Report

Woronora River
Stormwater Management Plan

September 2000

For

Sutherland Shire Council

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AWT Report No.: 2001/0023

File Reference: Woronora Final_ submitted a.doc

September 2000

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ACKNOWLEDGMENTS

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GLOSSARY

CMC	Catchment Management Committee
Colluvial	Soil material transported downslope by gravity and deposited at the base of the slope.
DLWC	Department of Land and Water Conservation
DUAP	Department of Urban Affairs and Planning
EPA	Environment Protection Authority
GRCMC	Georges River Catchment Management Committee
HIA	Housing Industry Authority
LEP	Local Environment Plan
NPWS	National Parks and Wildlife Service
Orographic	Orographic rain occurs when winds rise over the Dividing Range in eastern Australia or when onshore winds have to surmount coastal hills.
Point Bar Terrace	Depositional feature, composed of sand and gravel that accumulates on the inside on a river bend.
REP	Regional Environmental Plan
RTA	Roads and Traffic Authority
SEPP	State Environmental Planning Policy
SPCC	State Pollution Control Commission
RSA	Rail Services Authority
SSC	Sutherland Shire Council
SWC	Sydney Water Corporation
WQOs	water quality objectives

1 Introduction

1.1 Purpose of this Plan

This document is the Stormwater Management Plan (SMP) for the Woronora River Catchment. The Woronora River Catchment has an area of approximately 174 km² and is located approximately 22km south of the Sydney Central Business District (see Figure 1). The catchment starts in the vicinity of Darkes Forest and empties into the Georges River near Como. Sutherland Council, being responsible for the largest portion of the catchment, coordinated the preparation of this plan.

The aim of this plan is to improve the management of stormwater within the Woronora River Catchment. The plan:

- describes the catchment;
- identifies existing catchment conditions;
- establishes the values of the catchment;
- states appropriate management objectives;
- identifies management issues;
- evaluates potential management practices;
- contains implementation strategies for Sutherland and Wollongong Councils and other stormwater managers within the catchment;
- presents a performance monitoring program;
- establishes stormwater management objectives for new developments; and
- describes a mechanism for reporting on the implementation of the plan.

1.2 Framework for Preparing this Plan

This plan has been prepared to comply with the requirements of a notice issued to Sutherland Shire Council by the Environment Protection Authority (EPA) under section 12 of the Protection of the Environment Administration Act.

This is the first stormwater management plan prepared for the Woronora River Catchment. There are currently no other plans or reports that provide a framework for this plan.

The plan has been prepared giving consideration to the following legislation:

- *Environmental Planning & Assessment Act 1979*;

- *Local Government Act (NSW) 1993*;
- *Catchment Management Act (NSW) 1989*;
- *Clean Waters Regulation (1970)*; and
- *National Parks and Wildlife Act 1974*.

The following management plans or policies were also reviewed in relation to this plan:

- State Environmental Planning Policies (SEPPs);
- Georges River Catchment Management Committee Strategic Plan;
- Georges River REP 1999;
- Heathcote National Park Management Plan;
- draft Woronora Valley Master Plan;
- Sutherland Shire LEP 1993;
- draft Sutherland Shire LEP 1999;
- Sutherland LEP – Menai Town Centre 1992;
- Sutherland Strategic Plan; and
- draft Shaping the Shire.

The EPA (1997) released a series of proposed interim water quality and river flow objectives for the catchment for public comment. At this stage in the State Government's Water Reform Package, the water quality objectives (WQO's) are only expressed in terms of environmental values. A series of river flow management principles have been released for comment.

The health of the Woronora River and its management is also currently a focus of the Healthy Rivers Commission. An inquiry is being conducted into the state of the river system which will also develop ecological, commercial and social goals for the catchment. The draft report on the investigation into the Woronora River has been released for comment and is on exhibition until the end of August 1999.

1.3 Stakeholder Consultation

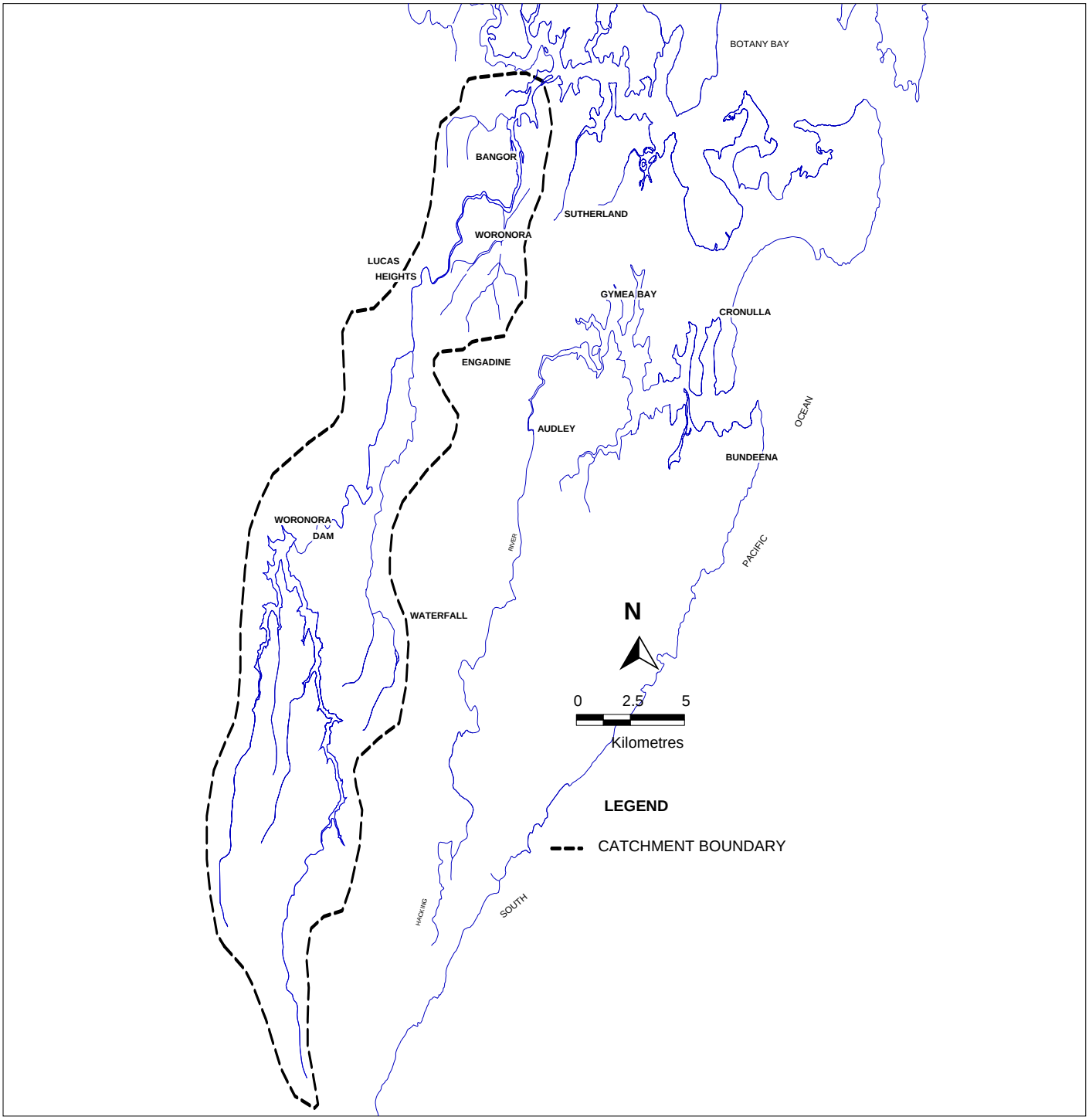
This plan has been prepared in consultation with a number of stakeholder groups, namely:

- Department of Land and Water Conservation (DLWC);
- Department of Urban Affairs and Planning (DUAP);

- Georges River Catchment Management Committee (CMC);
- Healthy Rivers Commission;
- Housing Industry Association;
- National Carpet and Upholstery Cleaning Association;
- National Parks and Wildlife Service (NPWS);
- NSW Environment Protection Authority (EPA);
- NSW Fisheries Department;
- Restaurant and Catering Association;
- Roads and Traffic Authority (RTA);
- Rail Services Authority (RSA);
- Woronora Life Saving & River Patrol Club;
- Woronora Valley Association; and
- General public

These stakeholders were invited to raise issues that should be addressed in the preparation of this plan. In addition, the stakeholders were invited to two public meetings that were held during the plan's preparation. The meetings discussed management issues and the management plan. The outcomes of the community consultation process are included in Appendix 1.

