sedimentation from building activities). 4. Develop position paper with recommendation for each shoreline zone and submit to DIPNR for inclusion within Regional Environment Plan (REP). 5. Use REP forum to seek acceptance of Councils and incorporate acceptable Shoreline Controls into LEP.	Sydney Harbour Catchment REP & DCP developed by DoP 2005.				Foreshore Building Line requirements in WLEP for property known as 170 Epping Rd Lane Cove North. Also Acid Sulphate Soil requirements in WLEP covering low lying properties bordering river near Lane Cove North.	Some new and large developments close to estuary shoreline and featuring extensive excavation

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
3. Develop an estuary education program based on a brochure/handout outlining the importance of estuary processes and the potentially adverse impacts of accelerated development and inconsiderate recreational activities.	1. Develop an information package aimed at the whole community describing key issues facing the future management of the estuary. 2. Prepare multiple copies of the information package (and distribute) to the broader community with rates notices. 3. Develop targeted information packages related to the impacts of various estuary uses (e.g., amateur and commercial fishing, boating, urban runoff). 4. Distribute to selected community groups, such as recreational and commercial fishing groups and tourists, residents on the estuary fringe, boating groups). 5. Organise media coverage of on-ground works that are being implemented.	Lane Cove River Estuary Community Education Kit prepared by T Issues Consultancy & Terra Cordis in 2009	Estuary map for discovering the Lane Cove River boat trips prepared by Patterson Britton & Partners for LCC and HHC, Lane Cove River Estuary Community Education Kit prepared by T Issues Consultancy & Terra Cordis in 2009		Lane Cove River Estuary Community Education Kit prepared by T Issues Consultancy & Terra Cordis in 2009		
4. Develop an inventory of Aboriginal and cultural sites throughout the estuary.	1. Liaise with local Aboriginal groups to identify and document additional Aboriginal sites, particularly those identified through Council related works such as road reconstruction activities. 2. Require that archaeological surveys be undertaken in high probability areas as part of subdivision or development applications. 3. Liaise with the local Aboriginal community to determine the appropriate level of information for dissemination to the broader community.	Aboriginal Sites report completed for all estuary Councils by Northern Sydney Aboriginal Heritage Office	Aboriginal Sites report completed for all estuary Councils by Northern Sydney Aboriginal Heritage Office				

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
5. Undertake river water quality monitoring to establish whether old landfill sites located along the shoreline (e.g. at Blackman Park and along Porters Creek) are leaching pollutants to Lane Cove River.	1. Set-up a water quality monitoring program based on obtaining water quality samples from 3 sites along the river in the vicinity of each landfill location (*i.e., one at the point of likely leachate discharge, and one each upstream and downstream*). 2. Undertake sampling of pH, DO and other parameters under wet weather flow conditions. 3. Analyse results and report on likelihood of leachate discharge to river and associated impacts on water quality.	Not Funded		Local schools participating in stream watch.	Wet weather monitoring not funded. Dry weather monitoring has been completed and is on-going.		
6. Undertake groundwater and sediment testing to monitor leachate discharge to the river from old landfill sites located along the shoreline (e.g. at Blackman Park and along Porters Creek).	1. Set-up separate groundwater monitoring programs for Blackman Park and for Porters Creek. 2. Undertake monitoring on fortnightly basis over 6 months, and on 3 occasions following major rainfall in the catchment. 3. Document results and prepare detailed report for submission to Committee. 4. Committee to review report and determine actions as a consequence of groundwater monitoring results.		Coffey Study Nov 2010 on landfill at Blackman Park.		Porters Creek is under OEH management system and reporting requirements. Monthly water quality testing and reporting to comply with management plan.		

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
7. Assess the impact of installation and operation of the Northside Storage Tunnel on estuarine water quality.	1. Liaise with community committee for Northside Storage Tunnel to determine status of ongoing Sydney Water assessments. 2. Undertake water quality sampling at points upstream and downstream of the NSOOS overflow point during wet weather conditions. Monitoring is to include all chemical and biological water quality properties monitored by Sydney Water as part of the Pollution Abatement Program. 3. Carry out laboratory testing of samples collected monthly and from 3 wet weather events. 4. Document results and prepare detailed report outlining interpretation of effective benefit of Northside Storage Tunnel installation on estuary water quality.						
8. Establish the extent to which catchment runoff and other effluent discharges (*e.g., from sewer pipes*) is the primary factor for poor water quality during wet weather conditions, and which areas of the estuary are the major sources.	1. Determine and map locations of all stormwater drains and major sewers within the estuarine catchment. 2. Identify and map effective "catchments" for each system. 3. Compile existing water quality data and interpret to establish conceptual understanding of water quality process for each catchment. 4. Use conceptual models to identify priority listing of creeks/catchments potentially contributing greatest pollutant loads to the estuary 5. Set-up program for detailed monitoring of individual tributaries, and prioritise according to predicted contribution to poor estuary water quality.	Sydney Water SewerFix consultation workshops completed in 2010. Addressing sewer overflow issues at Gloucester Ave (Ryde). Aim to reduce frequency of sewer overflows.	Committed to the Sydney Harbour Water Quality Improvement Plan	10 years of macroinvertebrate sampling results for Brickmakers Creek, Boronia Park.	No wet weather monitoring at City of Ryde. City of Ryde has committed to the Sydney Harbour Water Quality Improvement Plan	Committed to the Sydney Harbour Water Quality Improvement Plan	Sewage pumping stations near river's edge may be impacted by sea level rise.

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
9. Determine and adopt target values for water quality parameters for different reaches of the estuary consistent with the Interim Environmental Objectives of the NSW Water Reforms.	1. Conduct a series of workshop with EMC members and Key Stakeholders to determine targets for key water quality parameters and indicators. 2. Prepare a Discussion Paper summarising the outcomes of the EMC / Key Stakeholders Workshop. 3. Present Discussion Paper and recommendations to Council, CMA and DEC for adoption. 4. Prepare summary brochure outlining adopted target values and distribute to the broader community 5. Incorporate water quality target values / objectives into relevant Development Control Plans.	Not funded			Not Funded	Developed Technical Standard for Water Quality within WDCP (2004) with objective to minimise water pollution from new development.	
10. Compile all estuary related water quality data and use it to develop a long term water quality monitoring program for the estuary (i.e., the river section) that cuts across LGA boundaries and considers the overall water quality processes within the estuary.	1. Assess sampling sites and associated testing currently undertaken by Councils, Sydney Water and DEC, and use to determine "benchmark" locations along the Lane Cove River for long term sampling and laboratory testing. 2. Review water quality "hotspots" within the estuary and consider relative to Task 1. 3. Consider stormwater quality monitoring program and design estuary wide program to be consistent and to avoid overlap. 4. Determine preferred set of sites for water quality monitoring, as well as parameters to be monitored and frequency of monitoring. 5. Submit water quality monitoring program to Councils and recommend its implementation.	Not Funded			City of Ryde 7 years of biological and chemical data to inform the Plan	Not Funded, Separate to this task Willoughby, Lane Cove, North Sydney & Mosman developed water quality monitoring plan with consistent parameters in 2009. This is not specific to Lane Cove River.	

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
11. Undertake estuary wide water quality monitoring over 5 years in accordance with the program established as part of Strategy 10.	1. Implement program outlined under Strategy 10. 2. Undertake water quality sampling and laboratory analysis. 3. Analyse and interpret results biannually and prepare biannual report to Councils. Disseminate information to community. 4. Consider estuary water quality monitoring program in terms of stormwater management actions (*e.g., GPTs and Constructed Wetlands) viz., use monitoring program to determine effectiveness of source controls implemented under the Lane Cove River Stormwater Management Plan*. 5. Determine actions from results annually and feed into EMC's Annual Action Plan.	Not Funded	Some sporadic biological and chemical monitoring across system by catchment Councils. To be pursued through SHWQIP				
12. Investigate and assess measures to reduce the distribution of road borne pollutants to the estuary (including motor vehicle tyre rubber particles, glass etc.) in the vicinity of Epping Road Bridge.	1. Liaise with Lane Cove Tunnel project to determine adopted criteria for stormwater management in vicinity of road bridge crossing at Epping Road. 2. Assess criteria in terms of estuary water quality objectives. 3. Develop recommendations for modification to Stormwater Management Measures as appropriate (including during construction), and document in brief report. 4. Submit report to Lane Cove Tunnel Project team and liaise to ensure inclusion within design and subsequent implementation. 5. Develop a Spills Control Plan for Epping Road crossing.	Not Funded			Epping to Chatswood Environmental Monthly Reports submitted to Councils on a 6 monthly basis. Project has been completed.	Not Funded	

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
13. Develop measures to reduce the distribution of road borne pollutants to the estuary (including motor vehicle tyre rubber particles, glass etc.) in the vicinity of Fullers Bridge.	1. Liaise with Epping-Chatswood Rail Project to determine adopted criteria for stormwater management in vicinity of rail and road bridge crossings. 2. Assess criteria in terms of estuary water quality objectives. 3. Subject to nature of pollutants and relative contribution to estuary bed, investigate devices (*e.g., CDS units*) for trapping sediment and allowing removal before discharge to the estuary. 4. Develop recommendations for modification to Stormwater Management Measures as appropriate, and document in brief report. 5. Submit report to Epping-Chatswood Rail Project team and liaise to ensure implementation. 6. Develop a Spills Control Plan for Fullers Bridge.	Not Funded			Not Funded	Not Funded	

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
14. Investigate and assess measures to reduce the distribution of road borne pollutants to the estuary (including motor vehicle tyre rubber particles, glass etc.) in the vicinity of Fig Tree Bridge.	1. Undertake pilot study by examining runoff distribution to the estuary at Fig Tree Bridge. 2. As part of pilot study, trap sediment at discharge points after average rainfall events and test sediment residue. 3. Analyse results to establish primary pollutants from roadway areas. 4. Undertake sediment sampling from estuary bed beneath bridge to confirm presence of pollutants identified in sediment traps. 5. Subject to nature of pollutants and relative contribution to estuary bed, investigate devices (*e.g., CDS units*) for trapping sediment and allowing removal before discharge to the estuary. 6. Prepare report outlining recommendations for all bridge crossings. 7. Develop a Spills Control Plan for Fig Tree Bridge.	Not Funded			Not Funded	Not Funded	
15. Promote use of existing boat effluent pump out facilities via an education program targeted at all boat users who moor vessels within the estuary.	1. Develop brochure outlining extent of facilities and accessibility. Incorporate questionnaire requesting advice regarding adequacy of facilities. 2. Distribute brochure to local sailing clubs and display at refuelling points within lower Sydney Harbour, as well as at Libraries and offices of *Waterways Authority*. 3. Compile responses from questionnaire and determine further actions as part of EMC's Annual Action Plan.	Commenced			Commenced	Commenced	Facilities not clearly identified, nor conveniently located

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
16. Develop an estuary education program aimed at educating the community on the importance of water quality and stormwater issues.	1. Use the local media, flyers, schools and Council newsletters to report on stormwater issues. 2. Educate animal owners and supply bins and plastic bags in popular dog walking areas for disposal of droppings. 3. Educate residents regarding appropriate use of fertilisers, car washing, and disposal of garden wastes. 4. Undertake drain stencilling. 5. Rigorously enforce littering laws.		Various catchment based projects including Gore Creek and Stringybark Creek project.	Catchment Connections and Water For Life Grant Projects; dog litter bags and bins; distribution of "bin your butts" in shopping centres; and Littering and Illegal Dumping Action Plan. Hunters Hill Council recently completed 3 year Catchment Connections Project - 'One Drop Festival 18 June 2011'	City of Ryde recently completed 3 year Catchment Connections Project - 'One Drop Festival 18 June 2011'	Street to Creeks e-restore education, brochure, and drain stencilling. Education also provided to local schools.	
17. Monitor stormwater quality.	1. Use outcomes from developing Stormwater Catchment Action Plans to identify key sites within the stormwater drainage network where monitoring should occur. 2. Consider locations for monitoring stormwater control devices that will be constructed / installed as part of the Stormwater Management Plan. 3. Determine water quality parameters that should be monitored at each of these locations (*biological, chemical & physical characteristics*). 4. Determine frequency of sampling and testing that would be required for the monitoring.	Macroinverte-brate monitoring ongoing at selected sites. Other locally based monitoring ongoing.		Other locally based monitoring ongoing and Brickmakers Creek	Other locally based monitoring ongoing. City of Ryde reports covering 5 core and 8 satellite sites over 7 years on web-site.	Water Quality monitoring program ongoing, monitor for macro, biological and chemical parameters	

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
18. Investigate the impact of the Lane Cove River Weir on water quality and the potential for sediment trapping, and document the potential environmental benefits that would be afforded to the estuary from its removal.	1. Undertake sediment sampling / vibrocoring in pondage upstream of weir. 2. Monitor water quality quarterly over one year and following four major rainfall events in the catchment. 3. Through DEC, monitor fauna and birds dependent on the pondage. 4. Undertake survey of National Park users on concerns regarding loss of amenity afforded by pondage. 5. Prepare a report with DEC outlining problems with the weir and the benefits to the estuary that would be afforded by its removal.	Not Funded				Not Funded	
19. Develop Stormwater Catchment Action Plans for all urban sub-catchments draining directly to the estuary (*in accordance with the Lane Cove River Stormwater Management Plan*).	1. Identify stormwater issues within each catchment 2. Analyse and rank catchments based on identified stormwater issues 3. Identify actions to address issues for each catchment	Stormwater Management Plans for various sub catchments.	LCC Stormwater Outlets into Bushland Study 2004	Stormwater Management Action Plan for HHC completed Nov 2011	Not funded		
20. Design and construct stormwater management mechanisms (*e.g., Gross Pollutant Traps and constructed wetlands*) as recommended in the Lane Cove River Stormwater Management Plan.							

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
(i) Kittys & Martins Creek	Design and construct Water Quality Control Pond & Gross Pollutant Trap	Not Funded			Not Funded		
(ii) Porters Creek, near Macquarie Park Industrial Precinct	Design and construct Gross Pollutant Traps				Completed		
(iii) Buffalo Creek	Design and construct 3 Gross Pollutant Traps			1 GPT installed and since dismantled at Pains Rd	Not Funded		
(iv) Tannery Creek	Design and construct pollution control device		Sediment removal project completed 2007				
(v) Shrimptons Creek	Creek bed remediation, bush regeneration and installation of 14 PCDs				Completed		
21. Retain or reinstate vegetation along river and creek corridors to provide a 30 metre wide strip along each bank.	1. Identify landholders adjacent to Lane Cove River estuary. 2. Raise awareness of the importance of riparian vegetation and riparian zones along the creek through a variety of mediums such as media advertisements, landholder fact sheets, or field days with Council's Bush Care Coordinators. 3. Ground-truth and map riparian vegetation along the Lane Cove River estuary shoreline. 4. Identify priority areas along the shoreline for riparian rehabilitation. 5. Source funds to rehabilitate riparian zones. 6. Develop a program to undertake revegetation at identified priority sites.		LCC vegetation mapped 2010, salt marsh areas mapped 2010, LCC riparian areas mapped on LEP 2010.	Boronia Park, Buffalo Creek Reserve and Ferdinand St Reserve mapped in 2010 (Estuary Plans and Estuary Management Program); and River to River Project including community engagement through survey and letterbox drop. Council recently increased protection of bushland areas to E2.	City of Ryde mapped Riparian Zones - Shrimptons and Buffalo Creeks, increased protection to bushland areas to E2, completed flora and fauna inventory 54 bushland reserves 2006,2007 and 2008, mapped Saltmarsh 2010 and is reviewing vegetation communities with NSW OEH.		

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
22. Undertake investigations to establish/confirm the presence of contaminated sediments in Burns Bay (*as recommended by Birch 1999*)	1. Undertake vibrocoring and additional sediment sampling to determine the type, extent and level of contamination in areas with potential for dredging (*e.g., around the estuary shoreline where exposed sediments give off pungent odours at low tide*). 2. Carry out laboratory analysis on sampled sediments. 3. Prepare report documenting findings of sediment sampling and testing, and outlining recommendations for remediation of material / management of odour problem.		Some done as part of preliminary works prior to dredging Burns Bay.				
23. Dredge the mouth of Burns Bay to provide improved access from the Lane Cove River to the main channel that leads to the head of the bay and to adjacent mooring areas within the bay (*refer EMS Report*).	1. Undertake feasibility study detailing provisional dredge quantities, contaminants present etc. 2. Assess methods for dredging and logistics of undertaking work, including dredge spoil disposal sites. 3. Prepare Review of Environmental Factors. 4. Prepare design for dredging footprint and associated documentation for agency approvals. 5. Undertake dredging of navigation pilot channel. 6. Ongoing environmental monitoring of impact of dredging including up and down steam		Not funded - bay mouth not dredged.				

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
24. Dredge the head of Burns Bay to remove accumulated silt distributed to the bay by urban runoff, thereby alleviating issues with odours from exposed mud flats at low tide and improving access from public reserve areas along the shoreline to mooring areas.	1. Undertake feasibility study drawing from findings of Strategy E12. 2. Assess methods for dredging and logistics of undertaking work, including dredge spoil disposal sites. 3. Prepare Review of Environmental Factors. 4. Prepare design for dredging footprint and associated documentation for agency approvals. 5. Undertake dredging around perimeter of head of bay. 6. Ongoing environmental monitoring of impact including up and down stream.		Project completed 2006.				Burns Bay seemed navigable.
25. Investigate the potential for installation of floating pontoon boarding area for Woodford Bay shoreline aimed at improving access from public reserves to mooring areas for sailcraft (*refer EMS report*).	1. Undertake feasibility study to identify suitable location and need (include community consultation). 2. Prepare Review of Environmental Factors. 3. Prepare concept and detail design for jetty and floating pontoon. 4. Seek approvals from Waterways Authority and DIPNR and proceed with construction.		Investigations done, but project not recommended.				

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
26. Coordinate all Council sediment and erosion control policies to provide a consistent approach aimed at minimising sediment distribution to the catchment.	1. Require that Soil and Water Management Plans be submitted with all subdivision and development applications. 2. Plans to provide for both construction and post construction sediment and nutrient controls. 3. Modify Development Approvals process for all Councils to ensure consistency in requirements for erosion and sediment control measures. Link to LEP and disseminate to building departments of all Councils. 4. Assess opportunities and where possible, recommend that Council's development approvals process be modified to require developers to certify that Soil and Water management provisions are being provided at periodic points through the construction phase.	Part of DA process but no consistent approach.			Part of DA process but no consistent approach to enforcement. Normally erosion and sediment control plans are a requirement of most approvals requiring construction activity. Conundrum interpretation anomalies between Council and private PCA's.	WCC developed Technical Standard for Sediment and Erosion Control within WDCP (2004). Objective of standard is for developers to manage erosion and control sediment during excavation/ construction.	
27. Monitor shoaling of the in-channel bar located downstream of Figtree Bridge and along Cunningham's Reach	1. Obtain funding and conduct preliminary investigations 2. Determine transect line alignments for hydrographic survey in vicinity of shoal in these areas 3. Undertake hydrographic survey annually over 5 years. 4. Prepare comparative plots along each hydrosurvey transect line and update as additional data obtained. 5. Prepare report annually detailing results from monitoring and recommendations for dredging or otherwise.	Not Funded					

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
28. Assess the impact of increasing mangrove extent on associated fringing estuarine flora (*e.g. saltmarsh communities*) and monitor mangrove proliferation annually and over a 5 year timeframe.	1. Update existing mapping of mangrove extent as outlined in Estuary Process Study, including detailed ground truthing. 2. Establish a monitoring program similar to that developed by PBP for Waterways Authority for the Parramatta River, including transect lines for repeated survey of mangrove encroachment on the river / creek channel or adjacent shallows. 3. Undertake monitoring annually over 5 years. 4. Report on the findings of the monitoring program annually and recommend appropriate actions to applicable Councils.		Saltmarsh mapping project completed by Applied Ecology in 2010.				
29. Monitor the extent and proliferation of exotic species of bivalves in and around the mouth of Buffalo creek.	1. Establish a monitoring program to assess the rate of proliferation of exotic bivalves within Buffalo Creek, choosing sites based on data gathered for the EPS. Develop a grid over the creek mouth footprint detailing where cores of bed material are to be extracted. 2. Sample the bed of Buffalo Creek to determine the extent of exotic bivalves in and around the creek mouth (i.e., confirm suspicions arising from sampling completed for EPS). 3. Report to Council on the results of the monitoring program and the implications of these results on the health of native species in Buffalo Creek.	Not Funded					

RECOMMENDED STRATEGY	SUB-TASKS	Estuary-wide status (Nov 2011)	LCC Status Nov 2011	HHC status Nov 2011	CoR Status Nov 2011	WCC Status Nov 2011	Field Visit Notes (13/01/2012)
30. Undertake a Waterway Users Study to assess recreational facilities required to resolve incidences of congestion/conflict from boat traffic, and to determine the general suitability of existing foreshore	1. Develop program of consultation to obtain details of current and potential future waterway user demands. 2. Undertake consultation program. 3. Compile submissions and determine waterway user requirements. 4. Determine ways of reducing present and future congestion and conflict from boat traffic and assess the suitability of amenities. 5. Prepare report incorporating capital works program for the subsequent 5 years.	Public Health Needs Analysis completed by Gondwana - has identified key users of estuary.	Public Health Needs Analysis completed by Gondwana - has identified key users of estuary.				
31. Upgrade Burns Bay boat launching ramp and facilities.	1. Conduct a consultation program with the community to identify the extent of the facilities required. 2. Prepare concept design plans for works and seek Council/community approval. 3. Undertake detail design. 4. Construct improvement works.		Underway 2011				
32. Asses need for additional public amenities and facilities along the lower reaches of the estuary	1. Identify additional facility locations through consultation with boat user groups and other foreshore users. 2. Make recommendations to Council's for inclusion within individual Council capital works programs.	Project completed by Gondwana Consultancy in 2011.	Project completed by Gondwana Consultancy in 2011.				
33. Develop an inventory of benthic algae to assist in understanding the primary productivity of the estuary. Draw from the results of separate investigations being completed for Buffalo, Shrimptons and Stringybark Creeks.	1. Notify Universities of the suitability of the strategy as a research project for a graduate of marine biology. 2. Compile all data on benthic algae. 3. Undertake detailed survey of benthic algae. 4. Develop an inventory of benthic algae including species, distribution and seasonal biomass. 5. Analyse results and prepare a report, relating specifically to the primary productivity of the estuary.	Not completed, not relevant.					

5 MANAGEMENT AIMS

Following on from the issues and strategies identified and implemented in the EMP 2004, there remain critical elements of value in the estuary which need to be managed. The environmental and passive recreation values are paramount within the Lane Cove River Estuary, therefore, the key focus or goal of this Lane Cove River Coastal Zone Management Plan should be:

"To conserve and improve the existing natural environment and water quality of the Lane Cove River Estuary"

Eight broad **"Aims"** have been developed for the future management of the Lane Cove River Estuary. They seek to address the fundamental goal of the Coastal Zone Management Plan of achieving balanced and sustainable demands on the estuary from ecological and recreational (human) pursuits.

5.1 Water Quality Aim

"To optimise water quality within the Lane Cove River Estuary and its tributaries"

This Aim recognises the need for protection and improvement of water quality for both natural ecosystem and human use. As the water quality within the Lane Cove River Estuary can be highly variable, rather than stating what water quality levels should be, the word 'optimise' has been used to reflect 'fit for purpose' criteria.

5.2 Climate Change Aim

"To plan for and adapt to the potential impacts of climate change on the natural and built environments of the estuary"

This Aim was included in recognition of potential climate change impacts such as sea level rise on the estuary's ecological and built assets. This Aim was not intended to capture the broader climate change issues, such as reduction of CO_2 emissions, but instead is focused upon ensuring adequate planning and response mechanisms are allowed for in the future to adjust to climate change impacts.

5.3 Aquatic and Riparian Habitat Aim

"To protect, enhance and restore aquatic habitats and foreshore vegetation"

This Aim encompasses saltmarsh, mangrove, mud flats, sandy shoals and other habitats as well as riparian vegetation along the estuary. These areas provide an essential habitat for the broader ecology of Sydney Harbour and beyond, as well as unique remnants of intertidal communities. The Saltmarsh Management and Rehabilitation Manual (Applied Ecology, 2010) highlighted losses and degradation of saltmarsh habitats as significant issue for the Lane Cove River estuary. It also found that many other impacts such as uncontrolled water craft, polluted or intense runoff and development pressures can degrade these communities and need to be managed. The actions recommended in the Saltmarsh Manual relevant to this CZMP are listed in APPENDIX E Table 12-6.

5.4 Foreshore Protection Aim

"To manage existing built foreshore assets while maximising environmental values and minimise negative impacts of development on catchment and waterway health"

This Aim addresses the potential impacts of catchment development and ensures effective planning and policy measures, such as sediment and erosion controls plans, are available across the catchment. This Aim also recognises that built foreshore assets, such as seawalls, have a significant role to play in maintaining integrity and ecological value of the foreshore. The promotion of environmentally friendly seawalls guidelines which facilitate both the protection of foreshore assets and the provision of ecological services is also a key aspect of this Aim.

5.5 Estuary Health Monitoring and Evaluation Aim

"To develop and support coordinated monitoring, reporting and evaluation programs for the Lane Cove River Estuary"

This Aim was designed to ensure that actions are identified to monitor the progress and effectiveness of this plan. In this context, monitoring may consist of an estuary health report card collating biochemical and ecological monitoring, as well as annual assessments of actions completed.

5.6 Recreation and Public Health Aim

"To provide a framework for maintaining and enhancing the recreational amenity of the estuary"

The *Lane Cove River Estuary - Assessing Public Health Needs for Recreational Users* report prepared by Gondwana Consulting Pty Ltd in 2011 satisfies the intent of this Aim. This CZMP does not recommend any further actions relating to this Aim to avoid duplicating the actions recommended in the Gondwana report which are listed in APPENDIX E Table 12-6.

5.7 Natural and Cultural Heritage Aim

"To identify, acknowledge and protect natural and cultural heritage"

This CZMP does not recommend any further actions relating to this Aim to avoid duplicating the actions already recommended in some other reports prepared for the Councils. Any relevant actions are listed in APPENDIX E Table 12-6.