Figure 1. The Woronora River Catchment



2 Current Stormwater Management

Stormwater management within the catchment is the responsibility of a number of different organisations, however, the primary stormwater management role rests with local Councils. Sutherland Shire Council (SSC) undertakes most of the planning, construction, maintenance and operation of the stormwater system in the catchment. SSC conducted a study of the status of the stormwater system in the Shire in 1991. The results of this study refer to assets within the whole of the Shire and not just the Woronora catchment, but are useful to gain an understanding of the extent of Council's stormwater management responsibilities:

- there are approximately 600 km of stormwater drains, both piped and unpiped, in addition to natural watercourses;
- drains outfall through around 500 different outlets;
- fifteen of the major outlets have large industrial, commercial or retail areas in their catchment areas;
- the Shire's stormwater system handles a volume of 130 million cubic metres of urban runoff annually; and
- pollutants identified in the stormwater include- suspended solids, litter, oxygen demanding materials, micro organisms, toxic organic materials, road detritus, toxic trace metals, oils and surfactants; nutrients and sewage.

Council Responsibilities

Historically, urban runoff has been regarded by Councils as a drainage issue with the primary aim being to channel water away from developed areas quickly to reduce the potential for flooding. In the past, the responsibility for stormwater has been relegated to Councils' engineering sections to carry out the structural works controlling flooding. SSC has a Stormwater Management Section in a move towards balancing its resources between structural drainage constraints and the need for environmental quality. Structural controls to treat stormwater are still regarded as the most direct way of managing urban runoff. Council's existing stormwater works program has installed water pollution control devices in several parts of the catchment. The locations and types of existing devices are shown on Figure 2.

Council also has a regular street cleaning program which cleans major shopping areas and main streets. Council has three mechanical, sweeping trucks carry out this operation on a weekly basis, collecting in the order of 3000 tonnes of litter annually. Street sweeping carries out an important role in collecting litter and leaf material before it reaches the stormwater system.

Another important role fulfilled by Council is regulating land use planning and development. This is an important function in relation to stormwater management as it affects the type, extent and control of land use activities within the catchment (see Section 3.1).

The Sydney Coastal Councils (1997) *Stormwater Management Policy and Guidelines* set out model policies for urban stormwater management, which can be adopted or modified and implemented by local government. It states: "strategic planning and management should form an integral component of a Council's stormwater management system to ensure effective focusing of available resources to reduce stormwater pollution and effectively manage their infrastructure".

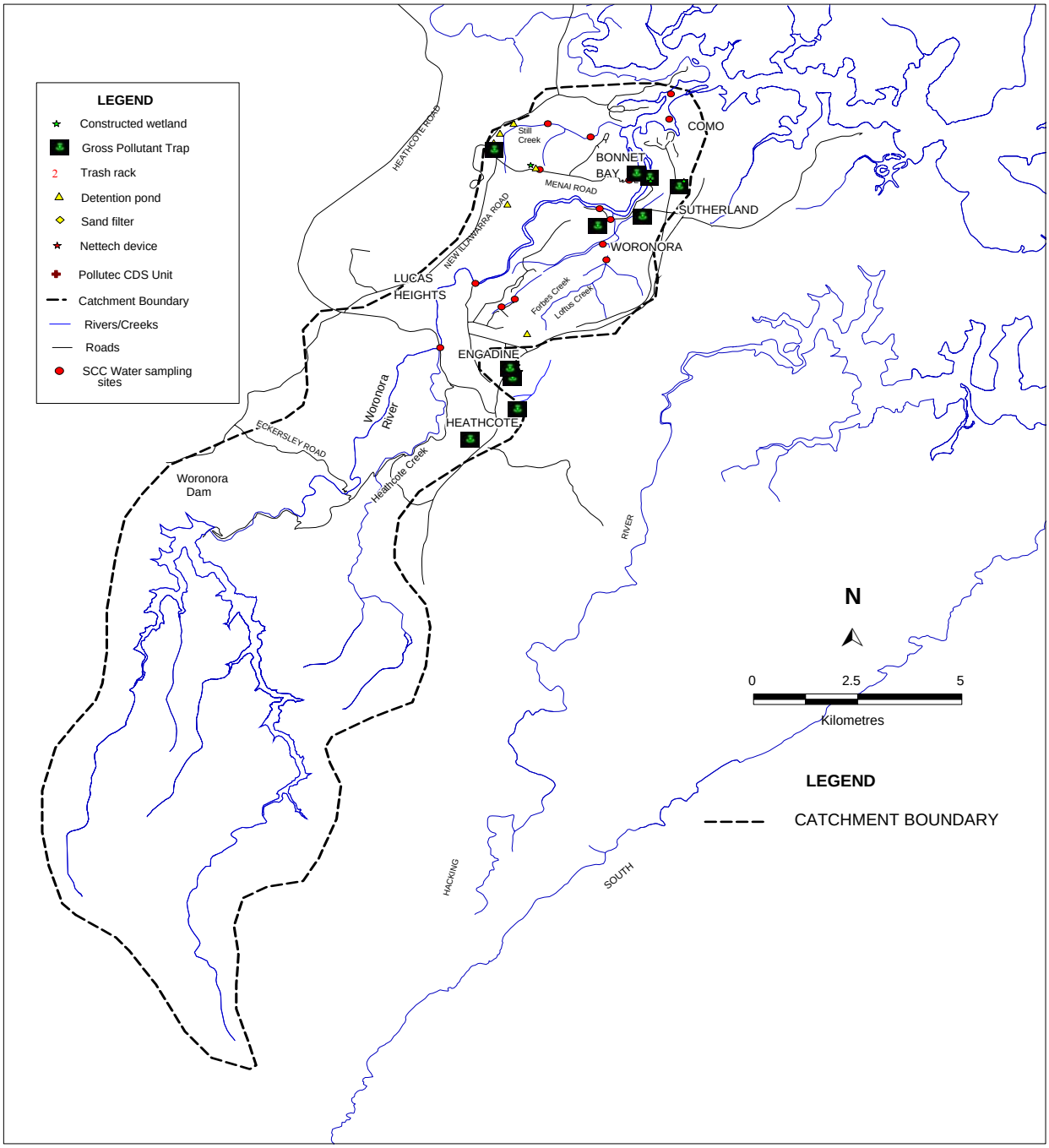
Other Authorities

Other authorities that have a role in stormwater management include:

- EPA policy co-ordination and regulation
- DLWC catchment planning
- CMCs catchment planning
- RTA management of RTA road runoff systems
- HIA land and housing development activities

This Stormwater Management Plan aims to outline specific control measures to address stormwater issues and impacts within the Woronora Catchment. This plan provides both short-term and long-term strategies and their responsible authorities for maintaining and/or improving stormwater quality based on catchment issues. The strategies provided incorporate a monitoring program and review phases to determine its effectiveness.

Figure 2. Existing pollution control devices in the Woronora catchment



3 Catchment Description

The Woronora River is the largest tributary of the Georges River, it originates as the Waratah Rivulet and flows from south to north with a catchment area of approximately 150 square kilometres. The main tributaries of the Woronora River are Heathcote Creek, Forbes Creek and Still Creek (see Figure 1).

The upper catchment has been dammed since 1942 and the dam controls approximately 45% of the total catchment hydrology. This dam supplies water to urban areas of Sutherland Shire and is operated by Sydney Water. From the dam in the south, the catchment is bounded to the west by the New Illawarra Road, Lucas Heights and Giles Junction. The catchment to the east of the river is generally bounded by the Illawarra railway line.

3.1 Land Use

Information about landuse activities within catchments is important for determining the potential sources and types of pollutants that may be entering the river system (refer to Table 3.1). The quality of stormwater within the Woronora catchment is predominantly defined by the quality of surface water runoff from the buildings, structures, pavement and ground surface within the catchment. On this basis, development, landuse and activities within a catchment area may be considered to be the predominant sources of potential contamination to stormwater.

A review of development plans for the Woronora Valley indicates that the area is made up of several types of landuse activities comprising Residential, Commercial/ Industrial, Special Use and Open Space.

The Woronora catchment is largely natural bushland to the south with urban settlement concentrated in the north. Most of the remaining natural bushland belongs to Heathcote National Park, east of the river. The other large portion of undeveloped land, west of the river, is Holsworthy.

Most residential development in the catchment is situated to the north, including the suburbs of Woronora, Sutherland, Menai, Lucas Heights, Engadine and Loftus. Distributed throughout the urban areas are pockets of commercial and light industry premises. The main centres for industrial activities in the catchment are located in Heathcote, Engadine and Menai.

Sydney Water Corporation (SWC) and NSW National Parks and Wildlife Service (NPWS) have named Woronora Storage Area as a Special Area. The Woronora system consists of the Woronora Dam and storage (Lake Woronora) which supplies water to five southern suburbs of Sydney.

Table 3.1: Types of pollutants related to landuse activities

Non-Point Sources	*Pollutants*
Urban runoff	Sediment, nutrients, organic material, litter, pesticides, herbicides, traces of fuels, oils and heavy metals.
Runoff from commercial areas	Litter, sediment, nutrients, fuels, oils and traces of heavy metals. Also potential for traces of pesticides.
Runoff from industrial areas	Grease, oils, heavy metals, nutrients, sediment, pesticides, herbicides, materials like paints, thinners, solvents.
Runoff from open space areas	Sediment, nutrients.
Rubbish dumping	Nutrients, pesticides, herbicides and sediment.
Swimming pools	Sediment, chlorine, copper sulphate and salt.
Building sites	Sediment, litter.

3.2 Topography

The typical landscape of the Woronora Valley is rolling to very steep Hawkesbury Sandstone slopes, ridges, and narrow incised valleys. Local relief is about 100-200 metres, with slope gradients of 20-70%. Crests and ridges are convex and narrow and less than 100 metres wide. Rock outcrops are common and occur as horizontal benches up to 10 metres in height (Hazelton and Tille, 1990).

3.3 Climate

The Woronora catchment is considered to have a warm temperate climate. However, temperature and precipitation levels vary significantly due to orographic effects and proximity to the coast. The upper catchment has an average of 1300 mm of rainfall per year, while the lower estuarine areas average 1000 mm per annum.

3.4 Geology and Soils

The soils are derived from the sandstone and shales of the Hawkesbury Sandstone, and Lucas Heights Groups. These soils tend to be shallow, discontinuous lithosols/siliceous sands associated with rock outcrops, earthy sands and locally deep sands on the inside of benches and along joints and fractures. The soils on the ridges are hard setting yellow podzolic soils and yellow soloths and earthy sands in valley flats. The erodibility and hard setting nature of the soil types on the catchment is an important consideration concerning the management of the area.

3.5 Natural Communities in the Catchment

Vegetation of the Woronora River catchment is typical of the Sydney Basin where sandstone occurs (Dames & Moore 1997a). Vegetation communities can be categorised into forest, woodland and heathlands, sedgelands (upland swamps) and riparian vegetation. These are only briefly described below as more detailed information is available in documents such as SSC's State of the Environment Reports.

Forests

The dominant tree species in the forested areas include the native species *Angophora costata, Eucalyptus gummifera, E. piperita,* and *E. sieberi.* Dominant medium trees include *Banksia serrata, Allocasuarina littoralis* and *Acacia irrorata*. These forests occur on the slopes of the larger valleys and gullies of the broader Woronora catchment. Small pockets of the Endangered Ecological Communities Sydney Turpentine Ironbark Forest and Shale/Sandstone Transition Forest on the ridgetops of Menai are all that remain of these endemic forests in the lower catchment.

Woodland and Heathlands

Species diversity is high within the woodland and heathlands areas. The woodlands contain *Angophora hispida, Eucalyptus gummifera, E. piperita, E. racemosa, E. oblonga* and *E. sieberi*. Heathlands and shrublands include *Banksia* spp., *Hakea* spp., and *Persoonia* spp.

Sedgelands

Rainfall is much higher in the southern catchment and consequently sedgelands or "upland swamps" are common (Dames & Moore 1997a). The dominant species are *Banksia oblongifolia*, *Banksia robur*, *Leptospermum juniperinum* and *Sprengelia incarnata*.

Riparian Habitat

The riparian zone along the Woronora River can be subdivided into several different environments, namely:

Alluvial Terrace

The alluvial terraces are located above the level of most of the smaller floods, but sand is deposited on the terraces during rare high floods (Dames & Moore 1997a). Vegetation on these terraces is similar to those on the upper slopes, but with more species such as sedges present. Common species include *Angophora costata*, *Eucalyptus piperita*, *Callitris rhomboidea, Acacia obtusifolia* and *Persoonia pinifolius*. In some areas along the lower Woronora River, lower Loftus Creek and Bonnet Bay there are patches of the listed Endangered Ecological Community Sydney Coastal River-flat Forest.

Dry Rock Surface

These surfaces are above the normal water table, but are located low enough to be swept by floods (Dames & Moore, 1997a). Along most of the river corridor dry rocks support heathland, with typical species such as *Epacris microphylla*, *Darwinia fascicularis*, *Leptospermum squarrosum* and *Grevillea oleoides*.

Wet Rock Surface

This environment occurs near the water table and is usually found in upland swamps in the upper catchment (Dames & Moore, 1997a). Typical vegetation includes *Restio complanatus, Epacris microphylla*, *Restio fastigiatus, Schoenus brevifolius* and *Callistemon citrinus*.

Boulder/Cobble Bar

These areas are covered by moderate to high floods and eroded and redeposited during high flood events (Dames & Moore, 1997a). The vegetation is characteristic of riparian zones and includes *Callistemon citrinus, Pseudanthus pimeleoides, Lomatia myricoides, Gleichenia dicarpa* and *Tristaniosis laurina.*

Pool

There are many pools in the Woronora River, some of which are quite extensive in length and depth. The vegetation in these pools is sparse, the main species being *Triglochin procerum* (Dames & Moore, 1997a).