5.8 Community Education

Lane Cove River Estuary Community Education Kit has been prepared by T Issues and Terra Cordis in 2009 for Lane Cove, Hunters Hill, City of Ryde and Willoughby City Councils. This Kit provides a range of education material and processes designed to provide Council staff with all that they need to deliver education that impacts on the community's connection with, and protection of the River. This CZMP does not recommend any further actions relating to this Aim to avoid duplicating the actions already recommended in the Community Education Kit report. Any relevant actions are listed in APPENDIX E Table 12-6.

5.9 Refined Aims

The above mentioned eight Aims have been refined to five key Aims of this CZMP as three aims (5.6, 5.7 and 5.8) are and have been addressed by other reports and studies. The Recreational Use Aim is being addressed by the Lane Cove River Estuary - Assessing Public Health Needs for Recreational Users (Gondwana Report, 2011) and the Community Education Aim is being addressed by the Estuary Community Education Kit (2009).

The five refined Aims of this Lane Cove River CZMP are listed in Table 5-1.

Table 5-1: Aims of the CZMP

Aims	Description
Water Quality (W)	To optimise water quality within the Lane Cove River Estuary and its tributaries
Climate Change (C)	To plan for and adapt to the potential impacts of climate change on the natural and built environments of the estuary
Aquatic and Riparian Habitat (A)	To protect, enhance and restore aquatic habitats and foreshore vegetation
Foreshore Protection (F)	To manage existing built foreshore assets while maximising environmental values and minimise negative impacts of development on catchment and waterway health
Estuary Health Monitoring and Evaluation (M)	To develop and support coordinated monitoring, reporting and evaluation programs for the Lane Cove River Estuary

It is important that these Aims are read and considered in a combined and integrated manner, and not in isolation. The estuarine environment of the Lane Cove River is a complex and highly integrated system, and as such, management of the estuarine environment needs to be multi-faceted, integrated and concurrent.

6 RISK ASSESSMENT

The Risk Assessment process used for the Lane Cove River Coastal Zone Management Study is adapted from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009), and is presented schematically in Figure 6-1.

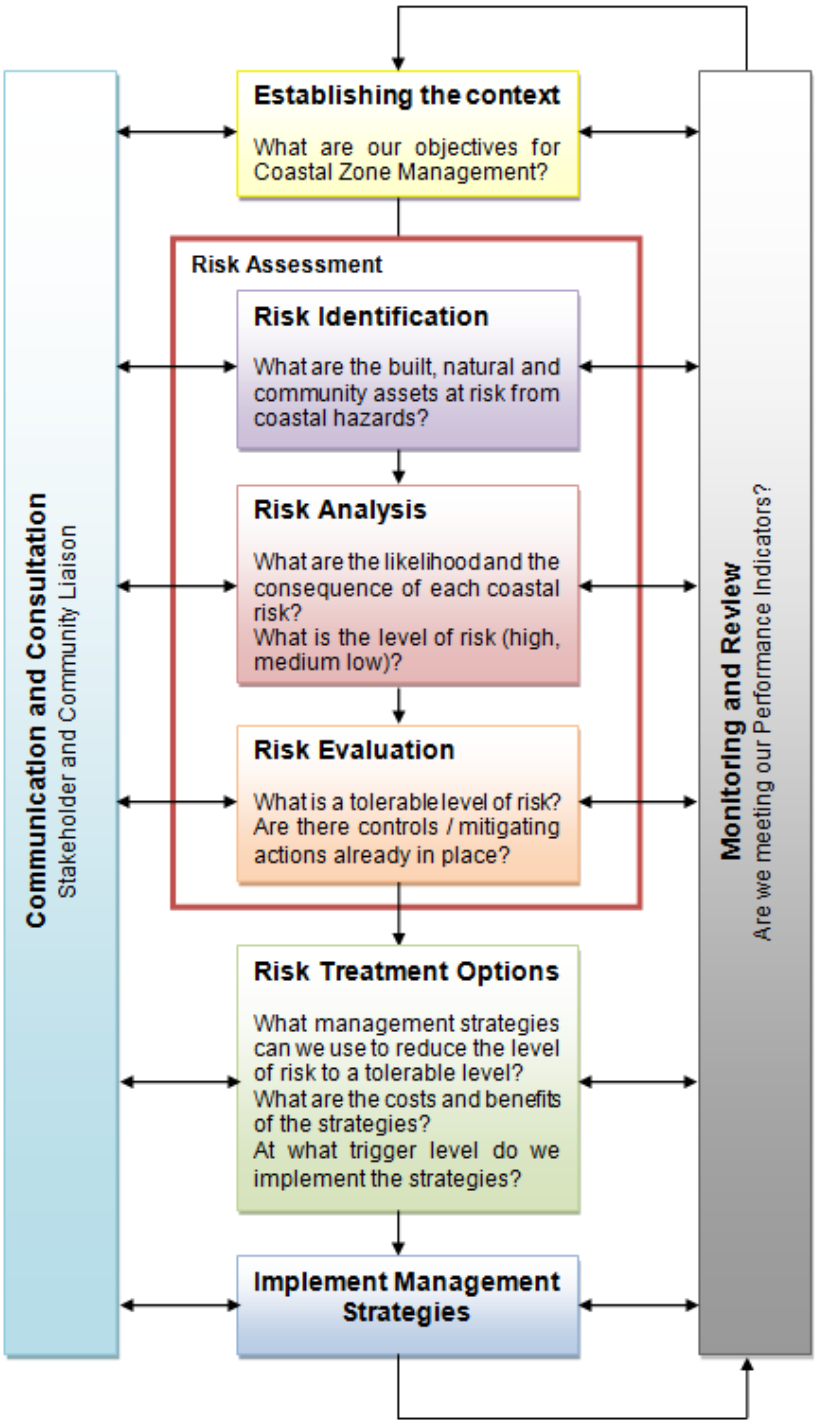

Figure 6-1: Risk Management Framework (ISO 31000:2009) adapted to Coastal Zone Management

6.1 Potential Risks to the Estuary

A key step towards improving, protecting or maintaining the values of the estuary is identifying the risks that may threaten those values. The use of a risk-based approach for managing coastal hazards is a requirement of the new CZMP Guidelines, and accords with current international best practice for natural resource management. A risk-based approach is particularly applicable to the impacts of projected sea level rise, where there is considerable uncertainty regarding when and if impacts will manifest, how such impacts may manifest. In case of estuaries, given the historical, ongoing and future pressures, such 'risks' may already be occurring.

A list of potential risks to the estuary was developed by the study team which included the high priority issues (risks) from EMP 2004 along with new issues such as the impacts of climate change and sea level rise. From the list, 16 risks were identified as relevant during the EMC workshop.

This section lists the Management Aims and the corresponding risks to the Aims.

6.1.1 Water Quality

Under this Aim, four risks were identified and agreed through the consultation process, and are presented in Table 6-1.

Table 6-1: Risks Relating to Water Quality Aim

	Aim
W	To optimise water quality within the Lane Cove River Estuary and its tributaries
	Risks
RW1	Sewer Overflows - Discharges of contaminants from the sewerage system through leakage, chokes and designated sewer overflows
RW2	Leak, spills or overflow from sewage pumping stations
RW3	Pollutants washed from urban areas into the estuary
RW4	Leak, spills or overflow from National Starch Factory (170 Epping Road)

6.1.2 Climate Change

Under this Aim, six risks were identified and agreed through the consultation process, and are presented Table 6-2.

Table 6-2: Risks Relating to Climate Change Aim

	Aim
C	To plan for and adapt to the potential impacts of climate change on the natural and built environments of the estuary
	Risks
RC1	Landward migration of saltmarsh and mangroves due to Sea Level Rise (SLR) but constrained due to foreshore urban development
RC2	Impact on riparian corridors due to climate change and SLR
RC3	Stormwater, Sewer pipes/pits inundation, overflow due to SLR
RC4	Storm surge inundation due to climate change and SLR
RC5	Flooding to low lying areas due to SLR
RC6	Increased salinity due to SLR (affecting flora and fauna)

6.1.3 Aquatic and Riparian Habitat

Under this Aim, three risks were identified and agreed through the consultation process, and are presented in Table 6-3.

Table 6-3: Risks Relating to Aquatic and Riparian Habitat Aim

	Aim
A	To protect, enhance and restore aquatic habitats and foreshore vegetation
	Risks
RA1	Loss of natural habitat along the river due to future development and excessive recreational uses
RA2	Dinghies left on the saltmarshes
RA3	Trees being cut to clear views (e.g. in Chatswood golf course) affecting riparian vegetation along the creek and estuary

6.1.4 Foreshore Protection

Under this Aim, three risks were identified and agreed through the consultation process, and are presented in Table 6-4.

Table 6-4: Risks Relating to Foreshore Protection Aim

	Aim
F	To manage existing built foreshore assets while maximising environmental values and minimise negative impacts of development on catchment and waterway health
	Risks
RF1	Foreshore construction not carried out under strict development controls
RF2	Bank erosion due to foreshore development and excavation
RF3	Navigation problem and reduced flushing potential due to sedimentation

6.1.5 Estuary Health Monitoring and Evaluation

This Aim was designed to ensure that actions are identified to monitor the progress and effectiveness of this plan. In this context, monitoring may consist of an estuary health report card collating biochemical and ecological monitoring, as well as annual assessments of actions completed.

Under this Aim, no major risks were identified during the consultation process.

6.2 Risk Analysis

Standard risk management approach defines the magnitude of risk as a combination of 1) the likelihood of a risk event occurring, and 2) the consequence if such an event does occur. For this project, a variation on the standard risk approach has been adopted to address management of existing threats (risks) that already have a 'frequency' of occurrence, as opposed to future / unrealised risks that have a 'likelihood' of occurrence.

Essentially, a threat or risk assessment process is the same, only risks are described in terms of their frequency, compared with risks that are described in terms of their likelihood. In both cases, the consequence or impact of the risks that have (or may) occur forms the second variable in calculating the magnitude of the threat/risk. The scale of the impacts that the risks pose and the frequency with which the risks can occur is used to prioritise the risks and therefore the actions to manage them.

As per standard risk assessment methodologies,

The Risk (R) is a product of the 'impact' (I) and 'frequency' (F), i.e.:

R = I x F, where R is the risk to the Lane Cove River estuary.

The scales and outcomes of their application to the risks identified for the Lane Cove River estuary is detailed below.

The impact scale developed for Lane Cove River estuary focuses specifically on how the impact may affect the environmental and/or community values of the estuary, since it is the conservation and improvement of these values that forms the management goal for the Plan. The impact scale used in the risk assessment is provided in Table 6-5.

Table 6-5: Impact Levels

Scale	Impact
Very low (1)	No or negligible impact to the environmental value
Low (2)	Small but measurable impact to environmental value but impact is temporary and value is maintained at current level over time
Medium (3)	Moderate impact to environmental value; impact is still temporary and recovery is likely over time
High (4)	Major impact to environmental value; impact will occur for period of months/years. Recovery is possible in the long term
Critical (5)	Permanent Loss of Value; recovery unlikely or irreversible

Frequency scale developed for Lane Cove River estuary reflects the varying level of occurrence of the identified risks. The scale is based upon the frequency range of the known threats to the Lane Cove River estuary, that being from 'almost never' to 'often or continuous'. The frequency scale used in the risk assessment is provided in Table 6-6.

Table 6-6: Frequency Scale

Scale	Frequency Descriptor
Almost never (1)	Once per lifetime
Rare (2)	Once per 5-10 years
Infrequent (3)	Once per year
Occasionally (4)	Few times per year
Often/Continuous (5)	Once a month or more

A risk matrix was developed to provide the overall risk level from the combination of impact and frequency, as given in Table 6-7. The matrix was developed bearing in mind that many of the risks are already occurring across the four Councils, but with varying frequency and/or impact. The matrix was designed to ensure that the combination of frequency and impact was a reasonable reflection of the level of risk that may already be occurring.

Table 6-7: Risk Matrix

		Impacts				
Frequency		Very Low (1)	Low (2)	Medium (3)	High (4)	Critical (5)
	Often / Continuous(5)	low	high	high	extreme	extreme
	Occasionally (4)	low	medium	high	high	extreme
	Infrequent (3)	low	medium	high	high	high
	Rare (2)	low	low	medium	medium	high
	Almost never (1)	low	low	medium	medium	high

Information and feedback from the Estuary Management Committee (EMC) workshop were used to evaluate the risks for their frequency and impacts. The current risk rating from the combination of the frequency and impact for each risk is presented in Table 6-8.

The risk rating was used as a key component in assessing the applicability of the management actions in Section 8, through use of a scoring system for the level of risk treated by the management action.

Table 6-8: Risk Assessment for Lane Cove River Estuary

Risk Event		Aims at Risk	Initial Impact	Initial Frequency	Initial Risk Rating	Existing Controls	Residual Impact	Residual Frequency	Current Risk Rating	Risk Score (Impact X Frequency)	Risk Rank
RF2	Bank erosion due to foreshore development and excavation	F	High	Infrequent	High	Strict building controls	High	Almost Never	Medium	4	13
RA1	Loss of natural habitat along the river due to future development, excessive recreational uses	A	Critical	Occasionally	**Extreme**	Regulatory controls, boating speed limits in river	Critical	Rare	High	10	7
RF1	Foreshore construction not carried out under strict development controls	F	High	Infrequent	High	Regulatory controls	Medium	Rare	Medium	6	12
RW3	Pollutants washed away from urban areas into the estuary	W	High	Often / Continuous	**Extreme**	Stormwater treatment devices, WSUD, Sediment and erosion controls	Medium	Often/Continuous	High	15	5
RW1	Sewer Overflows - Discharges of contaminants from the sewerage system through leakage, chokes and designated sewer overflows	W	High	Often / Continuous	**Extreme**	Sydney Water's Sewerfix Abatement program	High	Occasionally	**High**	**16**	1
RW2	Leak, spills or overflow from sewerage pumping station	W	High	Often / Continuous	**Extreme**	Sydney Water's Sewerfix Abatement program	High	Occasionally	**High**	**16**	1
RF3	Navigation problem and reduced flushing potential due to sedimentation	F	Low	Almost Never	Low	Navigation marks in the river	Low	Almost Never	Low	2	15

Risk Event		Aims at Risk	Initial Impact	Initial Frequency	Initial Risk Rating	Existing Controls	Residual Impact	Residual Frequency	Current Risk Rating	Risk Score (Impact X Frequency)	Risk Rank
RC4	Storm surge inundation due to climate change and SLR	C	Low	Often / Continuous	High	Foreshore Building line (15m) controls for all HHC properties and some LCC properties	Medium	Infrequent	High	9	8
RC5	Flooding to low lying areas due to SLR	C	Medium	Occasionally	High	Foreshore Building line (15m) controls for all HHC properties and some LCC properties	Medium	Infrequent	High	9	8
RC3	Stormwater, Sewer pipes/pits inundation, overflow due to SLR	C	Medium	Often / Continuous	High	None	Medium	Occasionally	High	12	6
RC6	Increased salinity due to SLR (affecting flora and fauna)	C	Low	Often / Continuous	High	None	Medium	Infrequent	High	9	8
RC1	Landward migration of saltmarsh and mangroves due to SLR but constrained due to foreshore urban development	C and A	High	Often / Continuous	**Extreme**	Bush regeneration programs	High	Occasionally	**High**	**16**	1
RC2	Impact on riparian corridors due to climate change and SLR	C and A	High	Often / Continuous	**Extreme**	Some bush regeneration programs	High	Occasionally	**High**	**16**	1
RA2	Dinghies left on the saltmarshes	A	High	Occasionally	High	HHC- Dinghy racks, educating community about importance of saltmarsh	Low	Occasionally	Medium	8	11

Risk Event		Aims at Risk	Initial Impact	Initial Frequency	Initial Risk Rating	Existing Controls	Residual Impact	Residual Frequency	Current Risk Rating	Risk Score (Impact X Frequency)	Risk Rank
RW4	Leak, spills or overflow from National Starch Factory (170 Epping Road)	W	High	Infrequent	High	EPA Licencing	Low	Rare	Low	4	13
RA3	Trees being cut to clear views(e.g. in Chatswood golf course) affecting riparian vegetation along the creek and estuary	A	Low	Infrequent	Medium	None	Very Low	Almost Never	Low	1	16

6.3 Risk Prioritisation

The overall risk rating (score) given to each risk was used to prioritise the risk from extreme impacts to low impacts risk. The Aim/s at risk due to each event and the risk ranking from highest risk to lowest risk are given in Table 6-9.

Table 6-9: Risk Prioritisation

Risk Rank	Risk Event		Aims at Risk
1	RW1	Sewer Overflows - Discharges of contaminants from the sewerage system through leakage, chokes and designated sewer overflows	Water Quality
1	RW2	Leak, spills or overflow from sewage pumping station	Water Quality
1	RC1	Landward migration of saltmarsh and mangroves due to SLR but constrained due to foreshore urban development	Climate Change, Aquatic and Riparian Habitat
1	RC2	Impact on riparian corridors due to climate change and SLR	Climate Change, Aquatic and Riparian Habitat
5	RW3	Pollutants washed away from urban areas into the estuary	Water Quality
6	RC3	Stormwater, Sewer pipes/pits inundation, overflow due to SLR	Climate Change
7	RA1	Loss of natural habitat along the river due to future development and excessive recreational uses	Aquatic and Riparian Habitat
8	RC4	Storm surge inundation due to climate change and SLR	Climate Change
8	RC5	Flooding to low lying areas due to SLR	Climate Change
8	RC6	Increased salinity due to SLR (affecting flora and fauna)	Climate Change
11	RA2	Dinghies left on the saltmarshes	Aquatic and Riparian Habitat
12	RF1	Foreshore construction not carried out under strict development controls	Foreshore Protection
13	RF2	Bank erosion due to foreshore development and excavation	Foreshore Protection
13	RW4	Leak, spills or overflow from National Starch Factory (170 Epping Road)	Water Quality
15	RF3	Navigation problem and reduced flushing potential due to sedimentation	Foreshore Protection
16	RA3	Trees being cut to clear views (e.g. in Chatswood golf course) affecting riparian vegetation along the creek and estuary	Aquatic and Riparian Habitat

The prioritisation of these risks has been used in the actions prioritisation method in Section 8.1 and Section 8.4.

7 PROPOSED MANAGEMENT ACTIONS

Management Actions (MA) have been proposed for each Aim, and linked to specific risks (more than one in many cases). Management actions have also considered, and are consistent with, the broader policies and management actions that are in place at state and regional level.

As there is always a variety of ways to address a given risk, the possible Management Actions identified utilise a variety of implementation mechanisms that can act at different levels, or on different aspects of the problem. Types of Management Actions considered include:

- planning controls and policies,
- economic incentives and cost sharing arrangements,
- regulation and compliance,
- on-ground works and rehabilitation,
- investigation,
- monitoring,
- research, and
- education and public relations

The Actions presented in the remainder of this chapter are under the same categories as the Management Aims. Some of the Actions formulated address a number of separate risks.

The relative **"Costs"** of each action is also provided. At this stage, costs are presented as High (H), Medium (M) or Low (L) only. High costs generally relate to strategies involving considerable on-ground works. Medium costs are strategies where further investigations are to be undertaken. Low costs involve works that can be done within the scope of existing duties (of Council personnel for example) or can be mostly conducted by voluntary labour.

7.1 Water Quality

A review of water quality data has been completed and is presented in the APPENDIX G.

The Lane Cove River weir experiences consistently high nutrient concentrations (based on ANZECC 2000 guidelines). This is likely due to the highly urbanised nature of the catchment resulting in higher nutrient loads from fertilizers and other domestic practices. Since the Northside Storage Tunnel program was implemented by Sydney Water Corporation in 2001, and the ongoing Sewer Fix Leakage and Choke Reduction program since 2005, there has been a decrease in the bacterial concentrations of both faecal coliform and enterococci in many receiving waters. Subsequently, only data collected since 2005 has been used to present the likely existing conditions. A number of sites including the weir at Lane Cove River were observed to consistently have up to seven times the recommended bacterial content for secondary contact (ANZECC 2000).[8]

Sewage pumping stations historically have been a source of faecal coliform pollution however the SewerFix Pumping Station Program increased the reliability of pumping stations, increased storage, installing alarms and mobile pumps to stop pumping stations from discharging to the environment.

[8] *SHWQIP, Data Compilation and Review 2011*

Private sewers (both legal and illegal) can be substantial contributors of pollutants to the estuary in the event of overflow and failures, delivering high loads of sediments, nutrients, pathogens and chemicals to the waterways. Local Council staff are often in a good position to have knowledge of the location and severity of problems associated with private sewers, with community members likely to contact staff when they notice a problem. These issues need to be reported to Sydney Water for rectification. Sewer overflow incidents from designated overflows should be reported to Sydney Water and any subsequent actions followed up and recorded.

Sydney Water needs to be engaged as a stakeholder by the Councils to form a partnership aimed at solving the broader sewer infrastructure problems. Water efficiency in residential homes, reducing cross connections and on-site management of stormwater will all contribute to reducing sewer flows into the already stressed system. Councils should also be mindful of development proposals and the potential impact on the sewer system capacity. Regional plans to increase density must be coordinated with Sydney Water to manage the ability of the system to cope. Greater information sharing and collaboration between Councils and Sydney Water could help to identify issues more quickly so they can be effectively managed.

All four Councils monitor macro-invertebrate populations in local streams and waterways, and interpret data through the SIGNAL (stream invertebrate grade number-average level) and AusRivAS Index systems. The SIGNAL scores provides a crude measure of water quality based on macro-invertebrate tolerance. High SIGNAL scores indicate good water quality and healthier rivers or streams potentially due to low levels of nutrients, salinity and turbidity, with high levels of dissolved oxygen. Low SIGNAL scores generally denote poor water quality and disturbance potentially due to low dissolved oxygen, turbidity, salinity, excess nutrients or another form of pollutant.

Comparative SIGNAL scores for the monitored creeks for three years are presented in Table 7-1. The ratings in some creeks have risen and others fallen, but overall the ratings are low. The highest recent rating was for Blue Gum Creek, and the lowest Terrys Creek. Both of these creeks have changed since the 2006-7 sampling. (NSROC 2009/10)

Table 7-1: Monitoring Results at Sites within Lane Cove River Estuary

Catchment	Location	SIGNAL Score			Trend
		2006-07	2007-08	2008-09	Improving-↑ Worsening-↓
City of Ryde	Buffalo Creek	3.18	3.10	3.27	↑
	Terrys Creek	3.28	3.20	2.27	↓
	Porters Creek	3.23	2.97	2.84	↓
	Shrimptons Creek	3.22	2.97	2.83	↓
Willoughby	Swaines Creek	3.33	3.30	3.00	↓
	Blue Gum Creek	2.80	-	3.70	↑
Lane Cove	Gore Creek	3.60	3.10	3.00	↓
	Stringybark Creek	2.57	3.00	3.00	↑
Hunters Hill	Brickmakers Creek	3.47	-	2.90	↓

These results are graphically presented in Figure 7-1. In the graph, the missing SIGNAL scores for Blue Gum Creek and Brickmakers Creek in 2007-08 have been estimated by averaging the two other scores.

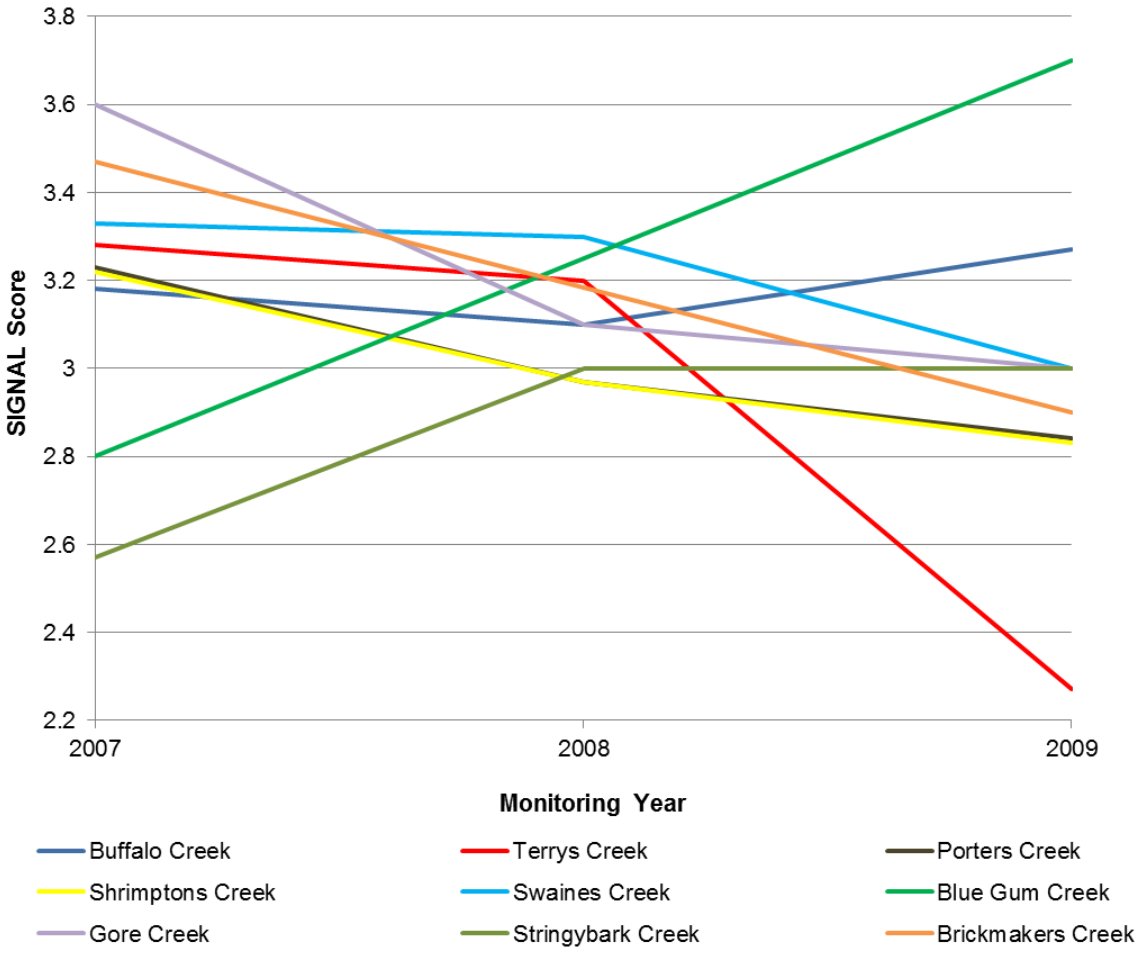

Figure 7-1: Monitoring Data for Creeks in Lane Cove River Catchment Area (NSROC SoE reports)

Stormwater is a major source of pollutants, such as nutrients, sediments, chemicals, pathogens and gross pollutants, to the estuary. Existing urban areas are substantial contributors of these pollutants to the waterways. **Water Sensitive Urban Design (WSUD)** is one of the key management measures that can control pollutants, such as nutrients, sediments, pathogens and gross pollutants, being exported into the estuary from urban lands.