Estuarine

Estuarine communities such as Mangrove swamps and salt marshes occur in areas above low tide that are subject to tidal influence. Mangroves (*Avicennia marina* and *Aegisceras corniculatum*) are the dominant canopy species for foreshore vegetation with salt marsh species occurring in patches where conditions suit. Estuarine vegetation communities play a vital role in the lower catchment's ecological functions by providing habitat, food, assisting in the recycling of nutrients and the prevention of erosion.

Fauna

Woronora's riparian and foreshore vegetation communities support fauna as diverse as its habitats with species ranging from mammals and amphibians to water fowl. There are a number of existing documents that detail the variety of species and their habitats in the catchment and that level of detail will not be covered here.

Mammals, such as the water rat, *Hydromys chrysogaster*, are likely to inhabit the lower reaches of the river, particularly below the tidal limit; while the Swamp Rat (*Rattus lutreolus*) is associated with the upland swamps (Dames & Moore, 1997a). Frogs and reptiles are abundant. Six species of frog were recorded during the Dames and Moore study (1997) and included the Common Eastern Froglet (*Crinia signifera*), various Tree Frogs (*Litoria dentata, L. freycineti, L. peronii, L. lesueurii*), Smooth Toadlet (*Uperolea laevigata*) and Bibron's Toadlet (*Pseudophryne bibroni*). Reptiles including

the Eastern Water Dragon (*Physignathus lesueurii*), Eastern Water Skink (*Eulamprus quoyii*) and the Long Necked Tortoise (*Chelodina longicollis*) are known to inhabit the river environment (Dames & Moore, 1997a).

A variety of bird species are found to inhabit riparian vegetation through the Woronora River valley. Species include the Azure Kingfisher (*Alcedo azurea*), Whiter-faced Heron (*Egretta novaehollandiae*), Pacific Black Duck (*Anas superciliosa*) and the Australian Wood Duck (*Chenonetta jubata*). Diving bird species predominantly associated Woronora Dam include Cormorants and Grebes (Dames & Moore, 1997a).

4 Existing Catchment Conditions

4.1 Hydrology

The major river system within the catchment is the Woronora River. Since the construction of the Woronora Dam in the 1920's, the river's flow regime has been altered. One of the major impacts of this is that small and medium flood events are trapped by the dam and do not reach the river downstream of the dam wall.

The three major sources of flow in the river are:

- leakage from under the dam;
- spillway flows during floods; and
- natural runoff during/after rainfall events.

Monitoring (refer to Dames and Moore, 1997) indicates that runoff ceases within one to two week after significant rainfall events.

Below the dam, the hydraulic characteristics of the river are dominated by pool/riffle sequences. The riffle structures regulate the hydraulic flow characteristics with the pools acting as storage within the system. (Dames and Moore, 1997)

4.2 Fluvial Geomorphology

The Woronora River exhibits the following geomorphic characteristics (Dames & Moore, 1997a) downstream of the dam:

- steep V-shaped valley walls and broad, relatively flat ridges between adjacent creeks;
- series of pools along the creek bed, with their hydraulic control structures usually being boulder riffles or occasionally bedrock shelves;
- cascading waterfalls caused by bedrock shelf hydraulic control structures and pools deeper than 2.5 metres (plunge pools);
- frequent deposits of sand on the banks of the stream, occasionally forming short natural levees in broader valleys;
- point bar terraces on the inside of bends formed from sand and small size colluvial deposits;
- cliffs on the outside of bends; and
- vegetated boulder terraces or bars around the mouths of larger tributaries.

The Woronora River meanders through the valley, narrowing upstream.

4.3 Water Quality

The Woronora River extends from its confluence with the Georges River at Como to its headwaters near Darkes Forest. Along its length, the river passes through several different types of aquatic environments, namely:

- tidal - from the Georges River to the causeway at North Engadine, the river is tidal with generally decreasing salinity upstream;
- freshwater - from the causeway, the river is fresh, passing through a series of weirs up to Woronora Dam; and
- impounded - upstream from the dam wall, the river is impounded forming a large lake that is used as the water supply for many of Sydney's southern suburbs.

Tidal processes at the entrance to Botany Bay drive the lower Woronora waters. As such, flushing times are governed by these ocean influences and can vary from less than one to five days at the entrance to more than 60 days at the upper limits (Sydney Water, 1997).

To ascertain the quality of water in the marine and freshwater ecosystems there are specific parameters that need to be assessed. The Australian Water Quality Guidelines for the Protection of Marine and Fresh waters (ANZECC, 1992) recommends upper limits for these parameters. To date, water quality standards for stormwater/urban runoff have not been established. The ANZECC Guidelines have been designed for receiving waters however, they are generally used as a standard by which the quality of waters can be measured.

4.3.1 Ambient Water Quality

Woronora River is most affected by stormwater runoff from Woronora Dam to its confluence with the Georges River. Many studies have been carried out on the Woronora River upstream of the dam and as such are not relevant to this study. Water quality data collected downstream of Woronora Dam generally form part of studies conducted on the Georges River and its inflows.

Sydney Water undertook a baseline study on the Woronora River during monthly sampling between July 1995 to April 1996, to establish the existing water quality. The study area extended from the dam wall to The Needles, incorporating a total of eight sites. The study determined that water quality for the Woronora River during summer low flow conditions indicated the following (Dames & Moore, 1997b):

- water temperature - increased with distance downstream, 18.2 to 24.6 degrees;
- pH - ranges were within the ANZECC (1992) guideline values;
- conductivity – ranged from 90µS/cm to 200µS/cm, well within the ANZECC (1992) guideline values;

- dissolved oxygen - levels were lower than the ANZECC (1992) guidelines, near the dam wall and the spillway. The remaining sites were above the ANZECC guidelines;
- phosphorus levels were within the ANZECC guidelines and ranged from 0.01 to 0.14mg/L (with the exception of one sample);
- total nitrogen - levels met the ANZECC standards for most of the sites along the Woronora River;
- turbidity – values ranged from 0.2 mg/L to 14 mg/L, the higher concentrations occurring during wet weather events; and
- mineral levels - aluminium (Al) and iron (Fe) met the guidelines, cadmium (Cd) results were variable, ranging from 0.4μg/L to 3μg/L and copper (Cu) was within the guideline limits stipulated by ANZECC.

Another study, commissioned by Sydney Water Corporation, compared water quality in the freshwater section of Woronora River to that of creeks with similar geomorphology but not impacted by an impoundment. This study determined the following (Dames & Moore, 1997a):

- water temperature - varied from 20.3 to 24.6, which were comparable with the reference streams;
- pH – all sites were within the ANZECC guidelines;
- dissolved oxygen – were generally lower in the Woronora River, however DO varies with both temperature and salinity;
- nutrients - total and oxidised nitrogen levels were much higher in Woronora River than the reference creeks, although no explanation was offered. Average phosphorus levels were within the ANZECC guidelines at all sample sites;
- turbidity – levels were generally low at all sites sampled in the Woronora River and were comparable with the reference streams; and
- minerals - aluminium (Al), iron (Fe) and manganese (Mn) met the guidelines, the exception being Mn levels at the dam wall, for the Woronora River. The reference streams tended to record slightly higher concentrations.

The results from these pilot studies indicated that the ambient water quality in the Woronora River is generally good for a partly urbanised river system.

4.3.2 Water Quality Monitoring

A number of monitoring studies have been undertaken on various sections of the Woronora River. These studies have varied in their purpose, but can be divided into two general areas:

- catchment based water quality monitoring; and
- receiving water quality monitoring.

The two monitoring regimes differ in that catchment based monitoring compares water quality across catchments. Catchment monitoring tends to focus on “hotspots” such as industrial and farming areas. In comparison

receiving waters based monitoring compares water quality up and downstream of an inflow, such as a stormwater discharge, to assess the impact of that inflow on the receiving waters.

Therefore, in order to ascertain whether the whole catchment is being assessed sufficiently, it is imperative to assess the water quality data under the context to which they were collected.

Sutherland Shire Council and Sydney Water have both undertaken water quality programs within the Woronora River Catchment. These monitoring programs are presented below in chronological order.

1992 Sydney Water - Pilot Studies

A series of pilot studies carried out by Sydney Water Corporation during 1992 included measurement of bacteria and physical parameters from two locations in the lower Woronora River estuary during wet and dry weather conditions. During dry weather, the Woronora River estuary was found to have generally low faecal coliform densities with mean densities never exceeding 200 cfu/100mL. The wet weather intensive sampling program identified that Woronora River was comparatively clean during wet weather with faecal coliform densities not exceeding 400 cfu/100mL during the study (Scammell, 1994).

1993-1994 Sydney Water – Faecal coliform Monitoring Program (Georges River and Botany Bay)

The faecal coliform monitoring program followed on from the pilot studies. The monitoring program ran from February 1993 to March 1994 and during this period, mean faecal coliform densities exceeded 200 cfu/100mL on only two sampling days, both of which occurred during rainfall (Kirby *et al*, 1995). An analysis of the faecal coliform data showed that 95% of all samples collected on days when there had been greater than 10 mm rainfall had faecal coliform densities below 130 cfu/100mL. Consequently, due to the relatively clean nature of the river, monitoring of the lower estuary of the Woronora River by Sydney Water Corporation was discontinued.

1993-1996 Sydney Water – Stormwater Monitoring Program

Sydney Water Corporation's stormwater monitoring program included a site on the Woronora River at The Needles. In this study, dry weather routine data and storm event based water quality data were collected through a series of wet weather events over the period 1993 to 1996. Bacteriological, nutrient and suspended solids data were collected as well as continuous flow measurement. The study showed that the bulk of the pollutant load was discharged to the estuary during wet weather conditions. In comparison to other major inputs into the Georges River catchment, including Salt Pan Creek, Cabramatta Creek and freshwater Georges River, Woronora River discharged the lowest level of pollutants.

1994 – 1999 Sutherland Shire Council - Strategic Water Quality Monitoring Program

Sutherland Shire Council initiated their Strategic Water Quality Monitoring Program in December 1994, in response to community concerns over water quality. The program monitors pollutant trends from catchments across the Shire on a biannual basis, in summer and winter. Sites within the sub-catchments have been selected in order to detect any trends in water quality reflecting land use.

The monitoring program is ongoing and is modified according to additional information and updated results (see Table 4.1 and Figure 3 for sites). For example, extra sites have been included since winter 1997 and wet weather sampling has been instigated.

Table 4.1: Sutherland Shire Council SWAMP Monitoring Sites for the Woronora River

SITE	MAJOR LANDUSE
Forbes Creek (North Engadine)	Residential
Woronora River above Heathcote Creek	Heathcote National Park
Heathcote Creek	residential landfill (not sampled in 1997)
Menai Road GPT inflow/outflow	residential/commercial
The Crescent (Woronora)	Woronora Heights
Forbes Creek (Woronora)	residential
Still Creek detention basin inflow/outflow	Developing residential/commercial

The monitoring program has identified that faecal pollution is still the major contributor to poor water quality. The faecal pollution can be attributed to a number of possible sources such as, sewer inflows, leaks into the stormwater system, illegal or faulty sewer connections and runoff contaminated by animal faeces (SSC, 1997).

High levels were also associated with zinc (Zn), lead (Pb) and Biological Oxygen Demand (BOD). The likely sources of zinc and lead are roads and the associated traffic. Airborne particulates from exhaust emissions settle and are washed off in stormwater runoff. High BOD levels indicate depleted oxygen concentrations due to polluted waters, which will have a detrimental influence on the aquatic ecology in those areas.

Summary

Sewage and stormwater pollution (such as litter, sediment and motor vehicle pollution) levels vary throughout the catchment. Urban areas contribute polluted stormwater generally across the developed portions of the catchment. Point sources of pollution are associated with particular land use activities such as retail and automotive/industrial centres. Sewage overflows are a contributor to stormwater pollution, although it is difficult to identify non-design sewage overflow points. Sydney Water's Sewage Overflow Reduction strategies are progressively addressing this issue.

The 1997 monitoring program undertaken by Sutherland Shire Council, indicates that 50 percent of the sampling sites had one or more parameters exceeding the ANZECC guidelines. However, the sampling sites are predominantly stormwater channels and inflow/outflow from pollution control devices. As such, these results are not wholly unexpected.

In comparison, the Sydney Water sampling regimes indicated that during both dry and wet weather flow conditions, Woronora River tributaries contribute relatively low volumes of pollutants to the river. Water quality results obtained in the estuary and freshwater section of the river suggest that these contributions do not have a substantial impact on water quality. The greatest inflow of pollutants in the lower Woronora is as a result of the tidal influence that mixes in the water of the Georges River, which is of poor quality.

Water quality in the river from the dam to the confluence of Heathcote Creek is considered to be good. From Heathcote Creek down to the estuary, water quality is generally good however becomes poor after wet weather events due to the extent of development in the lower catchment.

4.4 Aquatic Habitat

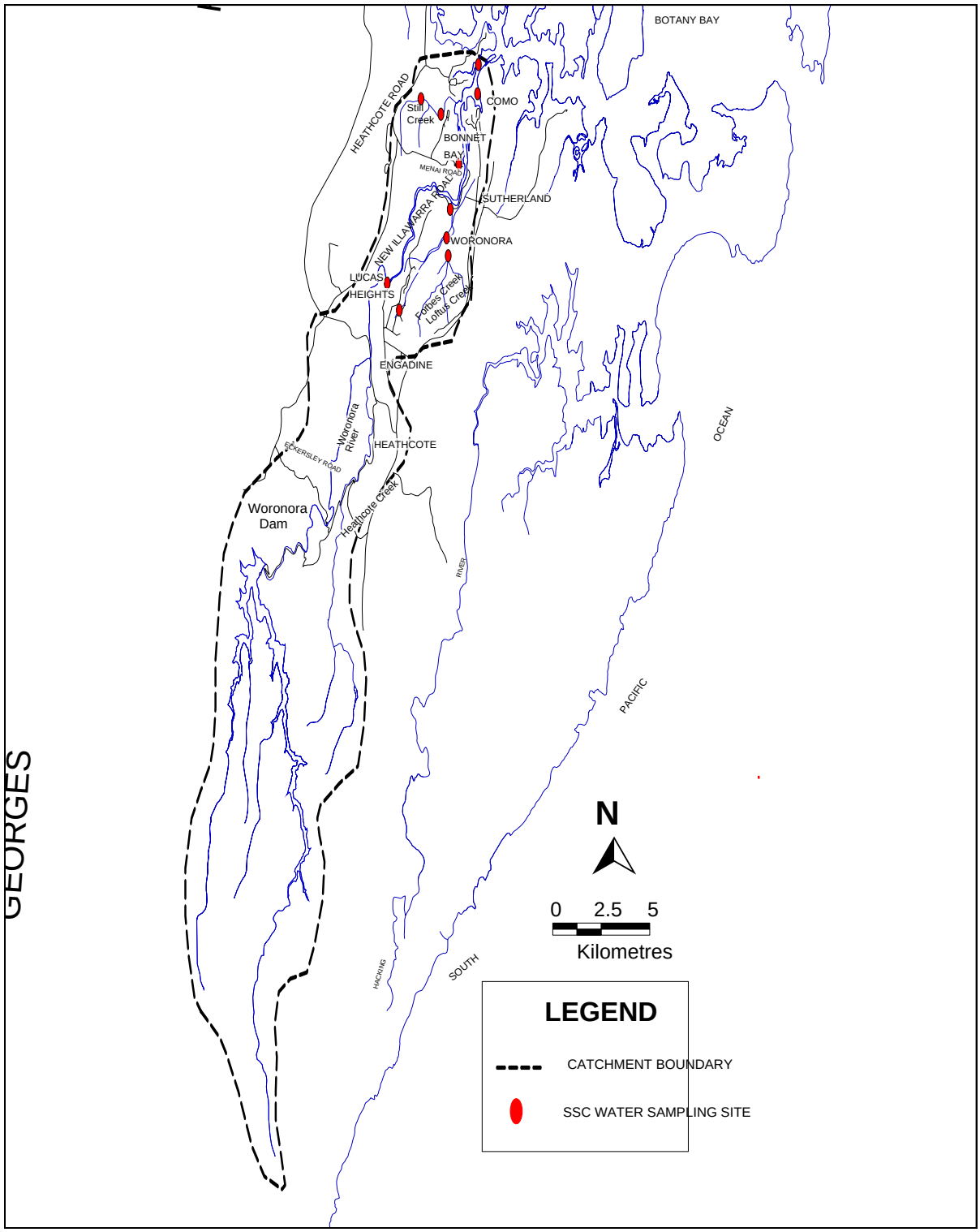
The state of the catchment can be measured by the health of its riparian and aquatic ecological communities as well as water quality. The Woronora catchment includes a broad range of aquatic habitats ranging from rock pools and leaf-litter habitats to estuarine wetlands, saltmarshes, mangroves and upland swamps.