WSUD devices such as GPTs and biofiltration systems are a key approach to reducing the pollutant loads entering the estuary from urban lands. These devices can be very effective at capturing pollutants, potentially capturing 90% of total sediments, over 70% of total phosphorus, over 40% of total nitrogen and up to 100% of gross pollutants as single devices or even higher amounts of pollutants if combined with other WSUD devices in a treatment train.

The Hawkesbury Nepean Catchment Management Authority Catchment Action Plan outlines various overall targets for Council to adopt and implement WSUD and are working on a regional water quality objective.

It is recommended that Councils apply the WSUD pollution reduction targets within their Development Control Plans to help achieve proposed improvements to the quality of flows entering the Lane Cove River estuary and subsequently Port Jackson. One way of reducing the volume of pollutants entering the estuary is to retrofit existing urban areas with appropriate WSUD devices to either reduce the

volume of stormwater generated or to treat stormwater to improve its quality before it enters the estuary. These devices can include artificial wetlands, vegetated swales, bioretention systems, rainwater tanks and gross pollutant traps.

In implementing WSUD, consideration must be given to the most appropriate devices and treatments trains for each situation and location. Consideration should include both the upfront and ongoing cost of options, as well as practical constraints to the implementation of specific options in different circumstances. The devices require regular maintenance, including removal of the pollutants that have accumulated. Where this maintenance is not undertaken, devices can become ineffective and can stop capturing new pollutants or can even become a source of pollutant loads to the estuary. Sufficient funding needs to be allocated to their on-going maintenance to ensure their effectiveness.

Models such as MUSIC (Model for Urban Stormwater Improvement Conceptualisation) can and should be used at different scales (catchment versus project scale) to assist in deciding on what treatment trains could best meet the targets while still optimising the use of available budgets.

A draft WSUD Action Plan has been developed by City of Ryde to provide direction and advice to landowners and developers including design principles to incorporate WSUD within development in the City of Ryde LGA. This should be viewed by the other Councils as a guide to the successful implementation of a WSUD strategy. The other councils have staff who are actively applying WSUD in an ad hoc way to Council works, where the opportunities exist, or in response to development proposals.

Stormwater runoff targets for all development works in each Council would provide a goal for future works and an effective means of reducing pollutants being delivered from these Councils to the Estuary. City of Ryde's current WSUD pollutant removal targets are given in APPENDIX B. Adopting a target for the Lane Cove River Estuary would send a clear signal to all Council and to potential developers that water quality is essential to the sustainable development of the area and measures need to be included in all major works within the catchment.

Further details about WSUD, its benefits, site selection process etc. are given in APPENDIX B. A list of possible sites where WSUD can be implemented is given in APPENDIX B, Table 12-1. A WSUD action plan which details the area of sub catchments, current and possible WSUD locations, types, areas being treated currently and remaining areas to be treated via WSUD is given in APPENDIX B, Table 12-2.

The proposed sites for possible implementation of WSUD for each Council are mapped and presented in APPENDIX H, Figures 19 to 22. These figures include both the CZMP proposed and the Council proposed WSUD sites.

The existing locations of stormwater treatment devices, pollutant hot spots etc. are mapped and shown in APPENDIX H, Figure 2.

Table 7-2 lists the possible management actions for this Aim.

Table 7-2: Management Actions (Water Quality)

Actions	Aim: Water Quality To develop and support coordinated monitoring, reporting and evaluation programs for the Lane Cove River Estuary	Risks Addressed	Cost
AW1	Liaise with Sydney water to ensure that the improvements in the sewer overflow performance continue throughout the catchment	RW1, RW2	High
AW2	Liaise with Sydney Water when sewers are observed to be causing water quality problems	RW1, RW2	Low
AW3	Continue current water quality monitoring and undertake wet weather monitoring	RW1, RW2, RW3, RW4	Low
AW4	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes of this	RW3	Low
AW5	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing and preparation of new Development Control Plans (DCPs)	RW3, RF3	Medium
AW6	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel naturalisation	RW3, RF3	Medium
AW7	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices.	RW3, RF3	Medium
AW8	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction	RW3, RF1, RF2, RF3	Low
AW9	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment	RW3	Low
AW10	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises	RW1, RW2, RW3, RW4	Low
AW11	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects	RW3	Low
AW12	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term	RW3	Low
AW13	Assess fertilizer distribution rates and procedures especially during periods of heavy rain	RW3	Medium

Links to further information and existing works:

- Sydney Water Sewerfix Wet Weather Alliance, Wet weather overflow abatement program http://www.sydneywater.com.au/Publications/FactSheets/OverflowAbatementProgram.pdf
- Water Sensitive Urban Design in Sydney

http://www.wsud.org/

- Case Study: City of Ryde - WSUD Systems and Interpretive Signs
- Case Study: Lane Cove Council - Lower Stringybark Creek Erosion Stabilisation Project
- Marrickville Council, Sub Catchment Planning with Local People http://www.marrickville.nsw.gov.au/environment/in_your_community/water_and_subcatchments/subcatchmentplanning.html?s=541993404
- Lane Cove River Water Quality Review Report 2012 prepared by BMT WBM

7.2 Climate Change

Climate change is expected to have significant impacts on local communities in Australia, particularly coastal communities. The major coastal impacts include sea level rise, foreshore erosion and inundation and more frequent and intense storms. It is projected that global climate change will lead to **Sea Level Rise** (SLR) along the east coast of Australia. If projected levels of rise occur then some areas of the foreshore along with assets and infrastructure on these areas will be impacted by flooding within a planning horizon of 2100. This may be made worse by storm surges that are also predicted to increase due to intensification of storms. In addition to impacts on man-made assets, some ecological assets are also likely to be affected if insufficient foreshore areas are available for these communities to retreat to.

In order to better understand the scale and location of such potential impacts, it is necessary to identify areas that are likely to be subject to flooding under various sea level rise and storm surge scenarios currently being predicted for the Lane Cove River Estuary.

A project "Demonstrating Climate Change Adaptation of Interconnected Water Infrastructure" is being delivered in partnership between Sydney Coastal Councils Group, Sydney Water, Water Research Laboratory (UNSW) and the NSW OEH which aims to undertake the necessary research to develop information, guidance and capacity building activities to ensure that organisations responsible for managing water infrastructure are able to implement appropriate asset management systems in a changing climate. Further details on the project can be found through the Sydney Coastal Councils group website.[9]

Recently, as part of its stage one coastal management reforms, the NSW Government announced that Councils would have the flexibility to determine their own sea level rise projections to suit their local conditions - the Government would no longer prescribe state-wide sea level rise projections for use by Councils. Hence, the 2009 NSW Sea Level Rise Policy Statement is no longer NSW Government Policy.

A recent report *"Assessment of the science behind the NSW Government's sea level rise planning benchmarks" (2012),* prepared by NSW Chief Scientist and Engineer Mary O'Kane details the adequacy of the science informing the NSW sea level rise benchmarks adopted in the 2009 Policy Statement. This report concludes that given the current level of knowledge, the way the science was used to determine benchmarks is adequate. However, for some years to come there will be more and

[9] *Sydney Coastal Councils Group http://www.sydneycoastalcouncils.com.au/Project/demonstrating_climate_change_adaptation_of_interconnected_water_infrastructure_project*

better models for predicting sea level rise which will be informed by more and better data enabled by rapid advances in sensing, positioning, computational and imaging technologies.[10]

As currently, there are no specific benchmarks adopted by the individual Councils, previously adopted benchmarks (SLR of 0.4m by 2050 and 0.9m by 2100) have been adopted in this CZMP to interpret the possible extent of sea level rise for the Lane Cove River estuary. These projections have been mapped and presented in APPENDIX H, Figures 3 and 4.

Table 7-3 lists the possible management actions for this Aim.

Table 7-3: Management Actions (Climate Change)

Actions	Aim: Climate Change To plan for and adapt to the potential impacts of climate change on the natural and built environments of the estuary	Risks Addressed	Cost
AC1	Identify and map areas likely to be impacted by sea level rise under different scenarios	RC1, RC2, RC3, RC4, RC5, RC6	Medium
AC2	Highlight areas of estuarine vegetation under potential threat due to sea level rise	RC1, RC2, RC6, RA1	Medium
AC3	Identify and conserve public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure	RC1, RC2, RA1	High
AC4	Replace existing stormwater pipes with more appropriately designed works when required as a part of asset replacement program	RC3	High
AC5	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified	RC3, RC4, RC5	Low
AC6	Establish consistent foreshore building line controls across all Councils	RC1, RC4, RC5, RF1, RF2	Low
AC7	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise	RC4, RC5	Low

Links to further information and existing works:

- Federal Government "Bathtub" Sea Level Rise Mapping (Sydney Region)
- Sydney Coastal Councils Group, Coastal Adaptation Decision Pathways Project (CAP) Fact Sheet – *Demonstrating Climate Change Adaptation of Interconnected Water Infrastructure* http://www.sydneycoastalcouncils.com.au/sites/default/files/custom_search/FactSheet%20Interconnected%20Water%20June%202012%20revised.pdf
- Case study, City of Ryde's Climate Change Adaptation.

[10] *"Assessment of the science behind the NSW Government's sea level rise planning benchmarks", Mary O'Kane, NSW Chief Scientist and Engineer* http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0016/26206/CSE-Report-Sea-Level-Rise-Benchmarks_.pdf

7.3 Aquatic and Riparian Habitat

Estuarine vegetation provides habitat that is important to fish and other animals. It also helps to hold sediments together and reduce turbidity of waterways. Saltmarshes support a rich and diverse community of invertebrates, provide roosting sites for many species of birds, and provide habitat for juvenile fish when inundated. In addition, mangrove forests are important habitats for fish, molluscs, crabs, bats and birds, and the trees provide large amounts of organic matter as a food source for the estuary.

Saltmarshes are generally found on soft substrate shores of estuaries and bays, and on some open low wave energy coasts. Saltmarshes along the banks of the Lane Cove River have been degraded and impacted by urbanisation, and displaced by mangroves. Today, only fragments of saltmarsh areas remain, and are placed under constant pressure from multiple processes including development, sedimentation, changed hydrology, mangroves expansion and climate change.[11]

A report "Saltmarsh Management Tools" for the Lane Cove River estuary, prepared by Applied Ecology, 2010, provides an overview and advice on planning for healthy saltmarsh communities into the future. This report covers planning for rehabilitation, legislative requirements, and management of threatening process and is underpinned by the principle that catchment scale planning is required. This report also details the saltmarsh environment in the Lane Cove River estuary, processes for rehabilitation, and planning protection for saltmarsh communities in the Lane Cove River estuary. The actions recommended in the Saltmarsh Site Assessments Manual relevant to this CZMP are listed in APPENDIX E Table 12-6.

Figure 7-2: Dinghies along the Banks of the River (Field visit photos)

Bush regeneration and revegetation of riparian and other lands is a popular method of controlling erosion and pollutant exports to waterways. It also has the potential to provide habitat, to create links between existing vegetation communities, and to provide shade to waterways thus reducing water temperatures and the incidence of algal blooms. Revegetation can be labour intensive and revegetated areas can require regular maintenance until vegetation has a chance to become fully established. Local bushcare groups and bush regeneration contractors can provide an important source of labour to undertaking such works, on both private and public lands. Involvement of the community in these types of works also increases their awareness of the problems faced by the

[11] *Saltmarsh Site Assessments Report, 2010, prepared by Applied Ecology*

environment of the estuary and catchment and of the types of actions they can take to reduce these problems.

Supporting the establishment and continuation of such groups can thus be expected to increase the awareness and knowledge of the community ensuring that community members behave in ways which protect and enhance the environmental values of the estuary as well as increasing the quantity and quality of vegetation in the catchment, improving water quality and habitat. Works should be undertaken where desirable and should be undertaken both on private and public lands, including within the Lane Cove National Park.

The existing Bushcare sites in the catchment area and saltmarsh communities along the banks of Lane Cove River are mapped and shown in APPENDIX H, Figures 5.

A new study provides important information about possible increased bushfire risk across south-east Australia, which may follow from climate change in coming decades. The study found that the combined frequencies of days with very high and extreme Forest Fire Danger Index ratings are likely to increase in south-east Australia by[12].

- 4–25 per cent by 2020,
- 15–70 per cent by 2050.

Table 7-4 lists the possible management actions for this Aim.

Table 7-4: Management Actions (Aquatic and Riparian Habitat)

Actions	Aim: Aquatic and Riparian Habitat To protect, enhance and restore aquatic habitats and foreshore vegetation	Risks Addressed	Cost
AA1	Councils to continue to undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation	RC1, RC2, RA1, RA2, RA3	Medium
AA2	Conduct a dinghy investigation and registration to identify disused dinghies. Install dinghy racks or assign dinghy storage areas	RA1, RA2	Medium
AA3	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and regeneration works on both public and private lands	RC1, RC2, RA1	Low
AA4	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management	RC1, RC2, RA1, RA2	Low
AA5	Identification and progressive control of invasive species from foreshore areas and adjacent bushland	RA1	Medium
AA6	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways	RA1	Medium
AA7	Promote and undertake compliance on	RA1, RF1,	Low

[12] *CSIRO, Climate Change, Adapting to Climate Change, Climate Change Impacts on fire weather* http://www.csiro.au/en/Outcomes/Climate/Adapting/Climate-Change-Fire-Weather.aspx

Actions	Aim: Aquatic and Riparian Habitat To protect, enhance and restore aquatic habitats and foreshore vegetation	Risks Addressed	Cost
	unauthorised riparian and estuarine vegetation clearing	RF2, RF3, RA3	
AA8	Encourage and assist revegetation of private foreshore areas	RC1, RA1, RF3	Low
AA9	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary	RC1, RC2, RA1	Medium
AA10	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways	RA1	Medium
AA11	Continue structural and operational improvements to fishway at Lane Cove weir	RF3	Medium
AA12	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire	RC2, RA1	Low

Links to further information and existing works:

- Lane Cove Estuary Saltmarsh Planning Manual, Saltmarsh Site Assessments, Saltmarsh Monitoring Manual, Applied Ecology, 2010
- Woollahra Municipal Council, Dinghy Storage Facilities http://www.woollahra.nsw.gov.au/recreation/boating_facilities/dinghy_storage_facility_locations
- Pittwater Council, Dinghy Storage Locations http://www.pittwater.nsw.gov.au/recreation/boating_facilities/dinghy_storage/dinghy_storage_locations
- CSIRO, Climate Change, Adapting to Climate Change, *Climate Change Impacts on fire weather* http://www.csiro.au/en/Outcomes/Climate/Adapting/Climate-Change-Fire-Weather.aspx
- Hunters Hill, Lane Cove, City of Ryde, Willoughby Council Bush Fire Management Committee, *Bush Fire Risk Management Plan, 2009*

7.4 Foreshore Protection

The consequences of urbanisation in the catchment are significant, with stormwater pollution, increased runoff and vegetation loss (including along riparian zones) all of great concern. Given that there will continue to be further development in the future, it is important that such development gives adequate and appropriate consideration of impacts on downstream receiving waters. Developments can have significant impacts during construction (particularly if there is inadequate control of on-site sediment), as well as post-construction.

The building and sub-division phases of developments are a time when the risk of significant erosion and export of sediments and nutrients is very high. During these phases, soil is disturbed and can be left exposed for significant periods of time. Little or no vegetation is available to hold soils together to prevent erosion. Moderate or large rainfall events occurring during these phases can thus generate very substantial erosion events that contribute sediments and nutrients to the waterways.

Sediment controls can be used to limit the amount of sediment exported off development sites during these phases. In some cases these controls may be missing or inadequately maintained to limit these damaging erosion events. Greater emphasis needs to be placed on:

- Ensuring that adequate sediment controls are implemented during the building and subdivision stages of all developments,
- Ensuring these controls are properly maintained so that they adequately control sediment movement on site. This is the case for residential and commercial developments overseen by Councils as well as infrastructure projects run by State and Federal Governments.

Appropriate sediment controls must be planned for before subdivision or building commences, then these must be subject to on-going monitoring of their presence and effectiveness.

Figure 7-3: Foreshore Building Constructions along Lane Cove River (Field visit photos)

It is considered that the extensive bushland helps to 'buffer' the impacts of the urbanised parts of the catchment on the health of the estuarine receiving waters. Should these undeveloped areas become urbanised, then the consequences on the Lane Cove River Estuary could be significant for any remaining areas of natural environment.

Seawalls are constructed to manage flooding, stabilise banks and to improve access to the waterway. In the past these seawalls were engineered, removing vegetation and aquatic habitat and acting to increase water velocities and change wave patterns, in some cases causing bank erosion locally in other parts of the estuary.

Figure 7-4: Seawalls along Middle and Upper Lane Cove River (Field visit photos)

Environmentally friendly seawalls can be used where erosion continues to be a substantial problem while providing vegetation and habitat for aquatic species. They are designed to mimic the natural intertidal zone providing a filter for pollutants which would otherwise enter the estuary and can avoid changing flow and wave patterns in a way which would cause erosion problems further along the shoreline.

Figure 7-5: Example of an Eco-Friendly Seawall ***(Source: HNCMA)***

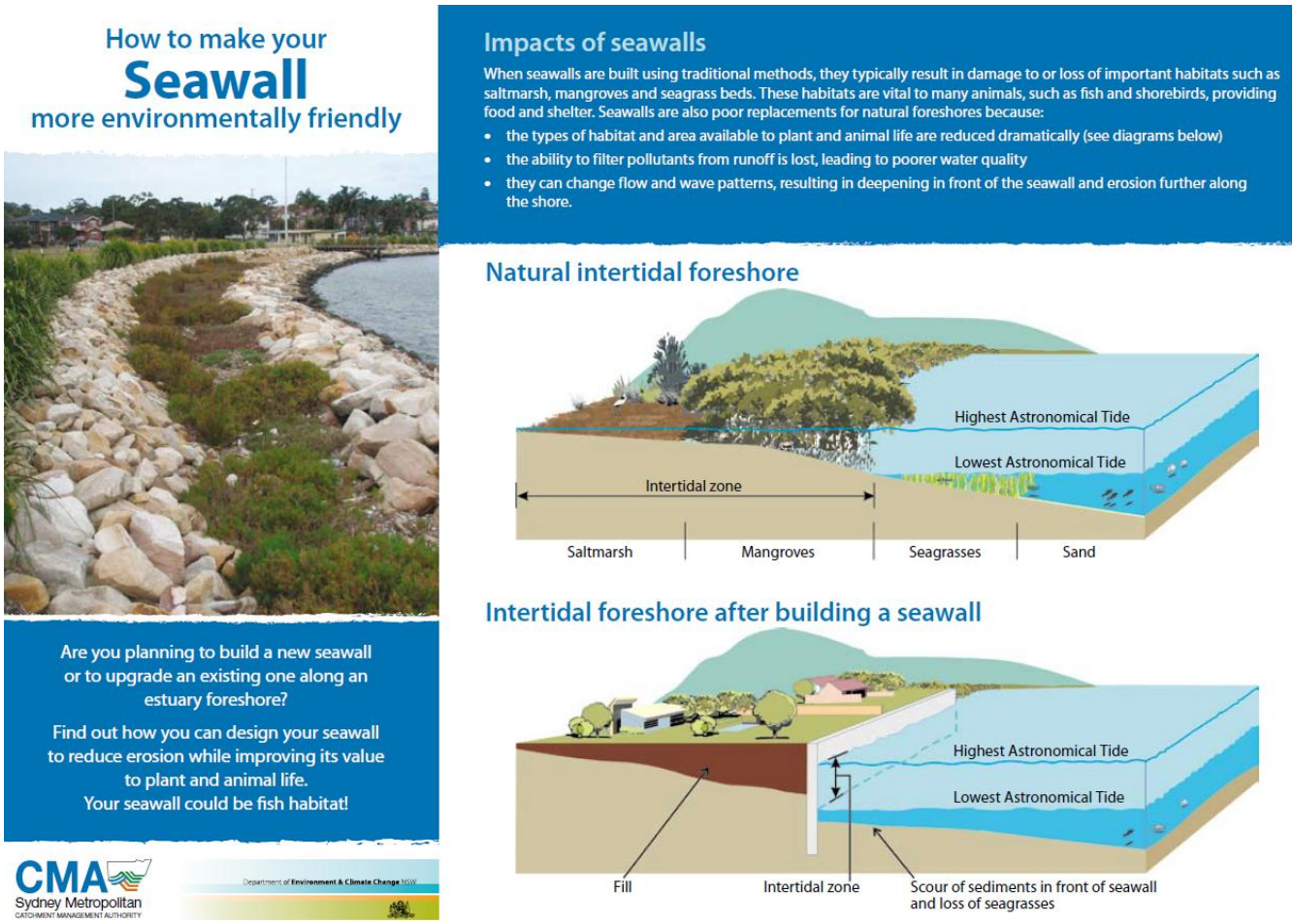

Figure 7-6: Seawall Brochure ***(Source: HNCMA)***

Table 7-5 lists the possible management actions for this Aim.

Table 7-5: Management Actions (Foreshore Protection)

Actions	Aim: Foreshore Protection To manage existing built foreshore assets while maximising environmental values and to minimise the negative impacts of development on catchment and waterway health	Risks Addressed	Cost
AF1	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints	RF2	Low
AF2	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation	RF2	Low
AF3	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices	RW3, RF1, RF2, RF3	Low
AF4	Explore options to improve the environmental value of existing seawalls through addition of habitat	RA1	Low
AF5	Monitoring and selective dredging of sediment build-up	RW3, RF3	High

Links to further information and existing works:

- OEH / HNCMA Environmentally Friendly Seawalls Brochure, http://www.sydney.cma.nsw.gov.au/index.php?option=com_remository&Itemid=51&func=select&id=51
- HNCMA Environmentally Friendly Seawall Guidelines, http://www.sydney.cma.nsw.gov.au/index.php?option=com_remository&Itemid=51&func=select&id=51
- Pittwater Council Best Practice Guidelines http://www.pittwater.nsw.gov.au/environment/water/estuaries/best_practice_guidelines/best_practice_guideline_3_-_seawalls
- Mosman Council's "The Quakers Hat Bay seawall project" http://www.mosman.nsw.gov.au/environment/cec/seawalls
- Chapman G. and Blockley D., The University of Sydney, "Building seawalls to sustain intertidal biodiversity in altered and urbanized estuaries" http://sydney.edu.au/science/bio/eicc/research/anthropogenic_disturbances/urban_structures/seawalls_estuaries.shtml
- Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 & Sydney Harbour & Foreshores Area DCP 2005

7.5 Estuary Health Monitoring and Evaluation

It is recognised that knowledge of the Lane Cove River estuarine environment can always be improved. On-going monitoring of the estuary is important to determine trends in its condition and health, and also to determine any improvements or benefits resulting from the implementation of this Coastal Zone Management Plan. The NSW Government advocates a Monitoring – Evaluation – Reporting (MER) framework for all natural resource monitoring and appraisal processes. The MER approach is considered to be a continuous learning and adaptive management framework whereby decision-makers can learn from previous successes and failures. They can also use this information to continuously respond and adapt to, or replace, policies, strategies, programs and actions so that goals are realistic and NRM outcomes are continuously improved (DECCW, 2010). The general MER process is presented in Figure 7-7.

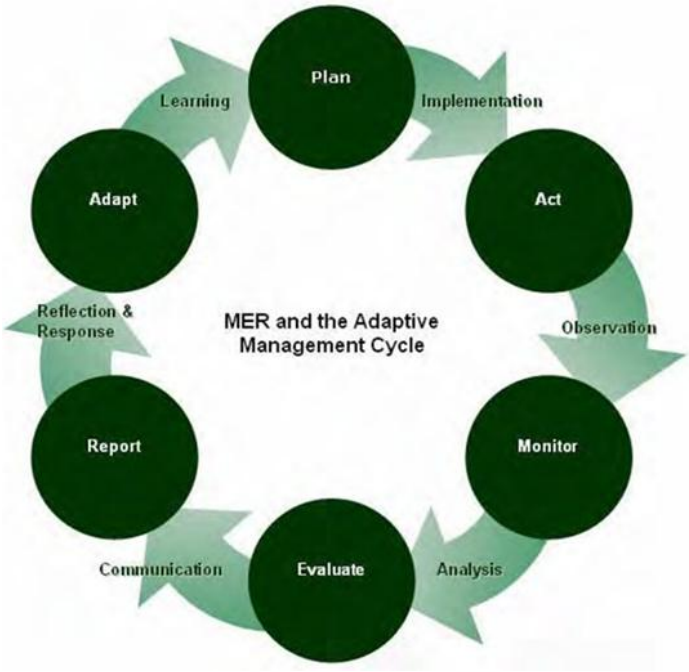

Figure 7-7: MER Framework and the Adaptive Management Cycle (DECCW, 2010)

The adaptive management approach is effective in NRM, because most NRM planning and investment decisions involve a high degree of complexity and uncertainty. There is also scope for the community to be involved in the MER process, thereby using the process as an education tool as well.

Understanding the current health of the estuary and trends over time is key to appropriately managing threats to the estuary. It is thus vital that the health monitoring programs are continued over time. Communicating the results of these monitoring in terms of the health of the estuary and pressures from the catchment and estuary uses is also important. The programs should work with Sydney Water to help identify the location, magnitude and impacts of any sewer overflows.

Future monitoring is recommended at sites with low SIGNAL scores such as Terrys Creek. Also, Councils should continue or undertake water quality monitoring and compare the results for each year as given in Table 7-1.

An Estuary Health Report Card is to be developed using data based on:

- Changes in saltmarsh condition and recovery potential since the baseline study completed in 2010;
- SIGNAL Scores for major tributary creeks measured 6 monthly as a proxy for estuary health;
- Beach suitability grade for estuary swimming pools published annualy as ameaure of reports on recreational water quality;
- Improvements in water quality identified through the Healthy catchments Healthy Harbour Water Quality Improvement Plan.

An excel spreadsheet has been developed for the four Councils. This spreadsheet allows the Councils to update and record the various stages of implementation of actions proposed in this Plan.

Current water quality monitoring sites in the Lane Cove River catchment area are mapped and shown in APPENDIX H, Figure 7. Table 7-6 lists the possible management actions for this Aim.