The silt/clay sediments, which occur along the lower reaches of the Woronora River, support estuarine wetlands. The Grey mangrove (*Avicennia marina)* and the river mangrove (*Aegisceras corniculatum)* dominate the intertidal area. Saltmarsh occurs on the landward side of the mangroves.

A biological study commissioned by Sydney Water Corporation to assess intertidal communities in the lower Woronora River found that the communities were sparse by comparison to high salinity locations. This would appear to be a natural consequence of the salinity regime of the area. The community that was present was not indicative of anthropogenic disturbance (AWT EnSight 1995a). Another study found that, in terms of fish biodiversity, the Woronora River compares favourably with its tributary creeks (Dames and Moore 1997a).

Algae identified in the Woronora River are those usually associated with low flow conditions and unpolluted waters such as *Golenkinia* and *Spirogyra* (Dames & Moore, 1997a).

Figure 3. Location of SSC water quality monitoring sites in the Woronora catchment (approximate).


BOTANY BAY
HEATHCOTE ROAD
Still Creek
COMO
BONNET BAY
MENAI ROAD
NEW ILLAWARRA ROAD
SUTHERLAND
WORONORA
LUCAS HEIGHTS
Forbes Creek
Loftus Creek
ENGADINE
Woronora River
HEATHCOTE
SCHERSLEY ROAD
Woronora Dam
Heathcote Creek
RIVER
OCEAN
PACIFIC
SOUTH
HACKING
GEORGES
N
0 2.5 5
Kilometres
LEGEND
CATCHMENT BOUNDARY
SSC WATER SAMPLING SITE

4.5 Urban Bushland

The natural ecosystems of the catchment remain continually under threat from urban expansion, the effects of stormwater runoff and competition from weed species. Outside of Heathcote National Park, the extent of urban bushland varies from forest remnants and council reserves to individual plantings. The broad level mapping that is available of vegetation in the catchment has been based on land use and landform information with little detail available on the condition of urban bushland.

While there is no specific information on the health of urban bushland, it is known that the introduction of urban runoff into natural ecosystems changes conditions for the biotic environment through:

- increased occurrence of erosion;
- increases in soil moisture levels;
- decreases in soil temperature;
- changes to soil aeration;
- increases in the levels of nutrients;
- changes to soil pH; which lead to
- changes to soil micro-organism and invertebrate communities.

These changes can be observed through the invasion and spread of weeds through remnant bushland pockets which changes the composition of the natural community. This makes it increasingly difficult for endemic communities to persist even though these remnant vegetation pockets are being protected from clearing and development. Urban stormwater runoff is recognised as being one of the major contributors to the degradation of bushland areas.

In the Woronora catchment, there are also a number of Threatened species and ecological communities that depend on these few declining undeveloped remnants for survival. Stormwater water activities must be considered within the context of the whole catchment and their potential impact on natural communities as well as the urban communities.

5 Catchment Values

An assessment of catchment values is an essential part of the stormwater management process. Catchment values, once established, help determine stormwater objectives and priorities. In general, values are not quantitative but qualitative and are derived from the community consultation process.

5.1 Consultation Process

Catchment values, issues and potential strategies for the Woronora River were identified through consultation with the community, Council and other stakeholders. Briefing papers were mailed out to the community and stakeholders to inform them about the stormwater plan process and to invite their participation.

Previous studies and community surveys, including *Shaping the Shire 1998-1999* (Sutherland Council) and the EPA's *Interim Environmental Objectives for NSW Waters* (community workshops for Hacking and Georges River), were also reviewed.

A series of workshops were held in Sutherland to facilitate community involvement in the process. At each workshop participants were asked to individually write down responses to the questions:

> *'Do you have any concerns with the quality of stormwater within your catchment?*
>
> *If so, what are your particular concerns?'*

The attendees were then divided into small groups to share and discuss their issues. After each group had discussed issues relevant to their area, they were then asked, within their groups, to determine what they thought were the major two or three priorities that were of most importance to the health of the catchment. In addition, a series of interviews were conducted with key industry stakeholders. A summary of the responses is presented in Appendix 1.

5.2 Values for the Woronora River Catchment

Related studies and community surveys reveal that environmental issues are a main area of concern for the community. The community recognises the different roles of the catchment and its waterways with the result that the key values have been separated into social, ecological and economic.

Social

- protect remaining natural areas;
- visual amenity;
- level of water quality to encourage swimming, fishing and boating;

- passive recreation; and
- preservation of catchment's valuable qualities for future generations.

Ecological

- water clarity and quality;
- retain and restore remnant riparian and catchment bushland;
- healthy aquatic ecosystem; and
- biodiversity within terrestrial and aquatic ecosystems.

Economic

- revival of oyster industry; and
- better valuation of natural bushland areas.

The community prioritised ecological and recreational values for their catchment.

6 Stormwater Management Objectives

6.1 Ecologically Sustainable Development

Stormwater management in the Woronora River catchment is to be based on ecologically sustainable development (ESD) principles (EPA, 1997). The decisions we make about community resources need to put in the context of the sustainable limits of our ecological resources.

The Australian goal for ESD is defined as "development that improves the quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (National Strategy for ESD, 1992).

Strategies for implementing changes to improve the quality of our environment require the effective integration of economic and environmental considerations. ESD is achieved through the implementation of the following principles and programs:

a) *Precautionary Principle* – is defined as "if there are any threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation" (*Protection of the Environment Administration Act 1991* and *Environmental Planning and Assessment Regulation 1994).*

b) *Intergenerational and Intragenerational Equity* – this requires that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations" (*Protection of the Environment Administration Act 1991* and *Environmental Planning and Assessment Regulation 1994).*

c) *Conservation of Biological Diversity and Ecological Integrity* - this principle requires the diversity of genes, species, populations and their communities, as well as the ecosystems and habitats they belong to, being maintained or improved to ensure their survival.

d) *Improved Valuation and Pricing of Environmental Resources* - this principle involves placing a monetary or social value on the environment, which ultimately increases its value. As such, pollution and/or future exploitation can be controlled under the 'polluter pays' principle, whereby polluters or those who destroy the environment are responsible and accountable for restoring it to its previous natural condition.

6.2 Management Objectives

Management objectives have been developed to protect the catchment values prioritised by the community and stormwater managers (as described in Section 5). These include both long-term objectives for the catchment and short-term objectives that help form the basis of actions to be incorporated into this Plan (EPA, 1997). The short-term management objectives provide goals that are linked to the longer term aims for the catchment. The identified management objectives are summarised in Table 6.1.

Table 6.1: Managerment Objectives determined through consultation process

Values	Long Term Objectives	Short Term Objectives
ECOLOGICAL	• improvement and maintenance of water quality (ambient water quality criteria) for the protection of aquatic and riparian ecosystems.	• maintain training of Council employees on Best Management Practices and introduce auditing of council practices in relation to stormwater management.
	• level of water quality in the catchment to meet the ANZECC Guidelines for primary contact for at least 80% of the time (except after periods of heavy rainfall).	• effective placement of water pollution control structures with the capacity for removal of sediment, nutrients, weed seed and other pollutants.
	• flows within the catchment to meet river flow objectives recommended by the Healthy Rivers Commission investigation results.	• improve management of existing water pollution control structures in the catchment.
	• long-term and comprehensive water quality and biological monitoring program in place that accurately indicates the health of the waterways.	• develop ecological and biological parameters to be measured as part of water quality monitoring
	• the contribution of stormwater on weed propagation should be minimised.	• control weed infestation along Woronora River and its tributaries.
	• minimise the impact of new urban developments on the stormwater system.	• level of water quality in the catchment to meet the ANZECC Guidelines for protection of aquatic ecosystems for 100% of the time.
	• to have a baseline of water quality, hydrological and ecological information to assist management and decisions for the catchment.	• further identify existing and potential pollution sources and problem areas.
	• minimise the amount of pollutant material entering the waterways.	• additional resources to Council to implement and enforce existing water quality protection policies and requirements (ie. building sites, new development).
	• eliminate sewer overflows and connections from entering waterways.	• stormwater/ polluted runoff is to be controlled at its source

SOCIAL	• to have effective and dynamic planning and management of stormwater quality issues in the catchment.	• improve the coordination of stormwater management in the catchment between Council and the other stakeholders.
	• effective community awareness and education programs to be implemented.	• effective community awareness and education programs to be implemented.
	• protection and rehabilitation of riparian and foreshore vegetation.	• audit of local commercial and industrial premises for water/stormwater management and associated activities.
	• integrate planning policies with stormwater and catchment management objectives. Policy of "no extra harm – net positive impact" in approving development.	• effective use of planning requirements to incorporate stormwater controls
	• the impact of stormwater on public health, safety and amenity should be minimised.	level of water quality to meet ANZECC guidelines for the protection of secondary contact recreation for at least 85% of the time.
ECONOMIC	• integrate reuse schemes into urban areas of the catchment as part of long-term management approach.	• introduce and encourage feasible stormwater on-site detention and/or reuse schemes.
	• meet a level of water quality in the lower Woronora that will meet the standard required by local aquaculture activities such as oyster farming.	• increase public awareness of economic benefits of increased catchment water quality as well as ecological and social goals.

6.3 Stormwater Management Objectives for Existing and Proposed Developments

Development and construction activities in the catchment are a major issue for stormwater management and protecting receiving water quality. The construction of new developments contributes sediment runoff from sites, litter, other pollutants (ie. fuel, oil) and increased flows to receiving waters. Specific pollutant objectives for existing and new developments have been set to assist in establishing stormwater outcomes and to minimise the impact of developments on catchment's waterways. The objectives in Table 6.3 have have been developed in line with other relevant management plans and planning controls and in consideration of the likely significance of pollutants presented in Table 6.2.

Table 6.2: Ranking of Objectives for Existing and New Developments*

Development Style		**Litter**	**Coarse Sediment**	**Fine Sediment**	**Total Phosphorus**	**Total Nitrogen**	**Faecal Bacteria**	**Hydrocarbons,** (rubber, fuels, oil & grease)
Low Density Residential	- existing	Y	N	N	Y	Y	Y	N
	- new	Y	Y	Y	Y	Y	Y	N
High Density Residential	- existing	Y	N	N	Y	Y	Y	?
	- new	Y	Y	Y	Y	Y	Y	?
Commercial & retail	- existing	Y	Y	Y	N	N	Y	Y
	- new	Y	Y	Y	N	N	Y	Y
Industrial	- existing	Y	Y	Y	?	?	?	Y
	- new	Y	Y	Y	?	?	?	Y
Fast Food Outlets & Restaurants	- existing	Y	N	N	N	N	Y	?
	- new	Y	N	N	N	N	Y	?
Carparks, Service Stations & Wash Bays	- existing	Y	Y	Y	N	?	N	Y
	- new	Y	Y	Y	N	N	Y	?

Adapted from the Upper Parramatta River Stormwater Management Plan, 1999

* Where "New Development" considerations include the construction phase
Y = key pollutant which needs to be addressed

? = variable pollutant which requires site specific assessment
N = not significant

Table 6.3: Stormwater Management Objectives

Pollutant	Objective
Existing Developments	
Suspended solids (i.e sediment)	Minimise soil erosion and the discharge of sediment by appropriate maintenance of erosion and sediment control measures including; maintenance of adequate ground cover on private and public areas, cleaning of sediment traps, remediation of erosion, education in the application of top dressing and turfing.
Nutrients and bacteria	Education and awareness of residents and relevant agencies, to be such that they employ best practice in applying fertilizers, location and management of compost, disposal of animal faeces, etc. with the target that nutrient and faecal bacteria levels of local surface drainage meet ANZECC guidelines for aquatic ecosystems as much as possible.
Motor fuels, oils and other chemicals	No export of fuels, oils or other chemicals from the site which ensures no contamination of waterways.
Litter	No litter is to placed where it can be washed or blown into waterways.
New Developments –Construction Phase	
Quantitative Objectives – applicable to subdivisions and all medium-large scale developments	
Suspended solids	For dispersible (Type D) and fine (Type F) soil types, suspended solids concentrations are not to exceed 50 mg/l for all 5-day rainfall totals up the the 75th percentile rainfall event. For coarse (Type C) soils, suspended solids concentrations are not to exceed 50 mg/l for all flow events up 25% of the 1 year ARI flow.
Nutrients	Nutrients loads in surface runoff to meet ANZECC guidelines for aquatic ecosystems.
Motor fuels, oils and other chemicals	No export of fuels, oils or other chemicals from the site which ensures no contamination of waterways.
Litter	No litter is to placed where it can be washed or blown into waterways.
Qualitative Objectives – applicable to all new developments, including individual building lots	
Suspended solids	Minimise soil erosion and the discharge of sediment by appropriate design, construction and maintenance of erosion and sediment control measures. Employ all practical measures to minimise soil erosion and the discharge of sediment in storm events, exceeding the design storms specified under 'Quantitative Objectives'.
Nutrients	Developers/builders to employ best practice in landscape design and garden establishment, with the target that nutrient levels of local surface drainage meet ANZECC guidelines for aquatic ecosystems as much as possible.
Motor fuels, oils and other	No export of fuels, oils or other chemicals from the site which ensures no

chemicals	contamination of waterways.
Litter	No litter is to placed where it can be washed or blown into waterways.
New Developments – Post Construction	
Suspended solids	80% of suspended solids average annual load is to be retained from leaving site for particles 0.5 mm or less. 50% of suspended solids average annual load is to be retained from leaving site for particles 0.1 mm or less.
Nutrients P & N	Every attempt should be made to maximise the performance of the design, by maintaining the installed stormwater systems on site so that nutrients concentrations meet ANZECC guidelines for aquatic ecosystems. In any case, 45% of the average annual load is to be retained
Faecal bacteria	50% of average annual pollutant load
Motor fuels, oils and other chemicals	No export of fuels, oils or other chemicals from the site which ensures no contamination of waterways.
Litter	70% of average annual litter load for material greater than 5 mm.
Hydrocarbons	90% of average annual pollutant load

In recognition that the retention of pollutants in only part of the necessary strategy for stormwater management, the Councils recognise that there area number of other non-quantifiable objectives, in addition to the above water quality focused objectives. These additional qualitative objectives are presented in Table 6.4.