Table 7-6: Management Actions (Monitoring and Evaluation)

Actions	Aim: Monitoring and Evaluation To develop and support coordinated monitoring, reporting and evaluation programs for the Lane Cove River Estuary	Risks Addressed	Cost
AM1	Continue and support current monitoring programs, undertake coordinated monitoring and collate data on an estuary wide basis using an Estuary Health Report Card	RW1, RW2, RW3	Low
AM2	Support the implementation and monitoring of the effectiveness of Plan	RC1, RC2, RW3, RA2, RF1, RA3	Low
AM3	Undertake a review of the CZMP every 5-10 years	RC1, RC2, RW3, RA2, RF1, RA3	Low
AM4	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures	RC1, RC2	Medium

Links to further information and existing works:

- City of Ryde, Water Quality Monitoring Program http://www.ryde.nsw.gov.au/Environment/Water+Quality+and+Pollution/Water+Quality+Monitoring+Strategy
- New South Wales Natural Resources, Monitoring, Evaluation and Reporting Strategy 2010–2015 http://www.environment.nsw.gov.au/resources/soc/10977nrmmerstrat1015.pdf
- Sydney Harbour Catchment Water Quality Improvement Plan, Hawkesbury-Nepean Catchment Management Authority http://www.sydney.cma.nsw.gov.au/sydney-harbour-catchment/sydney-harbour-catchment-water-quality-improvement/
- Georges River Health Monitoring Program http://www.georgesriver.org.au/River-Health-Monitoring-Program.html

8 ACTIONS ASSESSMENT AND PRIORITISATION

As it is not practical or affordable for Councils to implement all of these actions at once, a methodology for prioritising actions was developed. The result is a prioritised list of recommended actions to achieve the Management Aims within an affordable and realistic framework.

The process of assessment and prioritisation followed in order to identify the most appropriate order of implementation for the various proposed management actions includes three assessment criteria for each of the possible management actions.

8.1 Criteria 1: Risk-Actions Matrix

The risk-actions matrix considers the effectiveness of each proposed action in addressing each risk, along with the overall prioritisation of the risks, as defined previously Section 6.3.

The results of this assessment are shown in the matrix presented in Table 8-1. In this table, “YY” means that the action addresses the risk in a direct manner and holds double risk points, while “Y” means that the action addresses the risk indirectly and holds single risk point.

In order to provide a comparison between the different actions, a weighting was also placed on the risks (“risk points”) and total points for each action determined.

For e.g. Total points for Action AW1 = YY + Y = (Y*Y) + Y = (16*16) +16 = 48.

Relative risk score = Total points for any action / Maximum points out of all actions (i.e. 74 for action AA1). This weighting reflected the prioritisation ranking of risks and placed importance on risks that have a higher priority. Therefore, actions that address the more important risks resulted in a higher (weighted) “relative risk score”.

8.2 Criteria 2: Associated Cost

The likely costs associated with implementation of the actions have been considered in a very basic manner, and was presented in Section 7.

8.3 Criteria 3: Community Ranking

The likely community acceptance of the various different actions has been considered by the Estuary Management Committee members and the community during the community workshop. The collective results of the community workshop are given in APPENDIX C of this CZMP.

Table 8-1: Risk-Actions Matrix

Risk	RW1	RW2	RC1	RC2	RW3	RC3	RA1	RC4	RC5	RC6	RA2	RF1	RF2	RW4	RF3	RA3	Total Points	Relative Risk Score
Risk Rank	*1*	*1*	*1*	*1*	*5*	*6*	*7*	*8*	*8*	*8*	*11*	*12*	*13*	*13*	*15*	*16*		
Risk Points	16	16	16	16	12	11	10	9	9	9	6	5	4	4	2	1		
Actions																		
AW1	YY	Y															48	0.65
AW2	Y	Y															32	0.43
AW3	Y	Y			Y									Y			48	0.65
AW4					Y												12	0.16
AW5					Y										Y		14	0.19
AW6					YY										Y		26	0.35
AW7					YY										Y		26	0.35
AW8					YY							YY	YY		YY		46	0.62
AW9					YY												24	0.32
AW10	Y	Y			Y									YY			52	0.70
AW11					YY												24	0.32
AW12					Y												12	0.16
AW13					YY												24	0.32
AC1			Y	Y		Y		Y	Y	Y							70	0.95
AC2			Y	YY			Y			Y							67	0.91
AC3			YY	YY			Y										74	1.00
AC4						YY											22	0.30
AC5						Y		YY	YY								47	0.64
AC6			Y					YY	YY			Y	Y				61	0.82
AC7								Y	Y								18	0.24
AA1			**Y**	**YY**			**YY**				**Y**					**Y**	**74**	1.00
AA2							Y				YY						22	0.30
AA3			Y	Y			YY										52	0.70
AA4			Y	Y			YY				Y						58	0.78
AA5							YY										20	0.27
AA6							YY										20	0.27
AA7							YY					Y	Y		Y	YY	33	0.45
AA8			Y				YY								Y		38	0.51
AA9			Y	Y			Y										42	0.57
AA10							YY										20	0.27
AA11															Y		2	0.03
AA12				Y			YY										36	0.49
AF1													Y				4	0.05
AF2													Y				4	0.05
AF3					Y							YY	YY		YY		34	0.46
AF4							Y										10	0.14
AF5					Y										YY		16	0.22
AM1	Y	Y			Y												44	0.59
AM2			Y	Y	Y						Y	Y	Y			Y	60	0.81
AM3			Y	Y	Y						Y	Y	Y			Y	60	0.81
AM4			Y	YY													48	0.65

8.4 Actions Prioritisation

The three criteria (as previously discussed) were used to assess and prioritise the proposed management actions. Results for each individual criterion were converted to equivalent unit values, with maximum scores of 1.0 for each. The highest scoring option for Criteria 1 (Relative Risk Score), as defined in Table 8-1 , was given a score of 1.0; scores for all other options were calculated as the relative scores (as given in Table 8-1 divided by the maximum score (i.e. 74, refer to Table 8-1). For the second Criteria, low costs were given a score of 1.0, medium costs a score of 0.67 and high costs a score of 0.33. For Criteria No. 3, scores were based on the collective feedback from the EMC members and community, (out of a total possible score of 45).

The scores for the individual criteria were multiplied to give an overall score for each action,

Overall Score = Relative Risk Score x Cost Score x Community Score

The top fifteen ranked actions (overall rank 1 to 15) have been categorised as high priority actions, next fifteen actions (overall rank 16 to 30) are medium priority actions and rest eleven (overall rank 31 to 41) are low priority actions. The final results are presented in Table 8-2, along with the results for each individual criterion.

Table 8-2: Assessment and Prioritisation of Management Actions

	Management Actions		Rel. Risk Score	Cost Score	Comm. Score	Overall Score	Overall Rank
High Priority	AA1	Councils to continue to undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation	1.00	0.67	0.89	0.60	**1**
	AC6	Establish consistent foreshore building line controls across all Councils	0.82	1.00	0.69	0.57	**2**
	AW8	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction	0.62	1.00	0.87	0.54	**3**
	AA3	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and regeneration works on both public and private lands	0.70	1.00	0.76	0.53	**4**
	AC2	Highlight areas of estuarine vegetation under potential threat due to sea level rise	0.91	0.67	0.87	0.53	**4**
	AA4	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management	0.78	1.00	0.64	0.50	**6**
	AW10	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises	0.70	1.00	0.67	0.47	**7**
	AC1	Identify and map areas likely to be impacted by sea level rise under different scenarios	0.95	0.67	0.73	0.46	**8**

		Management Actions	Rel. Risk Score	Cost Score	Comm. Score	Overall Score	Overall Rank
	AC5	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified	0.64	1.00	0.71	0.45	**9**
	AA8	Encourage and assist revegetation of private foreshore areas	0.51	1.00	0.82	0.42	**10**
	AM2	Support the implementation and monitoring of the effectiveness of Plan	0.81	1.00	0.51	0.41	**11**
	AM3	Undertake a review of the CZMP every 5-10 years	0.81	1.00	0.51	0.41	**11**
	AW3	Continue current water quality monitoring and undertake wet weather monitoring	0.65	1.00	0.60	0.39	**13**
	AA7	Promote and undertake compliance on unauthorised riparian and estuarine vegetation clearing	0.45	1.00	0.80	0.36	**14**
	AM1	Continue and support current monitoring programs, undertake coordinated monitoring and collate data on an estuary wide basis using an Estuary Health Report Card	0.59	1.00	0.51	0.30	**15**
	AW2	Liaise with Sydney Water when sewers are observed to be causing water quality problems	0.43	1.00	0.69	0.30	**15**
Medium Priority	AM4	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures	0.65	0.67	0.62	0.27	**17**
	AF3	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices	0.46	1.00	0.58	0.27	**17**
	AW9	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment	0.32	1.00	0.69	0.22	**19**
	AW11	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects	0.32	1.00	0.67	0.22	**19**
	AA12	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire	0.49	1.00	0.44	0.21	**21**
	AA9	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary	0.57	0.67	0.53	0.20	**22**
	AC3	Identify and conserve public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure	1.00	0.33	0.58	0.19	**23**
	AW1	Liaise with Sydney water to ensure that the improvements in the sewer overflow performance continue throughout the catchment	0.65	0.33	0.89	0.19	**23**
	AC7	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise	0.24	1.00	0.71	0.17	**25**
	AA5	Identification and progressive control of invasive species from foreshore areas and adjacent bushland	0.27	0.67	0.87	0.16	**26**
	AA6	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways	0.27	0.67	0.87	0.16	**26**

	Management Actions		Rel. Risk Score	Cost Score	Comm. Score	Overall Score	Overall Rank
	AW6	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel naturalisation	0.35	0.67	0.62	0.15	**28**
	AA2	Install dinghy racks or assign dinghy storage areas, Conduct a dinghy investigation and registration to identify disused dinghies	0.30	0.67	0.73	0.15	**28**
	AW7	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices.	0.35	0.67	0.60	0.14	**30**
	AW13	Assess fertilizer distribution rates and procedures especially during periods of heavy rain	0.32	0.67	0.64	0.14	**30**
Low Priority	AW12	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term	0.16	1.00	0.82	0.13	**32**
	AA10	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways	0.27	0.67	0.56	0.10	**33**
	AW4	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes	0.16	1.00	0.62	0.10	**33**
	AW5	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing and preparation of new Development Control Plans (DCPs)	0.19	0.67	0.76	0.10	**33**
	AC4	Replace existing stormwater pipes with more appropriately designed works when required as a part of asset replacement program	0.30	0.33	0.71	0.07	**36**
	AF4	Explore options to improve the environmental value of existing seawalls through addition of habitat	0.14	1.00	0.49	0.07	**36**
	AF5	Monitoring and selective dredging of sediment build-up	0.22	0.33	0.58	0.04	**38**
	AF1	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints	0.05	1.00	0.58	0.03	**39**
	AF2	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation	0.05	1.00	0.44	0.02	**40**
	AA11	Continue structural and operational improvements to fishway at Lane Cove weir	0.03	0.67	0.56	0.01	**41**

Several recommended actions from some other reports, which were thought to be relevant and to be included in this CZMP, are presented in APPENDIX E Table 12-6 and mapped in Appendix H Figures 8 to 18.

9 STRATEGIC ACTION PLAN

The proposed management actions in the order of their priority are given in Table 8-2. The implementation of these proposed actions would provide significant benefits to Lane Cove River Estuary.

There are some actions which are already part of Council's core business and others which are important areas to work with external agencies like Sydney Water. This section, Strategic Action Plan, provides an implementation strategy based on defined packets of works including ongoing actions, policy driven actions, works driven actions and funding dependent actions. The Strategic Action Plan also identifies the 'approach' of action, indicating the department or section of the Councils that would nominally be given the responsibility for implementation. These include:

- Strategic Planning and Development Controls,
- Engineering Works and Asset Management,
- Communications and Education,
- Recreation and Heritage,
- Environmental Planning,
- Environmental Rehabilitation and Monitoring, and
- Compliance.

A detail Implementation Plan which includes the action ranking, timeframe of implementation, responsible authorities and funding resources is presented in APPENDIX D:.

Different colour codes have been used to differentiate the available funding and timeframe resources for each action.

Yellow coloured actions as listed in Table 9-1 are currently ongoing actions supported by the four Councils. These include ongoing bushcare programs and stricter and consistent sediment and development controls across all Councils. These actions are also the top four highest ranking actions and hence, developing and further continuing these actions would prove highly beneficial to the Lane Cove River estuary.

Green coloured actions imply that funding and resources for implementation of these actions can be extracted from Council's internal budget and hence, can be started as soon as possible. These include highlighting areas affected by sea level rise, undertaking wet weather monitoring, improving sewage overflow performance, maintenance of WSUD devices etc. These actions are listed in Table 9-2.

Orange coloured actions as listed in Table 9-3 require some form of external funding or grants, such as through OEH, DCCEE or other relevant authorities. It is recommended that depending on the priority of the action, funding should be sourced in a timely manner and actions can be implemented thereafter.

Purple coloured actions as listed in Table 9-4 also require external funding and resources and should be implemented as deemed appropriate. Some of the actions, such as encouraging private area vegetation and community education about environmentally friendly adaptation methods to climate

change/sea level rise do not have a specific timeline for implementation and hence can be carried out suitably as resources and funding become available in future.

Table 9-1: Management Actions (Ongoing) - Continue

Rank	Management Actions	
1	AA1	Councils to continue to undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation (sometimes grant funded)
2	AC6	Establish consistent foreshore building line controls across all Councils
3	AW8	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction
4	AA3	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and/or regeneration works on both public and private lands

Table 9-2: Management Actions - Within Councils Budget

Rank	Management Actions	
4	AC2	Highlight areas of estuarine vegetation under potential threat due to sea level rise
7	AW10	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises
8	AC1	Identify and map areas likely to be impacted by sea level rise under different scenarios
11	AM2	Support the implementation and monitoring of the effectiveness of Plan
14	AA7	Promote and undertake compliance on unauthorised riparian and estuarine vegetation clearing
17	AF3	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices
19	AW9	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment
19	AW11	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects
21	AA12	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire
22	AA9	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary
23	AC3	Identify and conserve public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure
26	AA5	Identification and progressive control of invasive species from foreshore areas and adjacent bushland (sometimes grant funded)

Rank	Management Actions	
28	AA2	Install dinghy racks or assign dinghy storage areas, Conduct a dinghy investigation and registration to identify disused dinghies
30	AW7	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices.
33	AA10	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways
33	AW4	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes of this
33	AW5	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing and preparation of new Development Control Plans (DCPs)

Table 9-3: Management Actions – External Funding Required

Rank	Management Actions	
15	AM1	Continue and support current monitoring programs, undertake monitoring and collate data on an estuary wide basis using an Estuary Health Report Card
26	AA6	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways
28	AW6	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel naturalisation
30	AW13	Assess fertilizer distribution rates and procedures especially during periods of heavy rain
32	AW12	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term

Table 9-4: Management Actions – External Funding Required, Do When Appropriate

Rank	Management Actions	
6	AA4	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management
9	AC5	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified
10	AA8	Encourage and assist revegetation of private foreshore areas
11	AM3	Undertake a review of the CZMP every 5-10 years
13	AW3	Continue current water quality monitoring and undertake wet weather monitoring
15	AW2	Liaise with Sydney Water when sewers are observed to be causing water quality problems

Rank	Management Actions	
17	AM4	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures
23	AW1	Liaise with Sydney water to ensure that the improvements in the sewer overflow performance continue throughout the catchment
25	AC7	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise
36	AC4	Replace existing stormwater pipes with more appropriately designed works when required as a part of asset replacement program
36	AF4	Explore options to improve the environmental value of existing seawalls through addition of habitat
38	AF5	Monitoring and selective dredging of sediment build-up
39	AF1	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints
40	AF2	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation
41	AA11	Continue structural and operational improvements to fishway at Lane Cove weir

10 CONCLUSION

The Lane Cove River Coastal Zone Management Plan (CMZP) investigates and proposes actions to address emerging estuarine issues including climate change and implementation of Water Sensitive Urban Design. Incorporating existing actions already being undertaken by Councils and State Agencies has enabled integration of the Plan with existing procedures and the current Lane Cove River Estuary Management Plan (EMP 2004) rather than duplicating such actions, and also demonstrates the need for new actions to manage estuary health.

As a first step to developing this Coastal Zone Management Plan, a review of the existing Estuary Management Plan (EMP 2004) was completed. The implementation status and success rate of the objectives and strategies recommended by the EMP 2004 were verified through data review, EMC workshop and ongoing consultation with the four Councils. A summary of this review is presented in Section 4.2 and Table 4-1. The EMP 2004 has proven to be a great step towards the ongoing management and protection of the Lane Cove River and its natural assets.

Five key Aims, as presented in Section 5, have been developed to address the primary goal of this Coastal Zone Management Plan i.e.

"To conserve and improve the existing natural environment and water quality of the Lane Cove River estuary".

A modified Risk Management approach was utilised for this CZMP which builds on planning and strategy works that have been carried out to date. A risk assessment was completed which identified **sixteen potential risks** to achieving the five Aims of the CZMP. Prioritisation of these risks was achieved through consultation with Councils and the community to determine those risks which posed the most serious threats and were most likely to occur if not managed. This is given in Section 6.3 and Table 6-9.

Management Actions have been developed and recommended which aim to reduce the risks to the Lane Cove River estuary (refer to Section 7 and 8.4). The Actions were formulated and assessed based on three different criteria; potential to address risks, likely costs and community acceptance. These have been arranged in a Strategic Action Plan (Section 9) which identifies funding sources and implementation timelines as well as provides a basis for the review and evaluation of the successful implementation of this CZMP.

A summary of the Aims of the Lane Cove River CZMP, Risks to achieving the Aims and proposed Management Actions addressing the Risks is presented in Table 10-1.

An excel spread sheet has been developed for the four Councils and is available on the Lane Cove River CZMP's webpage. This spread sheet allows the Councils to update and record the various stages of implementation of actions proposed in this Plan.

The Lane Cove River CZMP provides a framework for successful implementation of Plan actions and monitor changes that may present new or enhanced risks to estuary health requiring management. It has also involved the community to a high level in development of the Plan, to ensure that actions have broad community support, are aimed at community needs, and improve community awareness and understanding of the estuary.

Table 10-1: Summary of Aims, Risks and Proposed Management Action

	Aim: Water Quality	Action Rank	Action Priority
Risks Identified	Sewer Overflows - Discharges of contaminants from the sewerage system through leakage, chokes and designated sewer overflows		
	Leak, spills or overflow from sewage pumping station		
	Pollutants washed away from urban areas into the estuary		
	Leak, spills or overflow from National Starch Factory (170 Epping Road)		
Proposed Management Actions	Liaise with Sydney water to ensure that the improvements in the sewer overflow performance continue throughout the catchment	23	Medium
	Liaise with Sydney Water when sewers are observed to be causing water quality problems	15	High
	Continue current water quality monitoring and undertake wet weather monitoring	13	High
	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes of this	33	Low
	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing and preparation of new Development Control Plans (DCPs)	33	Low
	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel naturalisation	28	Medium
	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices	30	Medium
	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction	3	High
	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment	19	Medium
	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises	7	High
	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects	19	Medium
	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term	32	Low
	Assess fertilizer distribution rates and procedures especially during periods of heavy rain	30	Medium

	Aim: Climate Change	Action Rank	Action Priority
Risks Identified	Landward migration of saltmarsh and mangroves due to Sea Level Rise (SLR) but constrained due to foreshore urban development		
	Impact on riparian corridors due to climate change and SLR		
	Stormwater, Sewer pipes/pits inundation, overflow due to SLR		
	Storm surge inundation due to climate change and SLR		
	Flooding to low lying areas due to SLR		
	Increased salinity due to SLR (affecting flora and fauna)		
Proposed Management Actions	Identify and map areas likely to be impacted by sea level rise under different scenarios	8	High
	Highlight areas of estuarine vegetation under potential threat due to sea level rise	4	High
	Identify and conserve public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure	23	Medium
	Replace existing stormwater pipes with more appropriately designed works when required as a part of asset replacement program	36	Low
	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified	9	High
	Establish consistent foreshore building line controls across all Councils	2	High
	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise	25	Medium
	Aim: Aquatic and Riparian Habitat	**Action Rank**	**Action Priority**
Risks Identified	Loss of natural habitat along the river due to future development and excessive recreational uses		
	Dinghies left on the saltmarshes		
	Trees being cut to clear views (e.g. in Chatswood golf course) affecting riparian vegetation along the creek and estuary		
Proposed Management Actions	Councils to continue to undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation	1	High
	Conduct a dinghy investigation and registration to identify disused dinghies, Install dinghy racks or assign dinghy storage areas	28	Medium
	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and regeneration works on both public and private lands	4	High
	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management	6	High
	Identification and progressive control of invasive species from foreshore areas and adjacent bushland	26	Medium
	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways	26	Medium
	Promote and undertake compliance on unauthorised riparian and estuarine vegetation clearing	14	High
	Encourage and assist revegetation of private foreshore areas	10	High

	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary	22	Medium
	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways	33	Low
	Continue structural and operational improvements to fishway at Lane Cove weir	41	Low
	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire	21	Medium
	Aim: Foreshore Protection	**Action Rank**	**Action Priority**
Risks Identified	Foreshore construction not carried out under strict development controls		
	Bank erosion due to foreshore development and excavation		
	Navigation problem and reduced flushing potential due to sedimentation		
Proposed Management Actions	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints	39	Low
	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation	40	Low
	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices	17	Medium
	Explore options to improve the environmental value of existing seawalls through addition of habitat	36	Low
	Monitoring and selective dredging of sediment build-up	38	Low
	Aim: Estuary Health Monitoring and Evaluation	**Action Rank**	**Action Priority**
Risks Identified	-		
Proposed Management Actions	Continue and support current monitoring programs, undertake coordinated monitoring and collate data on an estuary wide basis using an Estuary Health Report Card	15	High
	Support the implementation and monitoring of the effectiveness of Plan	11	High
	Undertake a review of the CZMP every 5-10 years	11	High
	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures	17	Medium

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12 ABBREVIATIONS USED

ABBREVIATION	DESCRIPTION
CZMP	Coastal Zone Management Plan
DCP	Development Control Plan
DCCEE	Department of Climate Change and Energy Efficiency
DoP	NSW Department of Planning and Infrastructure
DPI	NSW Department of Primary Industries
EMP	Estuary Management Plan
EMC	Estuary Management Committee
HHC	Hunters Hill Council
LCC	Lane Cove Council
LEP	Local Environment Plan
LGA	Local Government Area
NPWS	National Parks and Wildlife Service
NSW OEH	NSW Government Office of Environment and Heritage
CoR	City of Ryde
SoE	State of Environment
SEPP	State Environment Planning Policy
SLR	Sea Level Rise
HNCMA	Hawkesbury-Nepean Catchment Management Authority
SWC	Sydney Water Corporation
SWMAP	Stormwater Management Action Plan
WSUD	Water Sensitive Urban Design
WCC	Willoughby City Council

APPENDIX A: RELEVANT PLANS, POLICIES AND LEGISLATION

SEPP 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 Planning becomes the consent authority for state significant development, significant coastal development and development in sensitive coastal locations.

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 water's 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,
- residential land within 100m of land identified under SEPP26.

As the coastal zone (as defined in section 4A of the Coastal Protection Act 1979) now includes coastal areas between Wollongong and Port Stephens, SEPP-71 is applicable to the whole Lane Cove River Estuary up to Fullers Bridge Weir, including all tidal tributaries, and will need to be considered during development of management options and during implementation, as appropriate.

SEPP (Major Development) 2005

The SEPP provides for the Minister to be the approval authority for major development as identified within the SEPP and schedules, subject to Part 3A of the EP&A Act. Although Part 3A of the EP&A Act has been repealed, SEPP (Major Development) remain in place for the time being.

SEPP (Infrastructure) 2007

SEPP (Infrastructure) 2007 was gazetted on the 1 January 2008 and was prepared to consolidate and update planning provisions relating to infrastructure and government land. The SEPP provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. The intent of the SEPP is to support greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency for the State.

The SEPP outlines planning processes for considering classes of public infrastructure and particular infrastructure projects; exempts some minor public infrastructure from the need for an approval; clarifies where new infrastructure can be located and provides for additional permissible uses on government land and requires State agencies constructing infrastructure to consult local councils when a new infrastructure development is likely to affect existing local infrastructure or services.

Division 25 of the SEPP relates to waterway or foreshore management activities. Section 129 of the SEPP identifies development which is permitted without consent and includes development for the purposes of waterway or foreshore management activities, which may be carried out by or on behalf of a public authority without consent on any land. These activities include:

- construction works;
- routine maintenance works;
- emergency works, including works required as a result of flooding, storms or coastal erosion;
- Environmental management works.

The clause also relates to development for the purpose of temporary works associated with drought relief which maybe be carried out by on behalf of a public authority without consent subject to certain criteria.

Some works proposed in this Coastal Zone Management Plan fall within the above categories, and as such, SEPP Infrastructure may be considered as a pathway for development consent for these works.

Sydney Harbour Catchment Regional Environmental Plan (2005)

Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (Harbour REP) covers all the waterways of the Harbour, the foreshores and entire catchment. It establishes a set of planning principles to be used by councils for the preparation of planning instruments, for the hydrological catchment of the Harbour. It also zones the waterways into nine different zones to suit the differing environmental characteristics and land uses of the harbour and its tributaries.

Sydney Harbour Foreshores Area Development Control Plan (2005)

A development control plan (DCP) has also been prepared to support the REP. The DCP provides detailed design guidelines for development and criteria for natural resource protection for the area identified as Foreshores and Waterways area. The DCP was made at the same time that the REP was gazetted.

Environmental Planning and Assessment Act, 1979

The Environmental Planning and Assessment Act, 1979 (EPA Act) is the principle legislation that establishes the NSW planning framework, and was intended as a system of land use control. This is essentially the overarching document which determines land use and planning in the Lane Cove River catchment. Those Parts of the EPA Act of particular relevance to the Lane Cove River Estuary are outlined herein.

Part 3A of the EPA Act, was repealed in early 2011 and therefore no longer applies.

Part 4 of the EPA Act – Development Assessment

Part 4 applies to the standard lodgement and consideration process for development applications, where the local council is the consent authority. In this case, the Local Environment Plans (LEPs) determine the permissibility of the development, with controls for particular sites found in the LEP and any applicable development control plan (DCP). Part 4 applies to the majority of development on land within the Lane Cove River Estuary catchment. Note that different LEPs apply to each LGA within the catchment.

Part 4 also stipulates the need for a Controlled Activity Approval (CAA) for works on 'Waterfront Land', in accordance with Part 3 of Chapter 3 of the Water Management Act 2000 (WM Act). 'Waterfront Land' broadly refers to land within 40 m of the highest bank of a river, and equivalent location for lakes, estuaries and coastal waters. Activities for which a CAA is required include erection of buildings, removal of material or vegetation, deposition of material, and carrying out any other activity that affects the quantity or flow of water. A large amount of development along the Lane Cove River may lie within 'Waterfront Land' as defined by the WM Act and will require a CAA, unless it can be shown to meet an exemption to the WM Act, as defined in Clause 39A of the Water Management (General) Regulation 2004.

Part 5 of the EPA Act – Development by the Crown

Part 5 of the EPA Act applies to those "activities" which do not require development consent under Part 4, but do require approval from a Minister or Public Authority, or are proposed to be carried out by a Minister or Public Authority.

NSW Coastal Protection Act 1979

In 2002, amendments were made to the Coastal Protection Act 1979 that requires Coastal Zone Management Plans to be prepared for parts of the NSW coastal zone. Under provisions of the Act, Coastal Zone Management Plans are required to be approved by the Minister prior to being gazetted by Councils. In order to comply with the provisions of the Act, Coastal Zone Management Plans need to address the following matters before they would be approved by the Minister:

- protecting and preserving beach environments and beach amenity, and
- emergency actions of the kind that may be carried out under the State Emergency and Rescue Management Act 1989, or otherwise, during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event, and
- ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion.

Once published in the Government Gazette, a Coastal Zone Management Plan becomes a statutory instrument under NSW legislation. In accordance with Section 55L of the Coastal Protection Act, 1979, a breach of (e.g. failure to comply with) the Plan may result in the Minister or a council bringing proceedings in the Land and Environment Court to remedy or restrain the breach.

As this CZMP does not relate to open coastal waters, there is no requirement for specifying emergency actions following storm erosion events.

NSW Local Government Act 1993

The Local Government Act 1993 provides the legal framework for an effective, efficient, environmentally responsible and open system of local government in NSW. Council's charter is outlined by the Act and includes 'to properly manage, develop, protect, restore, enhance and

conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of ecologically sustainable development'.

Under the provisions of the Act, Councils have numerous functions. Chapter 6 of the Act requires that all land vested in Councils must be classified as either Community or Operational land. Community land is land which should be kept for use by the general public (e.g. a public park). Councils must prepare Plans of Management to guide the use and management of Community land. Core objectives are defined in the Act for the management of different types of Community land. Plans of Management prepared for Community land within the study area should be generally consistent with the principles of this plan.

Under Chapter 13 of the Act, Councils are required to prepare Management Plans each year. The Management Plan details the Council's activities and budget for the next financial year. Subject to the competing demands and priorities, the various Councils relevant to the Lane Cove River Estuary will identify funding for the implementation of various elements of the Coastal Zone Management Plan through the relevant program areas.

NSW Crown Lands Act 1989

The Crown Lands Act is administered by the Crown Lands Division (CLD) of the Department of Primary Industries to provide for the administration and management of Crown land in the Eastern and Central Division of the State. Crown land shall not be occupied, used, sold, leased, licensed, dedicated or reserved or otherwise dealt with unless the occupation, use, sale, lease, licence, reservation or dedication or other dealing is authorised by this Act.

The Division also manages vacant Crown land, land retained in public ownership for environmental protection purposes and the lands of the Crown public roads network. Crown land is allocated for public uses, including schools, hospitals, sports grounds, community recreation and housing development. Crown reserves are managed in partnership with both councils and local community groups. The goal of Crown land management is to optimise environmental, economic and social outcomes for the benefit of the people of NSW.

Within the Lane Cove River Estuary, the major part of the Crown estate includes the bed of the river. Any activity that will impact on Crown land must be referred to the NSW Crown Lands Division (CLD) as a part of the Department of Primary Industries (DPI) for assessment of impacts and the consideration of approval of the activity by way of appropriate authorisation subject also to any Environmental Planning requirements.

NSW National Parks and Wildlife Act 1974

The NP&W Act is administered by the Office of Environment and Heritage (OEH), and addresses the protection of Aboriginal items and certain native flora and fauna.

Under the NP&W Act it is an offence to harm threatened species; buy, sell or possess threatened species; damage critical habitat; or damage the habitat of a threatened species without the issuing of a Section 120 licence.

If any identified archaeological sites or remains need to be removed or destroyed, prior to commencement of works in the area, an approval is required from the OEH for a section 87 or 90 permit.

The Lane Cove River Estuary study area could potentially contain a number of significant Aboriginal heritage sites. Conservation of key estuary areas may be supported by the protection of flora, fauna or Aboriginal heritage under this Act.

NSW Fisheries Management Act 1994

The FM Act has as part of its objectives the protection of fish stocks, key fish habitats and threatened species and their habitats. This Act also covers the sustainable management of commercial and recreational fishing and promotion of viable aquaculture in NSW.

Harm of aquatic habitats through dredging and reclamation, blockage of fish passage, harm of marine vegetation (seagrasses, mangroves, saltmarsh and algae) and the use of explosives is regulated under the FM Act. Permits are required to be obtained prior to undertaking such activities.

Any proposed damage to marine vegetation (including mangroves) requires approval and a permit to be obtained from DPI (Fisheries).

NSW Threatened Species Conservation Act 1995

If a proposed development is likely to significantly affect critical habitat of a threatened species, population or ecological community, or is within critical habitat, as defined by the Act, a Species Impact Statement (SIS) must be prepared. The test of significance is defined by an eight point test that is required for potentially affected threatened species under Section 5A of the Environmental Planning and Assessment Act 1979.

A licence under the Act is generally required for the harming or picking of listed threatened plants or animals.

The TSC Act applies to the Lane Cove River Coastal Zone Management Plan as many threatened species listed under the TSC Act are present in the study area. This Act will assist in implementing strategies to ensure habitat protection and conservation within the Lane Cove River Estuary catchment.

NSW Heritage Act 1977

The Heritage Act 1977 protects heritage items, sites, and relics and is administered by the NSW Heritage Office. A relic is defined as any item relating to European settlement that is older than 50 years. Under Section 139 an excavation permit must be obtained from the NSW Heritage Office for the excavation or disturbance of a relic.

Estuary Management strategies must ensure they do not detrimentally impact on heritage items listed under this Act.

NSW Protection of the Environment Operations Act 1997

The POEO Act lists activities requiring environmental protection licences from the OEH, and details pollution offences and penalties.

The Lane Cove River Estuary and its tributaries are subject to scheduled activities and other forms of pollution (commercial and recreational boats, industrial development, urban development etc.) that are administered under the POEO Act. Improved compliance with licence requirements may be necessary for sites such as National Starch Pty Ltd, 170 Epping Road, Lane Cove.

NSW Noxious Weeds Act 1993

The Noxious Weeds Act 1993 identifies noxious weeds and specifies control measures and duties of public and private landholders. The Act provides a framework for the state-wide control of noxious weeds by the Minister and local control authorities.

NSW Water Management Act 2000

A controlled activity approval is required for certain types of developments and activities that are carried out in or near a river, lake or estuary. Under the Water Management Act 2000 (WMA) a controlled activity means:

- the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or
- the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or
- the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or
- the carrying out of any other activity that affects the quantity or flow of water in a water source.

The WM Act also governs the issue of new water licences and the trade of water licences and allocations for those water sources (rivers, lakes and groundwater) in NSW where water sharing plans have commenced. The Water Act 1912 is being progressively phased out and replaced by the WMA but some provisions are still in force.

Note that Councils are offered some special exceptions under the WM Act, and that specific advice should be sought if provisions of the WM Act are to be triggered by any proposed works or activities.

NSW Coastal Policy 1997

The NSW Coastal Policy responds to the fundamental challenge to provide for population growth and economic development without placing the natural, cultural, spiritual and heritage values of the coastal environment at risk. To achieve this, the Policy has a strong integrating philosophy based on the principles of ecologically sustainable development (ESD).

The Policy addresses a number of key coastal themes including:

- Population growth in terms of physical locations and absolute limits;
- Coastal water quality issues, especially in estuaries;
- Disturbance of acid sulfate soils;
- Establishing an adequate, comprehensive and representative system of

reserves;
- Better integration of the range of government agencies and community organisations involved in coastal planning and management;
- Indigenous and European cultural heritage; and integration of the principles of ESD into coastal zone management and decision making.

The management of the coastal zone is the responsibility of a range of government agencies, local councils and the community. The Policy provides a framework for the balanced and coordinated management of the coast's unique physical, ecological, cultural and economic attributes.

The Lane Cove River and its foreshores falls within the defined coastal zone, therefore the Coastal Policy needs to be considered in the preparation of the Lane Cove River Estuary Coastal Zone Management Plan. Councils are required to implement the policy when making local environment plans applying to land within the coastal zone and to take the provisions of the policy into consideration when determining development applications in the coastal zone.

The Policy specifically recommends that detailed management plans for estuaries be prepared and implemented in accordance with the NSW Government's Coastal Zone Management Plan Guidelines.

White Paper - A new planning system for NSW

The White Paper – A new planning system for NSW and draft planning legislation were released on 16 April 2013 and are on public exhibition until 28 June 2013.

The purpose of this White Paper is to set out how the new planning system will function. This includes the new legislation, early community participation and a framework for strategic planning and development assessment. These changes will be supported by a positive change in the culture of people involved in the new planning system, with all of these factors working together to establish the ground rules for our new world class planning system.

In preparing the White Paper, the NSW Government has sought to respond to the questions, ideas and issues raised by the many people, businesses and organisations involved in the process to date. A comprehensive summary of the feedback from the community and stakeholders is provided in a separate report, The Green Paper Feedback Summary, released in December 2012.[13]

[13] *NSW Govt. Planning and Infrstructure, Policy and Legislation, A New Planning System for NSW, White Paper* http://www.planning.nsw.gov.au/PolicyandLegislation/ANewPlanningSystemforNSW/WhitePaper/tabid/648/language/en-US/Default.aspx

APPENDIX B: WATER SENSITIVE URBAN DESIGN

B.1 INTRODUCTION TO WSUD

One of the major ways to improve the water quality in urbanised areas is to ensure new developments as well as infill and redevelopments reduce pollutant loads (both nutrients and erosive flows) by implementing Water Sensitive Urban Design (WSUD). WSUD devices should be designed for normal flood conditions and will have little or no impact on large floods. They will however, if designed appropriately, have an impact on reducing smaller and more frequent storm events including those that are likely to contribute to erosion in natural streams. The term WSUD refers to many different possible actions (new devices, management interventions and practices and are under constant development). In this plan, six main types of WSUD devices are considered in more detail:

- bioretention systems/raingardens,
- gross pollutant traps,
- vegetated swales,
- rainwater tanks,
- buffers, and
- riparian revegetation.

Benefits of WSUD

While WSUD aims to minimise the impact of urbanisation on the water cycle, it delivers a range of other benefits:

- Introducing vegetated water treatment systems into the landscape can influence micro-climates and reduce the urban heat island effect,
- Vegetated treatment systems provide green infrastructure and green links to improve the look, function and recreational value of our cities,
- Road upgrades and/or traffic calming which include WSUD features can reduce stormwater loadings,
- Stormwater and wastewater reuse for council infrastructure such as sports ovals provide insurance against water scarcity and water restrictions,
- Reduced need for rehabilitation and maintenance of waterways.

A set of standard detail drawings for specific WSUD elements has been developed by other Councils and WSUD practitioners across Australia and these are added to concept designs to complete the work. It is recommended a set of standard drawings ether be adopted or developed (possibly through the current City of Ryde WSUD strategy) for the Lane Cove River Estuary Councils.

Bioretention Systems/Raingardens

Bioretention is a site-based system for using the physical, chemical and biological properties of plants, soil and microbes to filter stormwater. Bioretention systems can typically be used close to the source of urban runoff. Rainfall-runoff is captured and filtered through a planted out soil medium before being conveyed to a waterway, stormwater system or storage device for reuse. Water begins to pond on the surface once the capacity of the soil medium is reached and they can be designed to detain runoff from smaller events. The water is only allowed to pond for short periods and small

depths. The bioretention system contains vegetation that takes up nutrients and traps sediments. These systems operate in a similar way to an ephemeral wetland.

Bioretention systems have been further developed to incorporate a submerged or wet zone in their base. Typically some stormwater is trapped in a zone that is up to 45cm deep and made up of gravel or sand in the presence of a small amount of carbon (5% by volume). Because this zone becomes anaerobic it promotes denitrification. This significantly improves the nitrogen removal of the bioretention system. The process also improves copper and zinc removal rates (can meet ANZECC targets), and improves plant survival during long dry periods. Several of these systems have already been constructed in Sydney and South East Queensland.

Site Selection

The following criteria can be used as a first pass to determine where raingardens can be implemented:

- Catchment area: Catchment areas greater than 500m^2 require detailed analysis of storm flow levels and detailed consideration of the inlet and overflow structures.
- Raingarden size: Spaces less than 50m^2 may not be able to collect sufficient water to supply the plants without flooding.
- Road slope: Not greater than 5^o. Too much slope could cause significant erosion issues within the garden beds both at the inlets and along the length of the vegetated area. However, in some cases, cascading structures can be used to reduce the slope of the filter area.
- Traffic and pedestrian interference. Footpaths need to be at least 1.2m and raingardens, greater than 1.5m wide. High traffic zones and dense parking on the adjacent streets also will impact on the raingarden and should be reconsidered.
- Stormwater infrastructure: The presence of downstream stormwater pits allows raingardens to be drained into them, rather than back onto the street or infiltrated into the soil. Systems connected to stormwater pits can be lined to reduce the spread of surface runoff water into the groundwater.
- Soil type: Around the Lane Cove River catchment, most of the geology is Sydney sandstone, with some clay on the ridges. Care must be taken on rocky substrates that water filtering through the raingardens cannot find its way along rock ledges and discharge onto private property or otherwise disturb infrastructure.

  On clay soils, adequate subsurface draining and a connection to the stormwater system must be provided. Lining the raingardens with impermeable or near impermeable materials such as concrete render or geo fabric will reduce the risk and contain the treatment area.

  However, in locations with highly permeable (i.e. sandy) soils, and no risk of impact on nearby structures, the water from the raingardens can be allowed to filter directly into the ground water.

If the site complies with most of these criteria, a detailed concept design should be all that is required for smaller systems. Detailed engineering plans of the WSUD civil works will most likely be prepared

by a civil engineer and detail the road ways, kerb and pit concreting specifications and pipe designs. The overall WSUD construction plan should be additional to these plans, and should include inlet and outlet levels, the filter area surface material and shaping, lining of the base, a cross section of the filter media and drainage layers and a list of recommended plants.

Distributed WSUD elements around the catchment, totally approximate 1% of the catchment area, can be a very effective mechanism for intercepting and filtering stormwater pollutants. A plan showing potential areas can then be progressively implemented as opportunities arise. These could be road works, traffic calming devices, footpath works or larger developments, where open space or street realignment is occurring.

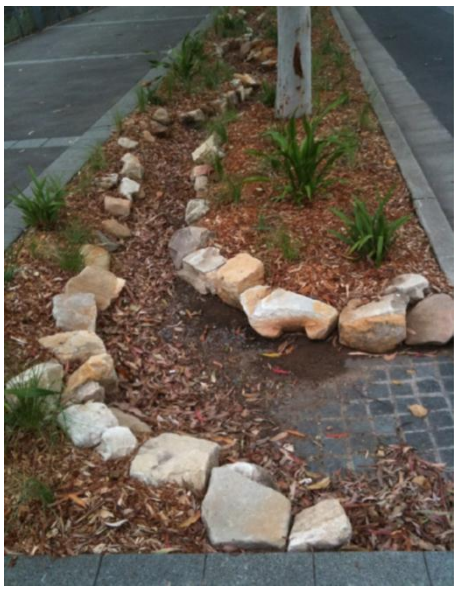

Figure 12-1: Example Raingarden in Sydney

Vegetated/Grassed Swales

Vegetated/grassed swales are constructed open channel drainage ways, vegetated with native or exotic grasses, trees and shrubs and are used to treat and convey stormwater runoff. Filtered stormwater is generally collected in slotted pipes at the base of the swale where it can be conveyed to a drainage system or waterway or even a storage device for reuse. Water is not allowed to pond for any significant period of time. Vegetated swales generally have gentle side slopes and can be roughly trapezoidal or parabolic in shape.

Figure 12-2: Examples of Grassed and Vegetated Swales

Gross Pollutant Traps (GPT)

A gross pollutant trap is a device designed to trap litter, coarse sediments and organic matter from runoff entering the stormwater system. They are generally thought to be inefficient at trapping nutrients and may impact on water quality by creating anaerobic zones if not regularly maintained.

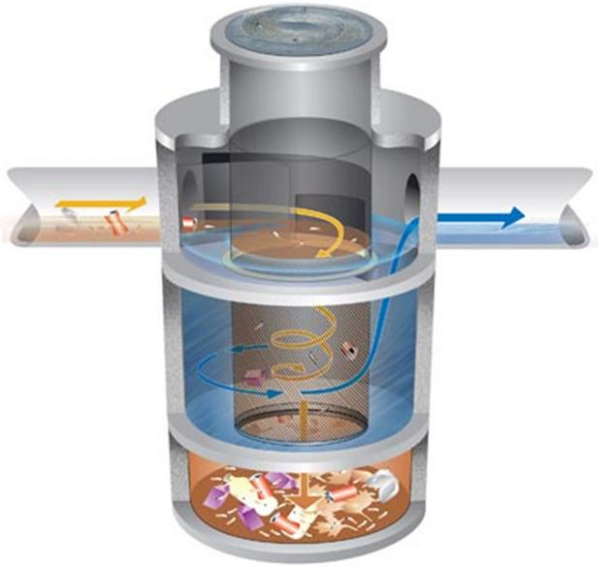

Figure 12-3: Gross Pollutant Trap Schematic[14]

Rainwater tanks

A rainwater tank is a water storage system designed to be installed on individual houses or businesses to catch rainfall falling on a roof surface. These tanks can provide water for non-potable domestic use, such as for flushing toilets, watering gardens, washing clothes and in hot water systems, or for irrigation of parks, supplying Council water trucks and cleaning of Council property and vehicles. These systems reduce the amount of water running off impervious areas and entering the stormwater system.

[14] *Source: Leichhardt Council*
http://www.leichhardt.nsw.gov.au/Cleaner-Water-for-Iron-Cove.html

Figure 12-4: Example Rainwater Tank[15]

Buffer Strips

A buffer strip is a relatively narrow area of land adjacent to a road or river, which is vegetated. This is intended to filter surface runoff before it reaches the stormwater system or stream.

Outlet protection

Rock armouring and constructing sediment traps within drainage lines through bushland has been adopted by most Councils as a way of reducing bushland erosion and capturing sediment. Willoughby Councils e.Restore program has, since 1997, been progressively installing these rock lined drains.

Other WSUD Devices

There are other WSUD devices such as sediment basins, sand filters and permeable paving that can also be used in urban developments. If they are designed and maintained correctly they will each have a positive impact on water quality.

[15] *Source: Rainwater Tanks Direct Online website*
http://www.rainwatertanksdirect.com.au/water-tanks/small-tanks.php

Figure 12-5: Porous Pavers at Sydney Water's new Potts Hill offices

B.2 EXISTING WSUD MEASURES IN THE CATCHMENT AREA

Hunters Hill Council

Hunter's Hill Council is moving towards creating an urban landscape that mimics the natural environment more closely. This is happening slowly, with features such as infiltration trenches, grassed swales, wetlands, riparian strips and detention ponds becoming part of the landscape.

Hunters Hill has developed a 'Sustainable Water – Development Control Plan 25 (DCP 25)' which requires any new buildings or home additions greater than 40 metres square in area, to adopt 'Water Sensitive Urban Design' principles. These are included in a publication available from council for builders/developers/home-owners and advise of the technical design practices they must use to fulfil the requirements of the DCP. This DCP was drafted and is compatible with the BASIX assessment tool.

Lane Cove Council

There are GPTs installed around the main shopping area on Longueville Road and in other GPTs in strategic locations. A raingarden at Tambourine Bay Road uses vegetation and biofiltration soils to treat the stormwater runoff from the roadway so that fewer pollutants enter the creek, bay and river. The raingardens are planted out with local indigenous plants. A stormwater harvesting system, shown in Figure 12-6, has been installed at Blackman Park to supply the park and the Council depot.

Figure 12-6: Existing Stormwater Tank at Blackman Park

Lane Cove Council bushland management involves armouring the drainage lines below storm water outlets in bushland areas. There have been several projects within the creek lines of the reserves to armour creek banks and repair eroded sections.

City of Ryde

City of Ryde is updating its WSUD policy and standards and is facilitating on-ground initiatives throughout the local government area. A bio-retention system at Santa Rosa Park on Shrimptons Creek is shown in Figure 12-7 and the provision of a stormwater quality improvement device and constructed wetlands on Buffalo Creek (Figure 12-8) are examples of projects undertaken by City of Ryde to better manage the local stormwater catchment. There are also stormwater harvesting initiatives completed near the commercial centres in Buffalo Creek catchment.

Council has developed a WSUD manual to guide internal and external works to incorporate WSUD into other capital projects.

WSUD in City of Ryde DCP

The pollution control targets mentioned in the DCP are:

- 90% reduction in the post development mean annual load of total gross pollutant loads (greater than 5 mm).
- 85% reduction in the post development mean annual load of Total Suspended Solids (TSS).
- 60% reduction in the post development mean annual load of Total Phosphorus (TP).
- 45% reduction in the post development mean annual load of Total Nitrogen (TN).

As discussed previously, setting these targets gives anyone planning development in the catchment an indication of the requirements for stormwater treatment measures which can be tested using the MUSIC program. HNCMA are also developing Sydney Harbour wide targets but the City of Ryde numbers are appropriate.

Figure 12-7: Existing Bio-Retention System at Santa Rosa Park (Shrimptons Creek)

Figure 12-8: Existing Wetland on Buffalo Creek

Willoughby Council

Willoughby Council has had a long term program of armouring the outlets of stormwater pipes discharging into bushland with rock lined channels. This reduces erosion and the creation of sediment from these high flow locations. The bush regeneration team also maintains the creek banks by progressively replacing weeds with native vegetation and armouring eroding sections as necessary. There have also been GPTs installed across the Council but none to date in the Lane Cove catchment.

B.3 FURTHER WSUD OPPORTUNITIES

Some key aspects of each Council which enable the implementation of WSUD were identified during site visits in June-July 2012. It is again recommended to consider WSUD in all on ground works conducted by Council using the site criteria listed above and to adopt the targets of the City of Ryde's WSUD Strategy.

Councils should actively look for opportunities to incorporate WSUD into infrastructure upgrade works and to specify WSUD in private developments where possible. Councils should also work cooperatively to develop guidelines, standard drawings and specifications for WSUD.

A guide to implementation of WSUD in each sub catchment is to consider the optimum sizing of WSUD elements for the removal of pollutants. Research conducted by the Healthy Waterways Partnership (2006) and presented in their WSUD Technical Design Guidelines for South East Queensland – Version 1 measured the percentage removal of nitrogen, phosphorus and total suspended solids from a range of biofiltration sizes.

The optimum sizing of the systems is a function of the catchment area. Figure 12-9 shows an example of the ability of a raingarden to remove TSS (to which heavy metals and other pollutants bind) from stormwater at a range of scales.

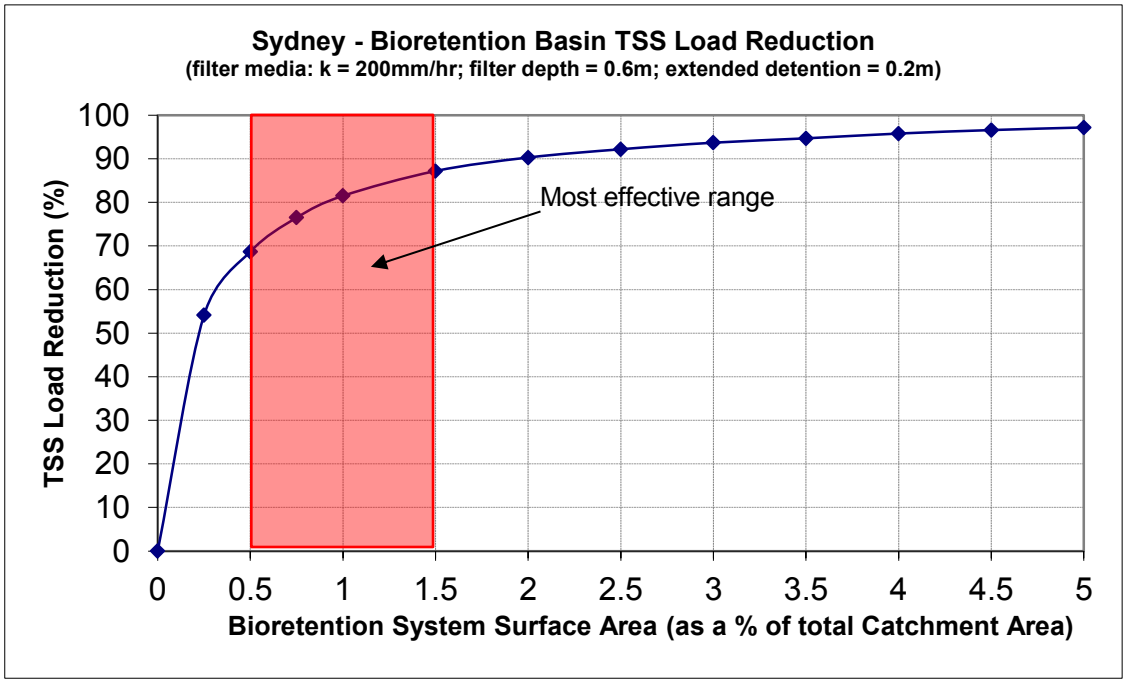

Figure 12-9: TSS Removal Effectiveness as a Function of Raingarden Size

The most effective size for a raingarden is between 0.5 and 1.5% of the catchment draining into it. Any larger and the extra cost and land take of the raingarden is not justified by the small amount of pollutant removal. Any smaller will not achieve a sufficient pollutant removal. The effectiveness of removing P and N produce similar graphs.

Therefore, across the sub-catchments of the Lane Cove River estuary, the target for WSUD implementation should be to install devices with a combined area of around 1% of the total catchment, located in strategic points to collect polluted runoff.

Table 12-2 is an Excel spread sheet which can be used to monitor the implementation of WSUD towards reaching the 1% target. It includes current and already proposed WSUD measures for each Council and sub catchment as well as space to insert WSUD when it is installed in the future.

Hunters Hill Council

In some of the steeper streets draining towards the River, wide road reserves with unlined kerbs allow for the easy retrofitting of swales. There are also pollutant hot spots around shopping areas which would be ideal for GPTs or small raingardens.

Figure 12-10: Mount St, Hunters Hill, potential to include a Swale

There is considerable development occurring on the western side of Burns Bay Road and the DCP needs to be stringently applied to these developments and to other future works to ensure erosion and sediment, as well as peak flows of stormwater flowing into the River, are reduced.

Lane Cove Council

The residential areas in Lane Cove Council have wide nature strips next to the footpaths which are suitable for incorporating raingardens. Some sites are shown in Figure 12-11.

Figure 12-11: Wide Nature Strips in Lane Cove Council

City of Ryde

City of Ryde should finalise the WSUD DCP and strategy. There are opportunities with the catchments for further raingarden and biofiltration systems as City of Ryde also has wide nature strips and reserves along the main drainage lines.

Commercial centres and lard hard stand parking areas should have water treatment systems such as GPTs as well as porous paving sand biofiltration retrofitted to remove heavy metal and hydrocarbon pollutants near the source. This has been done in Meadowbank and around other centres and adds character to the streetscape of the shopping precincts.

Willoughby Council

Future development in Blue Gum Creek and along the Pacific Highway should be strictly controlled for sediment and erosion management. Installing WSUD devices in the upper reaches of the catchment is limited by footpath width and the steepness of the slopes in bushland verges.

Development controls are the main way Willoughby Council can influence stormwater runoff issues in their part of the catchment and strict targets should be applied due to the valuable existing bushland and creek systems flowing through Blue Gum and Swaines Creeks. A proposal to create a wetland and biofiltration system within the Chatswood Golf Course was hampered by saline water reaching up to the proposed area, and this is only going to increase due to climate change.

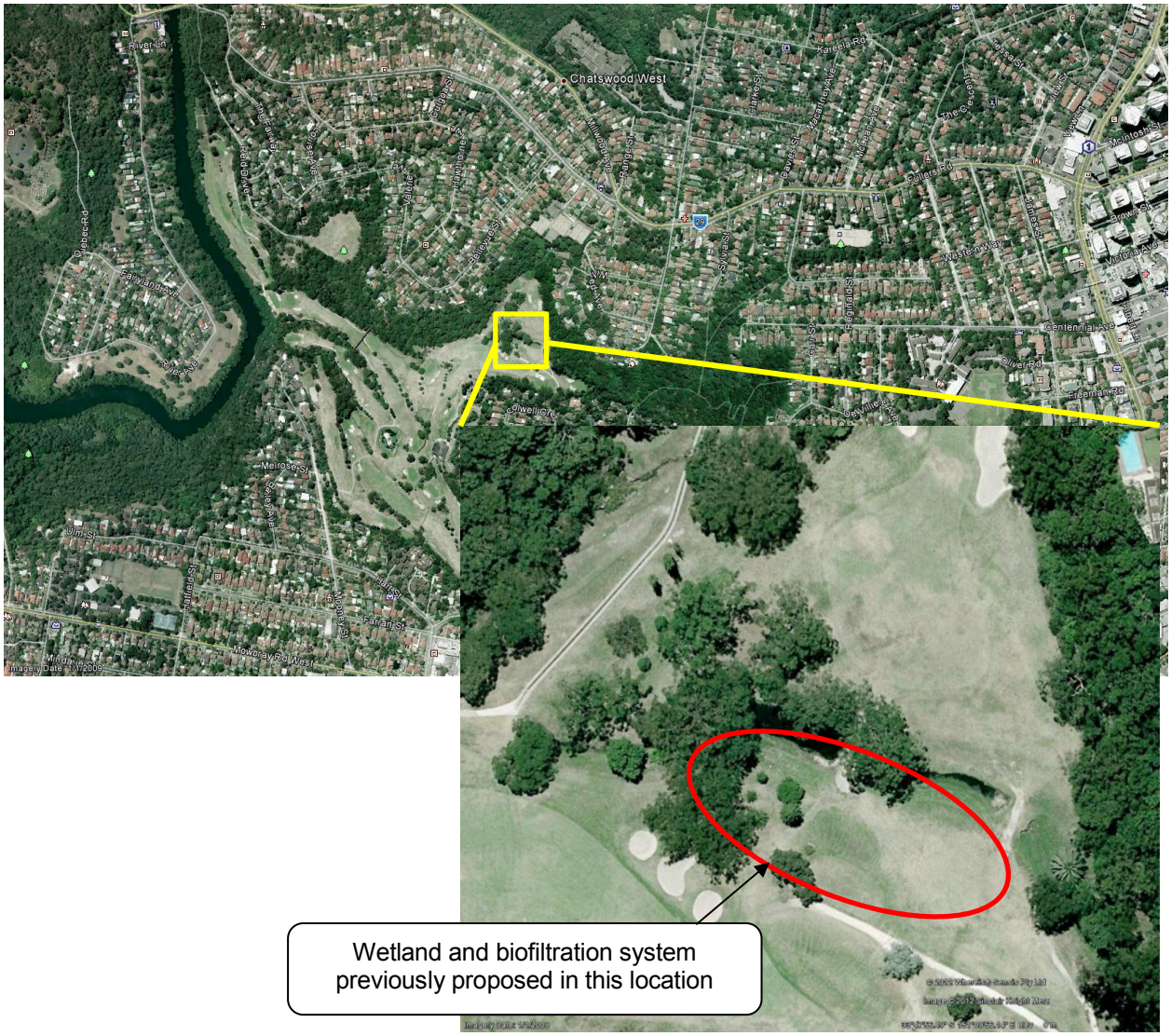

Figure 12-12: Previous location for WSUD, not possible due to saline waters

A possible list of WSUD sites has been prepared for this CZMP and is given in Table 12-1 and APPENDIX H:, Figures 19 to 22, along with the sites proposed by individual Councils[16].

Table 12-1: Proposed WSUD Sites in Lane Cove River CZMP and by Councils

LGA	Proposed WSUD	Location	Code	Proposed By
Hunters Hill	Raingarden or Swale	Alexandra Street between Martha and Kokera Streets	PWH1	CZMP
	Raingarden	Alexander Street between Ferry and Adi Streets	PWH2	
	Swale	Mount Street	PWH3	
	Raingarden	Saint Malo Reserve along Joubert Street	PWH4	
	Raingarden	Martin Street between Abigail and Bonnefin Streets	PWH5	
	GPT or Biofiltration	Princes Street, Boronia Park*	PWH6	
	Stormwater Harvesting	Boronia Park	HH0	Council
	GPT	Boronia Park creek inflow*	HH8	
	GPT	Hunters Hill High School	HH16	
Lane Cove	GPT	Intersection of Riverview and Kooyong Streets	PWL1	CZMP
	GPT or Biofiltration	Burns Bay Road near Burns Bay	PWL2	
	Raingarden or Swale	Ross Smith Pde near Bridge Street	PWL3	
	Raingarden or Swale	Little Street near Central Avenue	PWL4	
	Raingarden	Orion Road	PWL6	
	GPT	Epping Road	PWL7	
	Raingarden or Swale	Alder Ave near Cullen Street	PWL8	
	Raingarden	Moore Street near Barwon Road	PWL9	
	Raingarden	Willandra Street	PWL10	
	Raingarden	Centennial Ave between Elizabeth Pde and Arding Street	PWL11	
	GPT or Biofiltration	Stringybark Reserve	PWL12	
	Raingarden	Intersection of Norton Lane and Helen Street	PWL13	
	GPT	In Carpark, Howarth Road	PWL14	
	Raingarden	Ford Street	LCC1	Council
	GPT	Gore Creek	LCC2	
	Raingarden	Mary Street	LCC6	
	Raingarden	Dettmann Avenue	LCC7	
	Bioswale	Blackman Park	LCC12	
City of Ryde	Raingarden or Swale	Elliot Ave	PWR1	CZMP
	Raingarden or Swale	Melba Drive	PWR2	
	Swale	Princes Street between Buffalo Road and Blaxland Road	PWR3	
	Raingarden or Swale	Aitchandar Road	PWR4	
	Raingarden	Forrest Road near Malvina Street	PWR5	
	Swale	Malvina Street Near Forrest Road	PWR6	
	Swale	Twin Road between John Miller Street and Cressy Road	PWR7	
	Raingarden	Cressy Road near Coxs Road	PWR8	
	GPT	In car park, Magdala Road	PWR9	

[16] *Council proposed WSUD sites have been extracted from Table 12-6 Appendix E.*
**Same location.*

LGA	Proposed WSUD	Location	Code	Proposed By
	Raingarden or Swale	Pittwater Road near Blenheim Road	PWR10	
	Raingarden	Julius Ave	PWR11	
	Raingarden	River Ave near Fairyland Ave	PWR12	
	Bioretention	Buffalo Creek	CoR1	Council
	Bioretention	Gannan Park	CoR6	
	Bioretention	Gannan Park	CoR7	
	Bioretention	North Ryde Common	CoR8	
	Bioretention	North Ryde Common	CoR9	
	Bioretention	Blenheim Park	CoR10	
	Bioretention	Brereton Park	CoR11	
Willoughby	Raingarden or Swale	Hart Street near Mooney Street	PWW1	CZMP
	Raingarden	Mooney Street near Melrose Street	PWW2	
	Raingarden	Wilfred Ave	PWW3	
	Bioretention or Wetland	Oh Reid Memorial Park	PWW4	
	Investigate WSUD Options	Chatswood Golf Course	WCC1	Council
	Investigate Stormwater Systems	Chatswood Rotary War Memorial	WCC5	

A WSUD action plan is presented in Table 12-2. This action plan details the current and possible WSUD locations, types, areas being treated currently and remaining areas to be treated via WSUD.

Table 12-2: WSUD Action Plan

LGA	Sub-Catchment	Sub Catchment Areas[17], km^2	Total Required 1% Area, m^2	Existing WSUD/Stormwater treatment feature[18]	Estimated current WSUD Area, m^2	Proposed WSUD by Councils	Proposed WSUD Area, m^2	Proposed WSUD in CZMP	Location	Codes[19]	Proposed WSUD Area, m^2	Remaining WSUD area required, m^2
HUNTERS HILL	Clarkes Point Reserve	0.20	2,000	CDS3								
				EP3A								
										Total Proposed WSUD Area		2,000
	Onions Point Reserve	0.10	1,000	EP4A								
				EP5A								
				EP6A								
										Total Proposed WSUD Area		1,000
	Alexandra Bay	0.33	3,300	EP7A				Raingarden or Swale	Alexandra Street between Martha and Kokera Streets	PWH1	60	
				EP7C								
				EP7D								
				EP7E								
				EP17C								
										Total Proposed WSUD Area	60	3,240
	Ferdinand Street Reserve	0.15	1,500					Raingarden	Alexander Street between Ferry and Adi Streets	PWH2	45	
										Total Proposed WSUD Area	45	1,455
	Hunters Hill High School	0.49	4,900			HH16 GPT on outlet next to school oval		Biofiltration Swales	Mount Street	PWH3	180	
								Raingarden	Saint Malo Reserve along Joubert Street	PWH4	30	
								Raingarden	Martin Street between Abigail and Bonnefin Streets	PWH5	45	

[17] *Approximate*
[18] *(codes as per Appendix H Figure 2: Water Quality and WSUD)*
[19] *(as per Appendix H Figures 19 to 22)*

LGA	Sub-Catchment	Sub Catchment Areas[17], km²	Total Required 1% Area, m²	Existing WSUD/Stormwater treatment feature[18]	Estimated current WSUD Area, m²	Proposed WSUD by Councils	Proposed WSUD Area, m²	Proposed WSUD in CZMP	Location	Codes[19]	Proposed WSUD Area, m²	Remaining WSUD area required, m²
									Total Proposed WSUD Area		255	4,645
	Boronia Park_lower	0.19	1,900	G2	0		0					1,900
	Boronia Park_mid	0.59	5,900	P6	150	HH0 Stormwater Harvesting System	800	GPT or Biofiltration	Princes Street, Boronia Park	PWH6	20	
				P10	150	HH8 GPT on outlet to north of ovals						
				P11	150							
				FB3								
					450		800		Total Proposed WSUD Area		20	4,630
	Boronia park_upper	0.50	4,980	P7	150							
				P8	150							
				P9	150							
				EPT3								
				EP19								
					450		0				0	4,530
CITY OF RYDE	Buffalo Creek	5.45	54,500	CDS, Stormwater harvesting		CoR1 Bioretention systems to treat 28ha catchment	2800	Raingarden or Swale	Elliot Ave	PWR1	75	
				Hydrofilter		CoR6 Gannan Park bioretention system in northern corner	1200	Swale	Princes Street between Buffalo Road and Blaxland Road	PWR3	250	
				Hydrofilter		CoR7 Gannan Park bioretention system in north eastern corner	420	Raingarden or Swale	Aitchandar Road	PWR4	400	
				Wetland, Humegard	280	CoR8 and CoR9 Bioretention systems on North Ryde Common (With NSW Health)	2000	Raingarden	Forrest Road near Malvina Street	PWR5	20	

LGA	Sub-Catchment	Sub Catchment Areas[17], km²	Total Required 1% Area, m²	Existing WSUD/Stormwater treatment feature[18]	Estimated current WSUD Area, m²	Proposed WSUD by Councils	Proposed WSUD Area, m²	Proposed WSUD in CZMP	Location	Codes[19]	Proposed WSUD Area, m²	Remaining WSUD area required, m²
				Bioretention filter	300	Cor10 Blenheim Park bioretention system next to existing community building adjacent to Blenheim Rd	600	Swale	Malvina Street Near Forrest Road	PWR6	150	
					580		7020	Total Proposed WSUD Area			895	46,005
	Kitty's Creek	1.93	19,300					Swale	Melba Drive	PWR2	150	
								Swale	Twin Road between John Miller Street and Cressy Road	PWR7	150	
								Raingarden	Cressy Road near Coxs Road	PWR8	120	
										Total Proposed WSUD Area	420	18,880
	Lane Cove NP	3.03	30,300	CDS		CoR11 Brereton Park bioretention system to treat 1.68Ha catchment	168	GPT	In car park, Magdala Road	PWR9		
				Wetland				Raingarden or Swale	Pittwater Road near Blenheim Road	PWR10	90	
				Wetland				Raingarden	Julius Ave	PWR11	90	
								Raingarden	River Ave near Fairyland Ave	PWR12	200	
							168	Total Proposed WSUD Area			380	29,752
	Porters Creek	2.25	22,500									22,500
WILLOUGHBY	Blue Gum Creek	1.05	10,500	End of pipe armouring								10,500
	Swaines Creek	2.43	24,300	End of pipe armouring		WCC1 Investigate options with Chatswood golf club for WSUD	1000	Raingarden or Swale	Hart Street near Mooney Street	PWW1	60	

LGA	Sub-Catchment	Sub Catchment Areas[17], km²	Total Required 1% Area, m²	Existing WSUD/Stormwater treatment feature[18]	Estimated current WSUD Area, m²	Proposed WSUD by Councils	Proposed WSUD Area, m²	Proposed WSUD in CZMP	Location	Codes[19]	Proposed WSUD Area, m²	Remaining WSUD area required, m²
						WCC5 Investigate carpark stormwater and possibly install raingarden treatment	600	Raingarden	Mooney Street near Melrose Street	PWW2	30	
								Raingarden	Wilfred Ave	PWW3	30	
								Bioretention or Wetland	Oh Reid Memorial Park	PWW4	20	
							1600	Total Proposed WSUD Area			140	22,560
LANE COVE	Stringybark Creek	2.78	27,800	GPT		GPT x 2		Raingarden	Orion Road	PWL6	40	
				GPT				GPT	Near 61 Epping Road	PWL7		
				GPT				Raingarden or Swale	Alder Ave near Cullen Street	PWL8	60	
								Raingarden	Moore Street near Barwon Road	PWL9	30	
								Raingarden	Willandra Street	PWL10	40	
								Raingarden	Centennial Ave between Elizabeth Parade and Arding Street	PWL11	60	
								GPT or Biofiltration	Stringybark Reserve	PWL12	30	
								Raingarden	Intersection of Norton Lane and Helen Street	PWL13	40	
								GPT	In Carpark, Howarth Road	PWL14		
					0		0	Total Proposed WSUD Area			300	27,500
	Blackman Park/Stony Creek	0.96	9,600	Stormwater tank		GPT x 4						
						LCC12 Bioswale around southern edge of Blackman Park	600					

LGA	Sub-Catchment	Sub Catchment Areas[17], km^2	Total Required 1% Area, m^2	Existing WSUD/Stormwater treatment feature[18]	Estimated current WSUD Area, m^2	Proposed WSUD by Councils	Proposed WSUD Area, m^2	Proposed WSUD in CZMP	Location	Codes[19]	Proposed WSUD Area, m^2	Remaining WSUD area required, m^2
					0		600					9,000
	Burns Bay	1.45	14,500			LCC7 Raingarden in Dettmann Ave, Hodgson Park	300	GPT	Intersection of Riverview and Kooyong Streets	PWL1		
								GPT or Biofiltration	Burns Bay Road near Burns Bay	PWL2	20	
								Raingarden or Swale	Ross Smith Pde near Bridge Street	PWL3	90	
							300	Total Proposed WSUD Area			110	14,090
	Tambourine Bay	1.82	18,200	Raingarden		GPT x 2						
				Pipe Diversion		GPT x 1						
				GPT								
				GPT								
					0		0				0	18,200
	Gore Creek	2.30	23,000			GPT x 4		Raingarden or Swale	Little Street near Central Avenue	PWL4	45	
						LCC1 Raingarden in Ford St	300					
						LCC2 Install a GPT						
					0		300	Total Proposed WSUD Area			45	22,655
	Woodford Bay	0.58	5,760			LCC6 Raingarden in Mary St adjacent to Aquatic Park	400					
					0		400				380	4,980

APPENDIX C: COMMUNITY WORKSHOP

A community workshop/information session was held at Lane Cove Council premises at 7 pm on Tuesday 14 August 2012.

Community Representatives from:

Greenwich Flying Squadron

Lane Cove 12' Skiff Sailing Club

North Shore Rowing Club

Riverview Residents Association

Stringybark Creek Residents Associations

Lane Cove Bushland & Conservation Society

Lane Cove Bushland & Conservation Society

Greenwich Residents Association

IEWF (International Environmental Weed Foundation)

Willoughby Environmental Protection Association (WEPA)

Local and State Government Representatives:

Gus Pelosi, OEH

Jacqui Vollmer, Hunters Hill Council

Susan Butler, Lane Cove Council

Sam Cappelli, City of Ryde

Angelo Berios, Willoughby City Council

Consultants:

Reid Butler, BMT WBM

Smita Jha, BMT WBM

Gus Pelosi gave a short presentation on the history of the Estuary Management Program and the Lane Cove River EMP:

- High level of implementation of Lane Cove River EMP
- Focus on recreation, environment, social, traffic and other issues,
- Change in focus in 2010 to climate change assessment, estuary health monitoring,

- 1997 issues, most are still relevant, need to take big picture not just climate change,
- NSW government's views on CZMP.

Reid Butler gave a short presentation on status of the CZMP report and asked for input from community members.

Comments from community members and how they have been addressed in this plan is given in Table 12-3.

Table 12-3: Community Concerns addressed by CZMP Actions

Community Concerns	Aim	Addressed by Action
Issue of development control, OSD in upper catchment, WSUD	Water Quality	AW5, AW6, AW7, AW8, AW9
Monitoring water quality to see if devices are working to improve water quality	Water Quality, Monitoring and Evaluation	AW7, AW3, AM1
Pollution of Tannery Creek – potential for constructed wetlands like Salisbury Council	Water Quality	AW6
Tannery Creek cast iron sewer eroding substantially, discharges into Burns Bay	Water Quality	Further Information required
Look for areas where wetlands can be built	Water Quality	AW6, AW11
Asking for gully traps, told they were too expensive, some installed along Epping Rd	Water Quality	AW6
WSUD in the open, don't hide them	Water Quality	AW12
Dredging in 2004 still an issue	Water Quality, Foreshore Protection	AF5
Not issue for rowers but notice sediment is growing at Figtree Bridge	Foreshore Protection	AF5
Capt Cook catamarans sand and fill on shore being washed into the river	Water Quality, Foreshore Protection	AF5
Seawalls erosion escalated with Rivercats	Foreshore Protection	AF4
Sedimentation from high density development, trucks taking excavation materials away	Water Quality, Foreshore Protection	AW8, AW10, AF5
Enforcement is still a big problem	Water Quality, Foreshore Protection	AW8, AW10
Hydrology reports for big excavations	Water Quality, Foreshore Protection	AW8, AW10, AF3
Even catchments not undergoing development can shed lots of leaf litter, grass cuttings	Water Quality	AW6, AW7, AW12
Encourage more domestic water tanks to reduce runoff	Water Quality	AW12
Use eyes of the community for monitoring	Monitoring and Evaluation	AW12, AM1
Keep up reporting in case things go wrong	Monitoring and Evaluation	AM1
Dettmann Ave unmade road could be location for rain garden	Water Quality	Further Information required
MUSIC not yet in place, but needs to be applied across all Councils	Water Quality	AW11
Dinghy storage	Aquatic and Riparian Habitat	AA2

The community scoring for the proposed Management Actions are given in Table 12-4.

Score Card:

1	2	3	4	5
Not at All	Small Importance	Moderate Importance	Major Importance	Extremely Important

Table 12-4: Community Ranking of Actions

AIM	MANAGEMENT ACTIONS	Respondent Number									Total
		1	2	3	4	5	6	7	8	9	
WATER QUALITY	Ensure Sydney Water continues to improve the sewage overflow performance of the sewer systems throughout the catchment	5	5	5	5	5	5	5		5	**40**
	Liaise with Sydney Water when sewers are observed to be causing water quality problems	4	4		5	5	3	5	5		**31**
	Continue current water quality monitoring and undertake wet weather monitoring		5		5	5	2	5	5		**27**
	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes	5	5		5	5	4	4			**28**
	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing and preparation of new Development Control Plans (DCPs)	5	5	5	5	5	4	5			**34**
	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel naturalisation	5	5		5	5	3	5			**28**
	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices.	5	5		5	5	3	4			**27**
	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction	5	5	5	5	5	4	5	5		**39**
	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment	5	5	5	5	5	4	2			**31**
	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises	5	5		5	5	2	3	5		**30**

AIM	MANAGEMENT ACTIONS	Respondent Number									Total
	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects	5	5	5	5	5	2	3			**30**
	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term	5	5	5	5	5	3	4	5		**37**
	Assess fertilizer distribution rates and procedures especially during periods of heavy rain	5	5		5	4	2	3	5		**29**
CLIMATE CHANGE	Identify and map areas likely to be impacted by sea level rise under different scenarios	5	5		5	5	5	4		4	**33**
	Highlight areas of estuarine vegetation under potential threat due to sea level rise	5	5	5	5	4	5	5	5		**39**
	Identify and protect public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure	5	5		5	4	2	5			**26**
	Replace existing stormwater pipes with bigger pipes where required as a part of asset replacement program	5	5	4	5	5	5	3			**32**
	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified	5	5		5	5	3	4	5		**32**
	Establish foreshore building line controls across all Councils	5	5		5	4	4	3	5		**31**
	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise	5	5		5	5	3	4	5		**32**
AQUATIC AND RIPARIAN HABITAT	Undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation	5	5	5	5	5	5	5	5		**40**
	Install dinghy racks or assign dinghy storage areas	4	5		5	4	3	3	5	4	**33**
	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and regeneration works on both public and private lands	5	5		5	5	4	5	5		**34**
	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management	5	5		5	5	4	5			**29**
	Identification and progressive control of invasive species from foreshore areas and adjacent bushland	5	5	5	5	4	4	5	1	5	**39**

AIM	MANAGEMENT ACTIONS	Respondent Number									Total
	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways	5	5	1	5	4	3	5	5	5	**38**
	Promote and undertake compliance on unauthorised riparian and estuarine vegetation clearing	5	5	5	5	4	3	5		4	**36**
	Encourage and assist revegetation of private foreshore areas	5	5		5	5	3	5	5	4	**37**
	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary	5	5		5	4	2	3			**24**
	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways	5	5		5	5	2	3			**25**
	Continue structural and operational improvements to fishway at Lane Cove weir	5	4		5	5	2	4			**25**
	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire	5			5	4	2	4			**20**
FORESHORE PROTECTION	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints	5		5	5	5	3	3			**26**
	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices	5		5	5	5	2	4			**26**
	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation	5			5	5	2	3			**20**
	Explore options to improve the environmental value of existing seawalls through addition of habitat	5			5	5	2	5			**22**
	Monitoring and selective dredging of sediment build-up	5			5	4	4	3	5		**26**
MONITORING AND EVALUATION	Continue and support current monitoring programs, undertake coordinated monitoring and collate data on an estuary wide basis using an Estuary Health Report Card	5			5	5	3	5			**23**
	Support the implementation and monitoring of the effectiveness of Plan	5			5	5	4	4			**23**
	Undertake a review of the CZMP every 5-10 years	5			5	5	4	4			**23**
	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures	5			5	5	3	5	5		**28**

APPENDIX D: ACTION PLAN TABLE

Colour Code:

Already Ongoing Actions – To be Continued

Actions Within Council's Budget – Start Implementation

Actions Requiring External Funding – Source Funding and Start Implementation

Actions Requiring External Funding – Source Funding and Start Implementation when Appropriate

Table 12-5: Management Actions Implementation Plan

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
			1	2	3	4	5	5+		Lane Cove Council	Ryde Council	Hunters Hill Council	Willough by Council
1	AA1	Councils to continue to undertake targeted bushland rehabilitation and restoration programs, creation and enhancement of estuarine wetland communities (saltmarsh, mangroves, seagrass) and adjacent riparian vegetation	Funding available through part of Councils ongoing budget						All Councils bushland management sections				
2	AC6	Establish consistent foreshore building line controls across all Councils	Funding available through part of Councils ongoing budget						All Councils strategic planning sections	Estuary wide action			
3	AW8	Enforce implementation and maintenance of effective sediment controls during the subdivision and building phases of all developments (including infrastructure projects) by undertaking regular audits of developments during construction	Funding available through part of Councils ongoing budget						All Councils building compliance and enforcement sections				

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
4	AA3	Support the establishment and continuation of local Bushcare groups to assist with revegetation, restoration and regeneration works on both public and private lands	Funding available through part of Councils ongoing budget						All Councils bushland management sections				
4	AC2	Highlight areas of estuarine vegetation under potential threat due to sea level rise				Build on the figures in this CZMP with ground truthing. Funding may become available through the DCCEE			All Councils bushland management sections				
6	AA4	Provide information to private landowners that have key habitat and vegetation communities on their properties to describe the community, its importance to the estuary and options for its protection and management	As appropriate through community events and Council newsletters						All Councils bushland management sections	Estuary wide action			
7	AW10	Regulatory authorities to review minimum water quality and environmental objectives to reduce the impact of pollution from licensed industrial or commercial premises	As soon as possible						NSW OEH	Estuary wide action			
8	AC1	Identify and map areas likely to be impacted by sea level rise under different scenarios		Build on the figures in this CZMP with ground truthing. Further funding may become available through the DCCEE					All Councils, regional organisations				
9	AC5	Restrict new foreshore developments in areas where tidal inundation hazards under current and future sea level rise scenarios are quantified				Following on from Action AC1, prepare building control policy for developments in those areas identified at risk			All Councils development assessment sections				
10	AA8	Encourage and assist revegetation of private foreshore areas	As appropriate, funding will be required externally						All Councils bushland management sections				

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
11	AM2	Support the implementation and monitoring of the effectiveness of Plan	Funding available through part of Councils ongoing budget						All Councils, NSW OEH and other stakeholders	Estuary wide action			
11	AM3	Undertake a review of the CZMP every 5-10 years						Either funded through Council, the EMC or NSW OEH	All Councils, NSW OEH and other stakeholders	Estuary wide action			
13	AW3	Continue current water quality monitoring and undertake wet weather monitoring	As appropriate or required, funding will be required externally						All Councils	Refer to Figure 7 APPENDIX H:			
14	AA7	Promote and undertake compliance on unauthorised riparian and estuarine vegetation clearing	Funding available through part of Councils ongoing budget						All Councils bushland management sections and compliance sections				
15	AM1	Continue and support current monitoring programs, undertake coordinated monitoring and collate data on an estuary wide basis using an Estuary Health Report Card	Funding available through part of Councils ongoing budget, wet weather sampling may require additional funding and planning						All Councils	Refer to Figure 7 APPENDIX H:			
15	AW2	Liaise with Sydney Water when sewers are observed to be causing water quality problems	Funding available through part of Councils ongoing budget						All Councils bushland management sections and compliance sections				

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
17	AM4	Undertake monitoring of the interaction between estuarine vegetation communities, particularly in response to climate pressures						Build on current mapping as changes happen. Apply funding from Councils core bushland management budget	All Councils bushland management sections				
17	AF3	All councils and agencies involved in the building, design and approval of new foreshore developments to ensure compliance with environmental best practices	Funding available through part of Councils ongoing budget						All Councils development assessment sections	Estuary wide action			
19	AW9	Councils to adopt WSUD action plans based on a comprehensive framework of institutional capacity and assessment	Funding available through Councils ongoing training budget to attend courses in WSUD capacity building, such as MUSIC training						All Councils, HNCMA	Estuary wide action			
19	AW11	Use appropriate modelling tools such as MUSIC to evaluate and design WSUD projects	As soon as possible						All Councils development assessment sections	Estuary wide action			
21	AA12	Identify riparian corridors and estuarine wetland communities to be at risk from bushfire		Build on existing bushfire maps					All Councils bushland management sections				
22	AA9	Encourage NSW Fisheries to periodically map the distribution of estuarine vegetation (seagrass, saltmarsh and mangroves) for the estuary			Build on the figures in this CZMP using Fisheries				NSW Department of Primary Industries				

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
					mapping								
23	AC3	Identify and conserve public foreshore areas required for the retreat of estuarine vegetation in response to sea level rise from development or infrastructure				Following on from AC1, map areas for possible retreat for estuarine vegetation			All Councils bushland management sections				
23	AW1	Liaise with Sydney water to ensure that the improvements in the sewer overflow performance continue throughout the catchment	As appropriate or required, funding will be required externally						All Councils	Estuary wide action			
25	AC7	Educate the community about environmentally friendly adaptation methods to climate change/sea level rise						Utilise materials from DCCEE and others to develop consistent message	All Councils	Estuary wide action			
26	AA5	Identification and progressive control of invasive species from foreshore areas and adjacent bushland	Funding available through part of Councils ongoing budget						All Councils bushland management sections	Estuary wide action			
26	AA6	Identification and progressive control of terrestrial and aquatic noxious species from the estuary and other waterways			Progressively build upon Councils bushland management programs with periodic estuarine weeding projects. External funding may be required from OEH				All Councils bushland management sections	Estuary wide action			
28	AW6	Retrofit appropriate new WSUD devices in existing urban areas including measures such as artificial wetlands, vegetated swales, and channel		Following on from AW9, implement WSUD elements as the opportunities arise. Funding may become available from OEH, Federal Government grant programs or Section 94 contributions					All Councils	Estuary wide action			

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement						Responsibility	Specific Project Locations			
		naturalisation											
28	AA2	Install dinghy racks or assign dinghy storage areas, Conduct a dinghy investigation and registration to identify disused dinghies	As soon as possible						Lane Cove and Hunters Hill Councils	Specific actions and locations in Gondwana Report			
30	AW7	Undertake adequate and appropriate maintenance of existing WSUD devices to maintain their effectiveness, in particular GPTs and other stormwater quality improvement devices.	Funding available through part of Councils ongoing budget						All Councils engineering sections	Estuary wide action			
30	AW13	Assess fertilizer distribution rates and procedures especially during periods of heavy rain			A strategic project fund may be required				All Council Parks sections	Ovals near creeklines			
32	AW12	Engage the community in the planning, design and implementation for WSUD projects to help foster a sense of ownership and a willingness to support in the longer term							All Councils community engagement networks				
33	AA10	Prevent the introduction of terrestrial and aquatic disease and pests in the foreshore areas, estuary or other waterways	As soon as possible						All Councils bushland management sections	Estuary wide action			
33	AW4	Councils to review City of Ryde's implementation of WSUD strategy and base their future action plans on the positive outcomes of this	As soon as possible, funding through Councils ongoing budget						All Councils	Estuary wide action			
33	AW5	Councils to incorporate Water Sensitive Urban Design (WSUD) principles in redevelopments of urban areas, including public and private development, through the updating of existing	As soon as possible, funding through Councils ongoing budget						All Councils	Estuary wide action			

Rank	Management Actions		Year of Implementation and Possible Funding Arrangement					Responsibility	Specific Project Locations			
		and preparation of new Development Control Plans (DCPs)										
36	AC4	Replace existing stormwater pipes with more appropriately designed works when required as a part of asset replacement program			A strategic project fund will be required and may be available through DCCEE in the future.			All Councils asset management sections				
36	AF4	Explore options to improve the environmental value of existing seawalls through addition of habitat	As appropriate or required, funding will be required externally					All Councils engineering sections	Lane Cove River foreshore			
38	AF5	Monitoring and selective dredging of sediment build-up	As appropriate or required, funding will be required externally					All Councils engineering sections				
39	AF1	All councils and agencies involved in the building, design and approval of new seawalls to ensure compliance with the environmentally friendly seawall guidelines within legislative constraints	As appropriate or required, funding will be required externally					All Councils engineering sections	Estuary wide action			
40	AF2	Educate and support private landowners on the benefits of environmentally friendly seawalls and provide details of the planning and approval process for installation	As appropriate or required, funding will be required externally					All Councils				
41	AA11	Continue structural and operational improvements to fishway at Lane Cove weir	As appropriate or required, funding will be required externally					NPWS	Lane Cove Weir			

APPENDIX E: ACTIONS FROM OTHER RELEVANT REPORTS

Relevant Actions from[20]:

- Lane Cove River Estuary, Assessing Public Health Needs for Recreational Users, prepared by Gondwana Consulting Pty Ltd, 2011, and
- Lane Cove River Estuary Management Committee, Lane Cove Estuary Saltmarsh Site Assessments, prepared by Applied Ecology Pty Ltd, 2010

Table 12-6: Actions from other Relevant Reports

LGA	Specific Locations	Proposed Actions
Hunters Hill Council		
HH1	Buffalo Creek Reserve	Installation of a floating Baramy Trap in the main channel (below the bridge) is recommended to prevent upward tidal flushing of debris and downward movement of litter from the creek.
HH2		Monitor health of saltmarsh, monitor for changes in extent of saltmarsh areas.
HH3		Management of water quality issues are important at this site: regular cleaning and maintenance of GPTs and other water quality devices is required. Installation of end of line Traps is recommended for some additional inflows.
HH4		Maintain and extend the boardwalk through the southern section of the reserve.
HH5		Target weeding required in central section.
HH6		Bushland regeneration required in southern section.
HH0	Boronia Park	Boronia Park Stormwater Harvesting Investigation.
HH7		Bushland regeneration required in stream section.
HH8		Stormwater management including installation and/or maintenance of GPT at creek inflow.
HH9		Target weeding required in northern section.
HH10		Rationalise walking track network along northern foreshore/bushland.
HH11		Conduct risk assessment re informal lookout points on riverside rock ledges/outcrops.
HH12	Joubert Street	Upgrade access, significantly improve landscape treatments, and provide facilities aimed at anglers as well as general day-use. Significantly increase on-site management presence and site maintenance. Promote as an angling destination.
HH13		Upgrade and/or provide additional interpretation at historic lookout.
HH14	Hunters Hill High School Foreshore	Assess and maintain pipes and inlets/outlets; reconstruct where necessary.
HH15		Consider monitoring saltmarsh health, esp. in response to changes in hydraulic processes.
HH16		Stormwater management including installation and/or maintenance of GPT at drainage inflow.
HH17		Renew/upgrade interpretation.
HH18	Ferdinand St Reserve	Bushland regeneration and target weeding required in terrestrial section.
HH19		Information signs required for community education.
HH20		Supplementary planting may be required in the terrestrial section.
HH21	Mornington	Bushland regeneration required in the terrestrial section.

[20] *Actions provided by Councils*

LGA	Specific Locations	Proposed Actions
HH22	Reserve	Provide low-key passive use facilities on grassy bench and open-up view lines to waterway.
HH23		Investigate routes for walking track access to foreshore in west of reserve and develop link if feasible.
HH24		Investigate possible midden near eastern boatsheds and protect/manage as required.
HH25	Collingwood Reserve & Woolwich Baths	Install dinghy racks at rear of beach at base of beach access ramp.
HH26	Gale St Reserve	Upgrade seawall and water access, clear intertidal area to provide safer and more attractive water entry.
HH27	Valentia St Reserve	Reinstate small wading rock pool at rear of rock platform to west of wharf, with access from park/playground above.
HH28		Renew/upgrade Great North Walk orientation sign.
Lane Cove Council		
LCC1	Ford Street, Gore Creek	Construct a raingarden in Ford Street upstream of Gore Creek Reserve.
LCC2	Gore Creek	Install a GPT and undertake creek stabilisation and rehabilitation work to protect heritage site and EECs in Gore Creek.
LCC3	River Foreshore	Install dinghy racks or assign dinghy storage at along the river foreshore at locations identified in Gondwana Report 2011.
LCC4	Various Locations	Install tangler bins and monitor need for other angling facilities at key locations.
LCC5	Various Locations	Install interpretive signs about topics such as saltmarsh habitat, riparian corridors, heritage significance at various locations as appropriate.
LCC6	Mary Street	Construct a raingarden on Mary Street adjacent to Aquatic Park.
LCC7	Dettmann Avenue	Investigate suitable locations for a raingarden in Dettmann Avenue upstream of EEC community in Hodgson park.
LCC8		Improve pedestrian access to the foreshore through small parks and reserves and improve link on public land between these locations as identified in the Gondwana Report (2011).
LCC9	Cunninghams Reach	Upgrade picnic facilities at Cunninghams Reach including shade structures.
LCC10		Consider monitoring of boat wash impacts on saltmarsh areas.
LCC11		Coordinate and maintain safe ecologically sensitive links, clearly signposted, along the public foreshore reserves and upgrade paths between Figtree Bridge and Epping Road Bridge.
LCC12	Blackman Park	Construct a bioswale around the southern edge of Blackman Park playing fields for water quality improvements and flood mitigation.
LCC13	Blackman Park	Upgrade the recreational facilities at Blackman Park in accordance with the Blackman Park Plan of Management 2009 and Environmental Qualities Masterplan.
LCC14		Consider stabilising the existing sediment banks to stabilise saltmarsh, e.g. using low berms as identified in the Applied Ecology 2010 Study.
LCC15	Ventemans Reach	Monitor health and extent of saltmarsh and adjoining wetlands at Ventemans Reach.
LCC16		Continue bush regeneration and rehabilitation along the river foreshore and riparian corridors on tributary creeks.

LGA	Specific Locations	Proposed Actions
LCC17		Continue water quality monitoring at Stringybark Creek, Gore Creek and Tambourine Bay.
City of Ryde		
CoR1	Field of Mars Reserve Catchment	Bioretention system to complement existing wetland in Buffalo Creek catchment to treat a catchment area of approximate 28Ha.
CoR2	Sugarloaf Foreshore, Lane Cove National Park	Work with LCNP Authority for additional picnic facilities, within individual bush settings.
CoR3	Lane Cove River	Work with RMS for additional navigational aids in waterway.
CoR4	Lane Cove National Park, Sugarloaf Hill and Buffalo Creek to Magdala Park	Investigate possible location/s within the extent of boxed area for improved provision for parking off Pittwater Rd to provide alternative access to Sugarloaf Point Area.
CoR5	Magdala Park	Consider feasibility of a major upgrade of the existing little used but strategically important 'soft' water entry for canoe/kayak users and provide additional public amenities and improved launch site facilities for users from the Park.
CoR6	Gannan Park, Buffalo Creek Catchment	Construct a bioretention system at the northern corner of the Park to treat an catchment area of approximately 11.91Ha.
CoR7		Construct a bioretention system at the north east corner of the Park to treat a catchment area of approximately 4.15Ha
CoR8	North Ryde Common, Kitty's Creek Catchment	Work with NSW Health to construct a bioretention system at the existing headwall outlet to the Common to treat a catchment area of approximately 2.46Ha.
CoR9		Work with NSW Health to construct a bioretention system in the vicinity of the existing stormwater pipeline to on Common to treat a catchment area of approximately 2.24Ha.
CoR10	Blenheim Park, Lane Cove River Catchment	Construct a bioretention system next to the existing community building or alternatively at the low point of the Park within the off-leash dog area adjacent to Blenheim Rd to treat a catchment area of approximately 3.24Ha.
CoR11	Brereton Park, Kitty's Creek Catchment	Construct a bioretention system to improve stormwater quality runoff and protect an existing ecologically endangered community (Swamp Scelophyll Forest on Coastal Floodplains) and to treat a catchment area of approximately 1.68Ha.
CoR12	Porters Creek Depot, Porters Creek Catchment	Reconfigure site, finalise and upgrade soil and water management investigate site leachate controls to improve overall quality of water entering Porters Creek.
Willoughby City Council		
WCC1	Chatswood Golf Course	Investigate WSUD options with Chatswood Golf Course to improve water quality and reuse options along Swaines Creek.
WCC2		Consult with Chatswood Golf Course to develop and implement a sensitive management program within the buffer zone between the river and golf course. Address access, mowing regime and interpretive signage.
WCC3	Rotary War Memorial	Upgrade and rationalise the recreation facilities at Chatswood Rotary War Memorial Athletics Field to accordance with the site Master Plan and the Council's Open Space & Recreation Plan 2012, incorporating the relevant Actions listed in Section 4: Access to Water.
WCC4	National Starch Factory	Negotiate the creation of access along river foreshore near starch factory to provide safe linkage between the north and south of Epping Road.

LGA	Specific Locations	Proposed Actions
WCC5	Rotary War Memorial	Investigate effectiveness of carpark stormwater system at Chatswood Rotary War Memorial Athletics Field and other discharge points along oval.
WCC6	River Foreshore	Continue natural area restoration works along river including noxious weed control and revegetation.
WCC7		Coordinate and maintain safe and ecologically sensitive links along river between Mowbray and Fullers Park.
WCC8	Rail Tunnel	Investigate the discharge and possible reuse of water from the Rail tunnel.
WCC9	Blue Gum Creek	Consult with LCNP to develop restoration project for saltmarsh area in Blue Gum Creek.
WCC10	Blue Gum Creek and Swaines Creek	Continue water quality monitoring at Blue Gum Creek and Swaines Creek.

APPENDIX F: FEEDBACK FROM PUBLIC EXHIBITION

The Draft Lane Cove River Coastal Zone Management Plan (CZMP) was on public exhibition from 13 May 2013 until 24 June 2013 and members of the public were invited to have their say.

Table 12-7: Community Feedback from Public Exhibition

Comment	Response
Lack of status report for 2004 EMP Recommended Strategy No 7. Assess the impact of installation and operation of the Northside Storage Tunnel on estuarine water quality. It appears that nobody has performed these tasks, in particular, the actions to measure and record frequency and volume of overflows, measure pollutant charged flow.	No status report has been provided in the table on page 27 under Strategy 7. Sydney Water has not published any monitoring results regarding the Northside Storage Tunnel. Sydney Water staff requested that all reference to Sydney Water and actions against it be removed from the 2013 report. See Actions AW1 and AW2. Council will continue to liaise with Sydney Water.
Lack of mention of the West Pymble sewer surcharge, which was considered the next worst pollution source (after the siphon) in the massive study for the sewer pollution licence.	This surcharge is discussed in APPENDIX G:: Water Quality Review Report. See Actions AW1 and AW2.
Importance of maintaining and improving functioning habitat corridors and connections has been overlooked. Missing is the consideration of how to keep and/or re-establish habitat areas within functioning corridors for the benefit of our native flora and fauna – and also for the people. These habitat corridors and connections need to be mapped and considered now and then revisited at the time of any planning for development or changes within the Lane Cove River Coastal Zone. This message should be reinforced within this Management Plan.	Actions referred to indirectly. See AA4, AA8 and AA3 for actions on private land to protect habitat and encourage revegetation. See AA1 for action to protect, enhance and restore foreshore vegetation.
Coastal Management Principles (Table 1-1 p3) Principle 9 should include waterways – to maintain and improve easy access for the public in our local government area, especially as pressure for waterfront land/housing increases.	These principles are set by the NSW Government. The Lane Cove River CZMP has interpreted this principle to include waterways. See AC3 for action to conserve public foreshore areas from development or infrastructure, required for the retreat of estuarine vegetation.
Concern that the Plan does not have any statutory authority and be subject to many different decision makers. Need for consistency of management across local government boundaries.	Comments are noted, however the 4 estuary are committed to working cooperatively on the plan's implementation.
Plan needs to emphasise the critical nature of the funding required.	Section 9 identifies actions that can be funded within Councils' budgets and those that will require external funding.
The following issues need to be addressed in the plan: -Recommendation that all existing heritage listings be subject to urgent review. -Plan to take into account the natural and cultural	Heritage study and recommendations was out of the scope of this Plan. Appendix E lists some specific actions at sites in all 4 LGAs relating to natural heritage issues identified in other studies and reports.

Comment	Response
heritage with reference to the Sydney Harbour REP now SEPP and the accompanying DCP. -Funding ground-truthing of the draft regional Vegetation mapping for the Lane Cove River catchment.	Reference to SREP (Sydney Harbour Catchment) 2005 and Sydney Harbour and Foreshore Areas DCP 2005 included.
Impact from Climate Change/ Sea Level Management Actions should be actively pursued as matters of urgency. Concerns about an inconsistent and potentially non-scientific basis for planning with regard to SLR.	Comments are noted but this is a matter to be addressed elsewhere.
Water Quality: Sharing and collaborating between Councils and Sydney Water needs to be strongly promoted as sewage overflows, high pathogen counts, sediments and nutrients are all high risk. Funding is critical to the fast tracking of the high risk items.	See AW1, AC4 and AW2 for actions relevant to this issue.
Concerns about the White Paper - Ecologically Sustainable Development has been removed as an objective in the New Planning System for N.S.W. Economically Sustainable Development is a completely different concept, which conflicts directly with the aims of the EMP and the draft CZMP as well as other legislative controls.	Comments are noted, but this is a matter beyond the scope of this plan.
Concerns about Urban Consolidation which will increase the burden on already struggling infrastructure affecting the river system.	See AC4, AW1 for actions relevant to this matter.
Strategy 2 p 25 of CZMP should be funded and adopted by LCC to control building and construction activities within 75 metres of the shoreline/high water mark. A consistent approach to Strategy 26 p 38 re sediment and erosion control should be implemented by Lane Cove Council.	See AC6 and AW8 for corresponding action in 2013 draft Plan.

APPENDIX G: WATER QUALITY REVIEW REPORT

BMT WBM

A part of BMT in Energy and Environment

Lane Cove River Water Quality Review

March 2013

Lane Cove River
Water Quality Review

Prepared For:	Lane Cove River Estuary Management Committee (LCREMC), Hunters Hill Council, Lane Cove Council, City of Ryde, Willoughby Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Project Manager	Reid Butler
Author/s:	Reid Butler, Smita Jha
Client:	Lane Cove Council
Client Contact:	Susan Butler
Client Reference:	Lane Cove River CZMP Update Project

Synopsis: This report reviews the current available water quality information for the Lane Cove River

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY	
DRAFT	16/01/2012	RB	16/01/2012	RB, SJ	16/01/2012
FINAL	13/03/2013	RB	13/03/2013	RB	13/03/2013

DISTRIBUTION

DESTINATION	REVISION										
	DRAFT	FINAL	2	3	4	5	6	7	8	9	10
Lane Cove Council	1	1									
BMT WBM File	1	1									
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1 INTRODUCTION

The Lane Cove River is a tributary of Parramatta River and is located within 5 km of the Sydney Central Business District (CBD). The catchment area is 95.4km^2 and the area of the estuary zone is 3.0km^2.

This report reviews the monitored data at the Lane Cove River weir, Lane Cove River and its creeks. We have also analysed data from the constructed sewer overflow at Gloucester Ave, West Pymble, due to its large overflows. The Gloucester Ave sewer overflow discharges into the freshwater upper regions of Lane Cove River, above Lane Cove River weir and then flows into the estuary.

Water quality information for the estuary has been gathered by numerous sources and in varying formats. The consistency of data quality has not been commented on in this report, however, as a future measure, it is recommended that all sources be verified for accuracy.

1.1 Methodology

The methodology undertaken to complete this project is summarised below:

1. Desktop review of current quality of receiving waters and waterway ecology.
2. Identification of key influences on water quality and waterway health.

2 DESKTOP REVIEW

A desktop review of available water quality and aquatic ecology information that relates to the Lane Cove River catchment was undertaken. A summary of the sources reviewed, identified information gaps and the review findings are presented in the following sections.

2.1 Information Reviewed

The following data sources were reviewed:

- Sydney Harbour Catchment Water Quality Improvement Plan: Data Compilation and Review 2011, prepared by Water Research Laboratory, UNSW
- An Environmental Investigation of Sediments in the Lane Cove Estuary, 1999, Prepared by The Environmental Geology Group, School of Geosciences, The University of Sydney
- Northern Sydney Regional Organisation of Councils (NSROC), State of the Environment Report, 2009-2010
- (EICR) Environmental Indicators Compliance Report (volume 1-2), Sydney Water Annual report 2005, September 2005, Sydney Water Corporation.
- Wet Weather Overflow Abatement Program, Water Quality Gap Analysis, September 2006. Prepared for Sydney Water Corporation.
- Ecological and Human Health Risk Assessment of Chemicals in Sewage Overflows in the Sydney-Blue Mountains-Illawarra Regions, May 1998. Prepared by Sydney Water Corporation.
- Ecological and Human Health Risk Assessment of Chemicals in Sewage Overflows in the Sydney-Blue Mountains-Illawarra Regions, May 1998 (Appendicies). Prepared by Sydney Water Corporation.
- Sewer Overflow and Stormwater Discharge Sampling and Analysis Program Summary Data Report, 1993-1996. Prepared for Sydney Water Corporation.
- Stormwater Monitoring Project, 1995 Annual Report – Volume 1 (Client Draft). Prepared by Australian Water Technologies (Sydney Water).
- Clean Waterways Programme, Stormwater Monitoring Project, 1994 Annual Report – Volume 1. Prepared by Sydney Water.
- Clean Waterways Programme, Stormwater Monitoring Project Site Information Details, Technical Report January 1994 (Draft). Prepared by Sydney Water.
- Clean Waterways Programme, Stormwater Monitoring Project, 1993 Annual Report – Volume 1 (November 1994, revised June 1995). Prepared by Australian Water Technologies (Sydney Water).
- The Impact of Urbanisation on Water Quality in the Lane Cove River, Sydney New South Wales: a Comparison of Urban and Non-Urban Catchments by Catherine A. Preston Article first published online: 28 JUN 2008, DOI: 10.1111/j.1467-8470.1995.tb00682.x Australian Geographical Studies, Volume 33, Issue 1, pages 19–30, April 1995.

- Lane Cove Stormwater Management Plan 1999, prepared by Councils of the LCR Catchment Committee.
- Impact of urban development on aquatic macroinvertebrates in south eastern Australia: degradation of in-stream habitats and comparison with non-urban streams by P.Davies, A. Wright, S. Findlay, O.Johansson, S.Burgin. Aquatic Ecology, Volume 2, Issue 44, December 2010.
- Biotrack Australia Pty Ltd, Middle Harbour and Lane Cove Macrobiological Monitoring Program, June 2005. Prepared for Hornsby, Hunters Hill, Ku-ring-gai, Lane Cove, North Sydney, Ryde & Willoughby Councils.
- Aquatic macroinvertebrates in urban waterways: comparing ecosystem health in natural reference and urban streams by I.Wright, P. Davies, D. Wilks, S. Findlay and M. Taylor. Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. New South Wales. 2007
- Robyn Tuft & Associates, Ecological Assessment of Ku-ring-gai's Watercourses Lane Cove River Catchment, Autumn 2003. Prepared for Ku-ring-gai council.

2.2 Information Gaps

The desktop review indicated the following key information gaps:

- Sewer overflow water quality data is monitoring data is limited to sampling three events in 1994 and 1995.
- Data regarding stormwater runoff characteristics of the catchment is limited to one study.

2.3 Data Review Findings

Substantial water quality data of the waterway has been collected from Lane Cove River weir. Water quality sampling was conducted every 20 days from 1995 to 2005 and the results are summarised in the EICR 2005 report. Samples were analysed for the following parameters: temperature, conductivity, dissolved oxygen, pH, total phosphorus, filterable phosphorus, total nitrogen, oxidised nitrogen, ammonia, chlorophyll-a, faecal coliforms, and enterococci. The available data indicates that bacterial counts within the receiving waterway increase substantially during wet weather periods. Eutrophication is also an issue within the waterway.

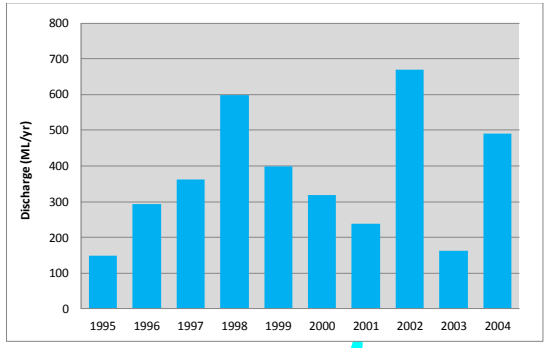
The available stormwater quality and discharge data is limited to the Preston (1995) study. Various creeks discharging into the upper regions of the Lane Cove River between 1989 – 1992 during wet, dry and recovery weather conditions were analysed in the study. Preston found that over 90% of the annual pollutant load was carried during wet weather and sourced from urban runoff and sewer overflows.

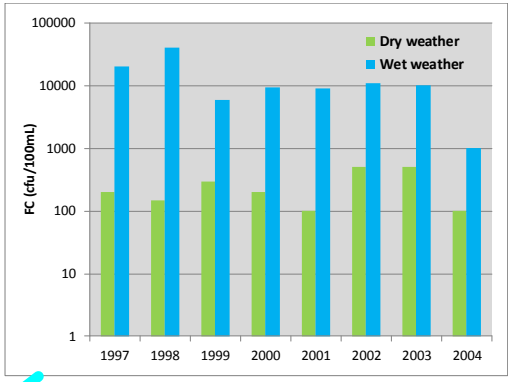
Sewer overflows impact on the estuary by discharging faecal coliforms and other sewer borne pollutants into the estuary during wet and sometimes dry weather. An understanding of the relative impact of the sewer overflow and stormwater runoff is important to determining the management priorities for the receiving waterway.

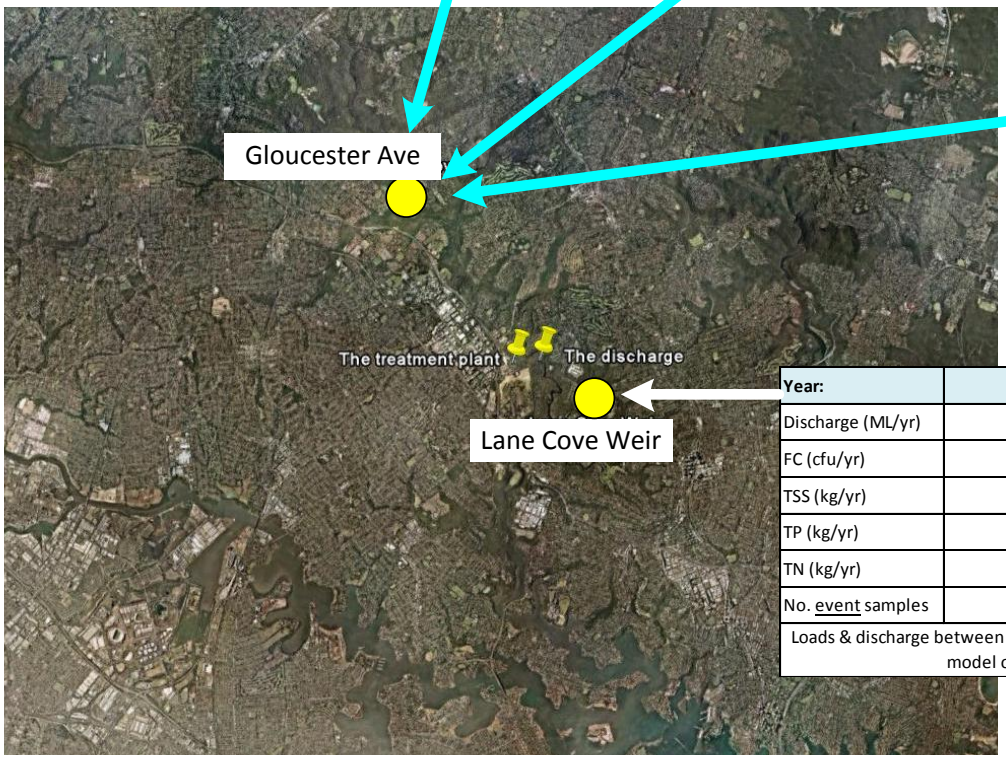
Sewer overflow water quality data is limited to sampling of three events in 1994 and 1995 at the Gloucester Avenue overflow. The sewer overflow rates were monitored by Sydney Water.

Figure 2-1 shows a summary of the available data in spatial context.

Macroinvertebrate data has been collected in recent years as macroinvertebrates are important indicators to the ecological health of a waterway. The studies conducted in the waterway indicate long term poor water quality and habitat condition. Whilst macroinvertebrates are an indicator of water quality and health, they do not allow for easy identification of key contaminants affecting the waterways nor sources of the impacts on ecological health. Key contaminants need to be understood before effective water quality improvement measures can be assessed. These studies have been conducted at many locations throughout the catchments, by qualified biologists, as well as by school groups as part of the Streamwatch program. These disparate datasets can be combined to give an overall picture of ecological health.







Overflow event:	13-15 Apr 1994	2 -8 Mar 1995	17 - 18 May 1995
FC (cfu/100mL)	652,000	1,907,000	1,293,000
TSS (mg/L)	66	43.7	54.5
TP (mg/L)	1.07	1.48	1.80
TN (mg/L)	7.0	10.7	12.6

Year:	1993	1994
Discharge (ML/yr)	10,978	11,401
FC (cfu/yr)	223000	589
TSS (kg/yr)	148974	228052
TP (kg/yr)	502	683
TN (kg/yr)	7606	9309
No. event samples	17	15
Loads & discharge between unsampled estimates were model outputs.		

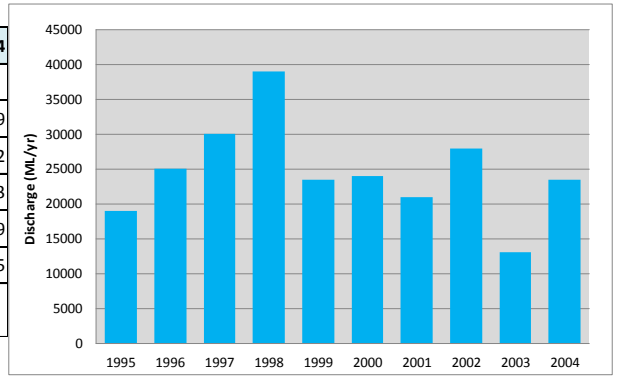


Figure 2-1: Key available water quality data

3 WATER QUALITY

The ANZECC (2000) trigger values for physical and chemical stressors for southeast Australia for slightly disturbed ecosystems are presented in Table 3-1 along with the results obtained by averaging the water quality data collected since 2005 by Sydney Water Corporation at Lane Cove River Weir.

Table 3-1: Summary of Water Quality Data

Water Quality Constituent	ANZECC Guidelines		Lane Cove Weir
Conductivity (µs/cm)	-		
Dissolved Oxygen (%)	80% Lower Limit	110% Upper Limit	68
Dissolved Oxygen (mg/L)	-		6.5
Temperature (˚C)	-		19.5
pH	7 (Lower Limit)	8.5 (Upper Limit)	7.5
Ammonia (µg/L)	15		90
Oxidised Nitrogen (NOx) (µg/L)	15		350
Tortal Nitrogen (µg/L)	300		85
Filterable Phosphorus (µg/L)	5		20
Total Phosphorus (µg/L)	30		55
Faecal Coliforms (cfu/100mL)	1000*		2000
Enterococci (cfu/100mL)	230*		1000
Chlorophyll a (µg/L)	4		14

* Based on secondary contact. Values for primary contact are 150 cfu/100mL and 35 cfu/100mL for faecal coliforms and enterococci respectively.

The upper catchment site in Lane Cove River has consistently high nutrient concentrations (ANZECC 2000). This is likely due to the highly urbanised nature of the catchment resulting in higher nutrient loads from fertilisers and other domestic practices.

Lane Cove River at the weir was observed to have consistently high bacterial concentration for secondary contact (ANZECC 2000).

There is irregular distribution of bioavailable phosphorus with isolated concentrations in Lane Cove River.

3.1 Primary Pollutant Sources

As discussed in the Section 2.3, the two primary pollutant sources into Lane Cove River are the sewer overflow from Gloucester Ave and catchment runoff. As there is little available information regarding stormwater quality or quantity alone (and excluding sewer overflows), a simplistic catchment model was developed using SourceCatchments[1]. The model was built with the purpose

[1] *SourceCatchments is a catchment modeling software developed by eWater CRC (http://www.ewater.com.au/products/ewater-source/for-catchments/)*

of estimating stormwater for relative comparison to the sewer overflows. An image of the model is shown in Figure 3-1.

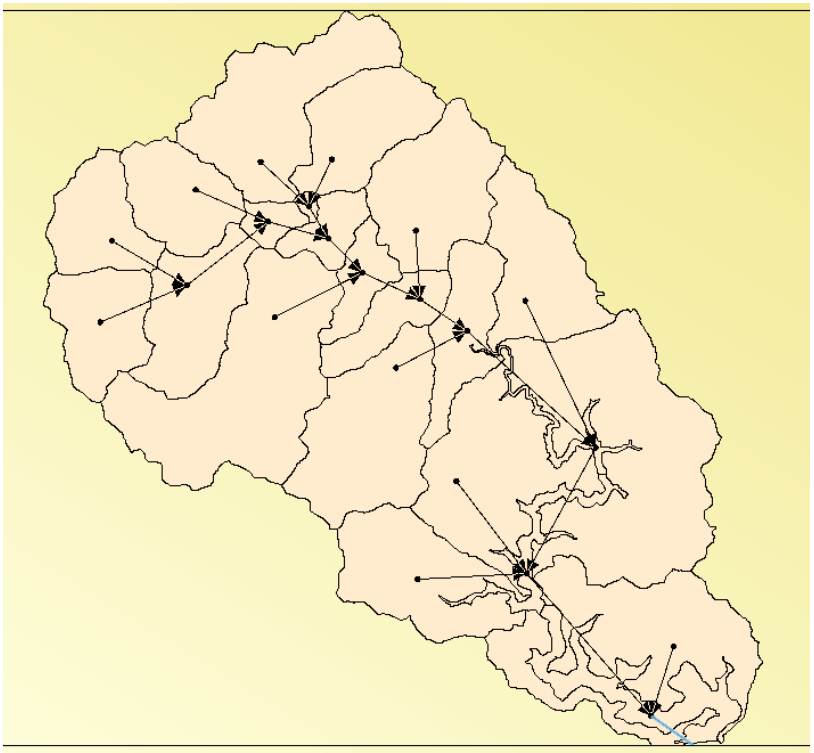


Figure 3-1: Lane Cove River catchment runoff model built in Source Catchments

3.2 Analysis of Pollutant Sources

The results of the catchment modelling indicate that the stormwater discharge from the Lane Cove River catchment into the receiving waterway is substantially greater than the sewer discharge, as shown in Figure 3-2. This result agrees with the EICR (2005) report, which reported sewer overflows only accounted for up to 5% of the discharge from the Lane Cove River catchment between 1995 to 2004.

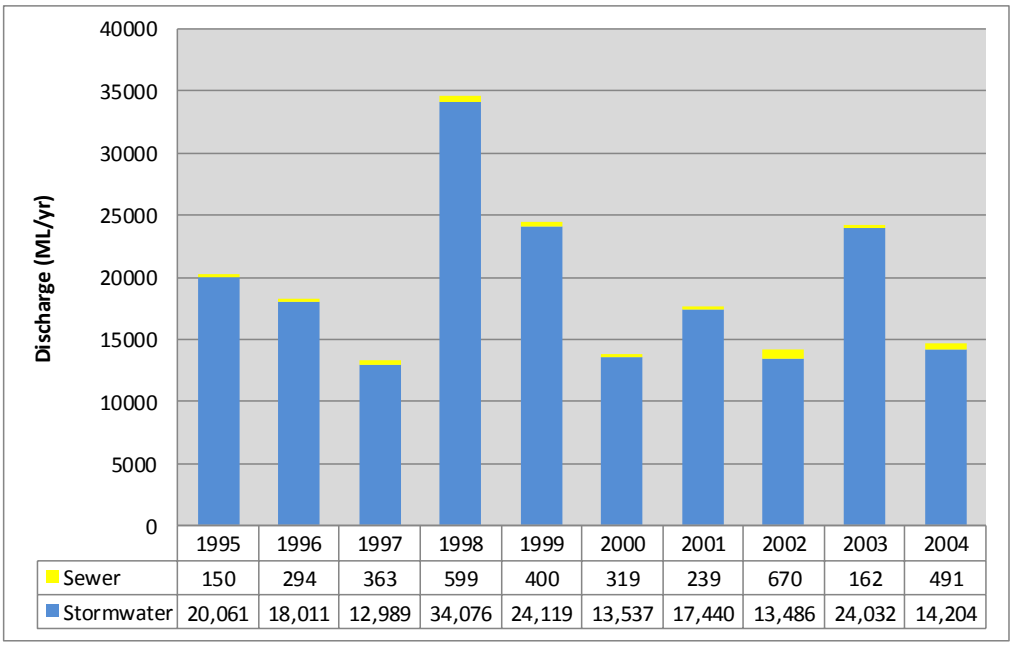


Figure 3-2: Comparison of stormwater and sewer annual discharge

The estimated average concentration of key water quality parameters is provided in Table 3-2[2]. These concentrations have been best estimated using available site data and data from other similar sites. Table 3-2 indicates that excluding TSS, all the other parameters have higher concentrations in sewer overflows than in stormwater discharge.

Table 3-2: Estimated Average Concentration of Key Water Quality Parameters in Stormwater and Sewer

Parameter*	Stormwater	Sewer
FC (cfu/100mL)	1,700	1,000,000
TP (mg/L)	0.23	1
TN (mg/L)	1.83	8
TSS (mg/L)	120	45

* FC = Faecal Coliforms, TP = Total Phosphorus, TN = Total Nitrogen, TSS = Total Suspended Solids

Whilst the concentrations are generally higher in sewer overflows than in stormwater, the difference in flow quantities means that stormwater pollutant loads are substantially greater for all parameters except FC. This is shown in Figure 3-3.

[2] *The efficiency of existing water quality measures within the catchment were unknown and were not included.*

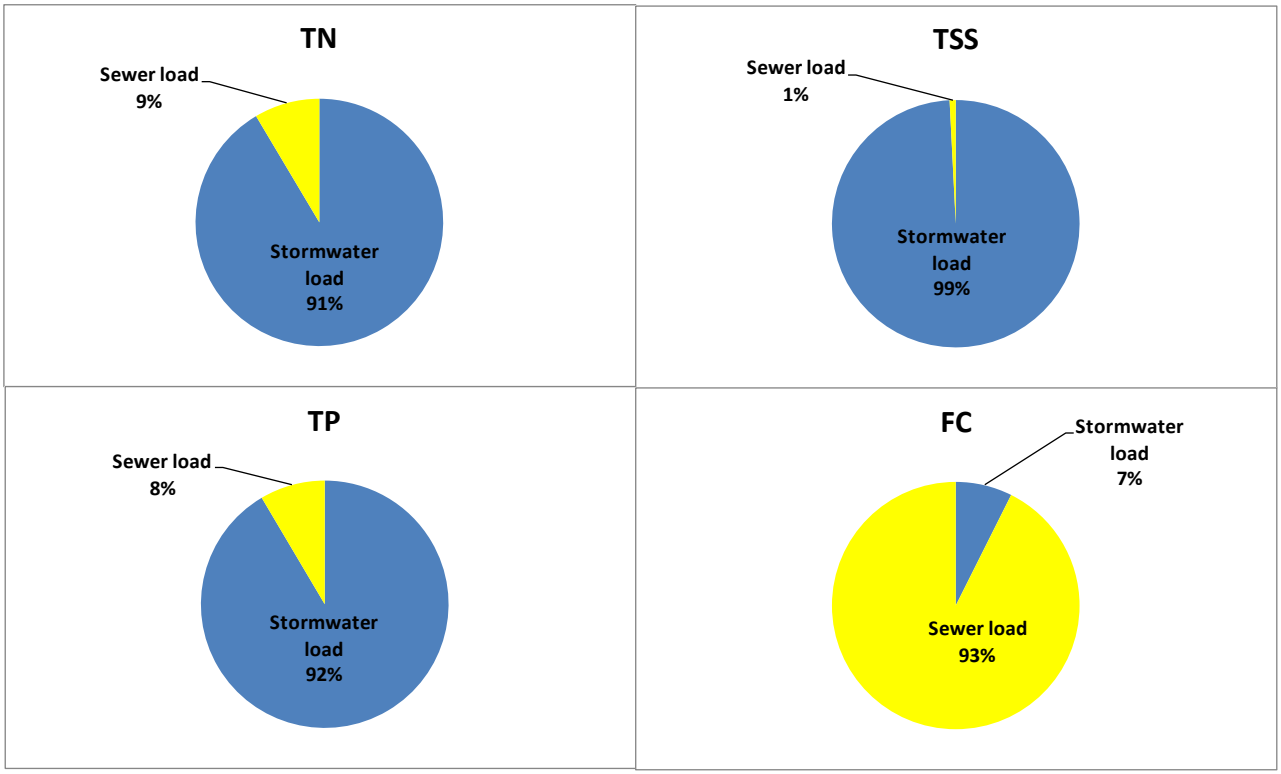


Figure 3-3: Comparison of source loads at Gloucester Ave

Therefore, stormwater discharge accounts for approximately 95% of discharge from the Lane Cove River catchment and is therefore substantially greater than sewer overflow from Gloucester Ave, which accounts for a only a maximum of 5% of the discharge. For this reason, stormwater is the primary source of TN, TP and TSS pollutant loads. The sewer overflows provide the primary faecal coliform pollutant load to the waterway.

Some recent sampling results for faecal coliforms and enterococci are available for the harbour swimming sites at Tambourine Bay and Woodford Bay. Table 3-3 shows low compliance of the Tambourine Bay baths, mainly due to the poor flushing of the bay.

Table 3-3: Bacterial sampling results at two baths in Lane Cove River Estuary (2007-8)[3]

Site	Compliance (%)		Overall rank (out of 41 Sydney Harbour baths)
	Faecal Coliforms	Enterococci	
Tambourine Bay	74	61	36
Woodford Bay	97	77	17

Since the NSOOS siphon at Cunningham's Reach was diverted into the Northside Storage Tunnel in 2001, these baths have had better compliance with the guidelines, but during wet weather, they can both be severely affected by sewer overflows.

Repairs to the Northern Suburbs Ocean Outfall System (NSOOS) were carried out as a part of Sydney Water's $560 million SewerFix Program to protect public health and the environment. It

[3] *Harbourwatch website www.environment.nsw.gov.au*

includes the Avoid Fail program, which aims to improve the overall performance of the wastewater system by ensuring large wastewater systems do not fail in their operation and cause overflows.

Work to repair sections of the NSOOS is completed at Greenwich, Lane Cove, Cremorne and Manly. The work involved crews entering the NSOOS via maintenance holes to clean decayed concrete from the pipe's roof and walls, replace corroded joints and repair the internal structure of the maintenance hole. A coating was then applied to protect the roof and walls of the pipe. This will ensure the structural reliability of the NSOOS for many years to come.[4]

3.3 Pollutant Export Rates

Export rates from catchment sources have been published for various water quality constituents. The calibrated nutrient and faecal coliform model result published by Sydney Water Corporation (1995) for the Lane Cove River catchment is presented in Table 3-4.

Table 3-4: Summary of pollutant export rates from diffusive sources (Sydney Water Corporation, 1995)

Catchment	Area (ha)	Total Phosphorus Export (kg/ha/yr)	Total Nitrogen Export (kg/ha/yr)	Faecal Colifrom export (terra cfy/ha/yr)	Suspended Sediment Export (kg/ha/yr)
Lane Cove River					
Upper Lane Cove River	7,172	0.09	1.15	0.03	31
Central Lane Cove River	1,521	0.6	3.55	0.2	533
Lower Lane Cove River	851	0.4	2.7	0.12	458

Note: The rates in the above table are estimations based on modelling and do not present data measured in the catchment.

4 SEDIMENT STUDY[5]

All analyses of surficial sediment for organochlorine compounds (Heptachlor, Heptachlor-epoxide, Aldrin, Dieldrin, Lindane, Gamma and Alfa Chlordane, DDT, DDD, DDE and HCBs) were below detection limits (50µg/kg), with the exception of one sample in Burns Bay, which contained minor quantities of DDE (0.13µg/kg).

One core was taken in the main channel of the Lane Cove River Estuary and cores were recovered from four embankments on the northern shore to estimate the depth of anthropogenic influence and to determine pre-anthropogenic metal concentrations. Cores from Woodford and Burns Bay displayed high concentrations of heavy metals to a depth of about 30 cm, whereas cores from Tambourine and Gore Creek Bays and from the Lane Cove River upstream of the Fig Tree bridge have elevated metals to 60-70 cm sediment depth.

[4] *The NSOOS is northern Sydney's largest wastewater system and runs from Blacktown to North Head Wastewater Treatment Plant in Manly.*
http://www.sydneywater.com.au/MajorProjects/North/NSOOS/oldindex.cfm

[5] *Source: The Environmental Geology Group, School of Geosciences, The University of Sydney, "An Environmental Investigation of Sediments in the Lane Cove Estuary", 1999*

Selective chemical extraction procedures suggest that approximately 50-90% of the total absorbed Cu is bioavailable, whereas about 90% Pb and Zn are bioavailable. Some oysters were sampled and were found to have elevated concentrations of heavy metals.

5 MACROINVERTEBRATES[6]

In 2008/2009 NSROC reported on water quality based on "SIGNAL" (Stream Invertebrate Grade Number Average Level) which assess the number and species of macro invertebrates in waterways as an ecological health indicator. Generally, given the close urban development in some of the region, creek quality in the Lane Cove River region is not as high as in pristine areas.

Comparative SIGNAL2 scores for selected creeks for two periods are presented in Table 5-1 where each water bug is assigned a value; 1 being very tolerant and 10 being very sensitive. These values are used to calculate an 'average score' for a river or stream. A low SIGNAL2 score indicates poor water quality, potentially due to low dissolved oxygen, turbidity, salinity, excess nutrients or another form of pollutant. Higher SIGNAL2 scores are indicative of good water quality and healthier rivers or streams.

The ratings in some creeks have risen and others fallen, but overall the ratings are low. The highest recent rating was for Blue Gum Creek, and the lowest Terrys Creek. Both of these creeks have changed since the 2006-7 sampling.

A comprehensive water quality study undertaken by Sydney Water for Ryde Council in 2011[7] and confirmed that the four Ryde creeks in Table 5-1 had similar SIGNAL scores and similar states of health. Buffalo and Porters Creeks had marginally higher scores than the other two. This was also found to have not changed significantly since sampling by Ecowise began in 2004. A comment was made that following drought conditions around 2007, a return to higher rainfall patterns may increase the biological diversity of the creeks, however, the number of taxa found in 2011 was consistent with the low numbers of the past.

Some Councils have chosen to scale back the frequency of macroinvertebrate sampling as the results have been consistent for several years.

Table 5-1: Water Quality Results at sites within Lane Cove River Estuary

Catchment	Location	SIGNAL2 Score	
		2006-7	2009-10
Ryde	Buffalo Creek	3.18	3.27
	Terrys Creek	3.28	2.27
	Porters Creek	3.23	2.84
	Shrimptons Creek	3.22	2.83
Willoughby	Swaines Creek	3.33	3.0
	Blue Gum Creek	2.80	3.7
Lane Cove	Gore Creek	3.6	3.0
	Stringybark Creek	2.57	3.0
Hunter's Hill	Tarban Creek	2.65	3.0
	Brickmakers Creek	3.47	2.9

[6] *Northern Sydney Regional Organisation of Councils (NSROC), State of the Environment Report, 2009-2010, Available from: http://www.lanecove.nsw.gov.au/Our%20Environment/Council%20activities/State%20of%20Environment/StateoftheEnvironmentReport.htm*

[7] *Biological and Water Quality Monitoring – Prepared for City of Ryde (2011) Sydney Water*

6 SUMMARY

There are various disparate data sources for water quality in the Lane Cove River Estuary and the accuracy of each has not been verified.

There is a lack of inflow water monitoring. This data gap limits the accuracy of Lane Cove River catchment inflows to determine the effectiveness of management actions, as no calibration data will be available. Hence, installation of flow/level gauging on the Lane Cove River should be investigated[8].

Currently, the receiving waterway, Lane Cove River, has substantially high bacterial counts during wet weather periods, and experiences problems with eutrophication.

A number of macro invertebrate studies have been conducted within Lane Cove River and indicate that the ecological health of the receiving waterway is poor and has not changed significantly for almost the past decade.

As stormwater is a the primary pollutant source in the catchment for key water quality parameters such as TN, TP and TSS, improvement of Lane Cove River will need to address improving stormwater discharge and this can be progressed by determining a target water quality objective for the catchments. Reducing sewer overflows for high faecal levels during storms will help reduce bacterial contamination and this needs to be completed by Sydney Water at the major overflow locations (specifically Gloucester Avenue).

Ongoing urbanisation of the catchment in the future will increase catchment runoff and pollutant loads if development controls and diverse water quality improvement measures are not put in place and maintained.

8 Sydney Harbour Catchment Water Quality Improvement Plan: Data Compilation and Review 2011, prepared by Water Research Laboratory, UNSW

APPENDIX H: MAPS

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