Table 6.4: Qualitative Post-Construction Phase Stormwater Management Objectives for New Development (applicable to all development)

Pollutant/Issue	**Management Objective**
Runoff volumes and flow rates Stormwater quality**	Impervious areas connected to the stormwater system are to be minimised Reuse of stormwater for non-potable purposes maximised Use of vegetated flow paths e maximised Use of stormwater infiltration ‘at source’ where appropriate
Riparian Vegetation and Aquatic Habitat	Protect and maintain natural wetlands, watercourses and riparian corridors All natural (or unmodified) drainage channels within the site which possess either: (a) baseflow (b) defined bed and/or banks; or (c) riparian vegetation are to be protected and maintained. “Natural “ channel designs* should be adopted in lieu of floodways in areas where there is no natural (or unmodified) channel

Flow	Alterations to natural flow paths, discharge points and runoff volumes from the sites are to be minimised. The frequency of bank-full flows should not increase as a result of development. Generally, no increase in the 1.5 year and 100 year peak flows.
Amenity	Multiple use of stormwater facilities to the degree compatible with other management objectives.
Urban Bushland	Impact of stormwater discharges on urban bushland areas minimised.

* "Natural channel designs" involves the creation of channels with attributes of natural channels, including a meandering plan, riffle zones, use of natural materials and riparian/floodplain vegetation

** Stormwater quality benefits of "*Water Sensitive Urban Design*" principles may contribute to the achievement of the above pollutant retention criteria

7 Stormwater Management Issues

In order to formulate and direct strategies to improve water quality, the factors that currently prevent, or have the potential to prevent, objectives from being met must be identified.

The issues of concern for the Woronora catchment have been determined through consultation with community and Council, and through the review of existing information from reports, studies and monitoring programs. The issues raised encompass a range of aspects including bio-physical, social, planning and managerial impediments.

Table 7.1: Summary Results of Consultation

SHORT TERM OBJECTIVE	ISSUE	POTENTIAL CAUSES
Management Issues		
• improve the coordination of stormwater management in the catchment between Council and the other stakeholders.	Lack of communication and co-ordination between management agencies	• piecemeal approach to catchment management, stormwater management; fragmentation of responsibility in legislation. • no single authority responsible for co-ordinating stormwater management activities in the catchment.
	Lack of integration and information sharing between authorities	• poor communication between authorities • lack of catchment based delegation of management responsibilities.
	Lack of commitment from the community and Council to implement necessary changes	• lack of community ownership on water quality problems. • lack of directions/strategies to improve water quality.
• audit of local commercial and industrial premises for water/stormwater management and associated activities.	Lack of monitoring/auditing of building site compliance	• insufficient allocation of resources. • lack of regulatory powers to enforce
• additional resources to Council to implement and enforce existing water quality protection policies and requirements (ie. building sites, new development).	Lack of understanding from developers/builders of details in conditions of consent	• lack of clarity or explanation of conditions of consent
• improve management of existing water pollution control structures in the catchment.	Lack of maintenance of pollution control structures: racks, pits etc	• inadequate resources.

• introduce and encourage feasible stormwater on-site detention and/or reuse schemes.	Volume and quality of stormwater	• not enough on-site detention and treatment of runoff before it reaches receiving waters.
	Reuse of stormwater	• incorporating reuse into existing/proposed stormwater systems is regarded as expensive, complicated or ineffective.
• further identify existing and potential pollution sources and problem areas.	Lack of knowledge on the pollution contributions from various parts of the catchment	• no identification of data gaps to assist monitoring, studies. • no overall plan to direct water quality improvement strategies.
• maintain training of Council employees on Best Management Practices and introduce auditing of council practices in relation to stormwater management.	Lack of awareness of Best Management Practices (BMP) of Council staff, building and construction workers, shopping centres etc throughout the catchment	• lack of education and training for Council staff on recent changes and updates of BMP; and • lack of education and training in BMPs for building and construction industry workers and other such retail/commercial industries in the catchment; and • lack of auditing of the above mentioned industries to enforce the adoption of BMPS
Social Issues		
• improve the coordination of stormwater management in the catchment between Council and the other stakeholders.	Rhetoric hasn't historically matched action	• lack of coordinated approach • no catchment based solutions
• effective community awareness and education programs to be implemented.	Lack of community interest	• easier to blame government agencies than do something yourself. There is an attitude that "someone else will fix it".
Planning Issues		
• effective use of planning requirements to incorporate stormwater controls • improve the coordination of stormwater management in the catchment between Council and the other stakeholders.	Lack of integration of Master and Control Plans Reduction of public access	• piecemeal approach to catchment management, stormwater management. • historical lack of planning development around riparian and foreshore areas. • road and houses built too close to watercourses.
• undertake a Pollution Source Inventory and Catchment Processes Study to further identify existing and potential pollution sources and problem areas.	Inappropriate development	• lack of understanding of geological/environmental constraints to some development.
• additional resources to Council to implement and enforce existing	Lack of effective planning and controls on development	• little emphasis on implementing environmental controls through planning in the past.

water quality protection policies and requirements (ie. building sites, new development).		• lack of commitment from Council and other management authorities to introduce and enforce "hard" changes. • planning doesn't adhere to natural constraints and catchment impacts.
Bio-physical Issues		
• effective community awareness and education programs to be implemented.	Health risks from poor water quality (ie. restricting swimming activities)	• faecal bacteria pollution entering waterways, sources: domestic animals, sewer overflows.
• effective placement of water pollution control structures with the capacity for removal of sediment, nutrients, weed seed and other pollutants.	Pollutants from road runoff, ie. sediment, grease, oil.	• Ineffectiveness of existing structural controls. • no identification of best placement for source control system throughout catchment. • lack of land space to accommodate suitably sized structural controls to contain and treat runoff from large, urbanised sub-catchments.
	Sedimentation in runoff and waterways	• lack of sediment controls to reduce erosion from construction sites. • sediment from industrial and commercial centres. • sediment from roads and other impervious areas.
• effective community awareness and education programs to be implemented.	Litter in watercourses	• poor public awareness of litter contribution to waterway problems. • lack of community ownership and responsibility towards local waterway.
• level of water quality to meet ANZECC guidelines for the protection of secondary contact recreation for at least 85% of the time.	High levels of nutrients	• sewer overflows • high nutrient runoff from developed areas (fertilisers, plant material, etc.)
• effective use of planning requirements to incorporate stormwater controls	Increased volumes of stormwater flow	• Increasing spread of impervious surfaces through development of the catchment • Artificial and concrete lined channels as a result of previous flood/drainage management approaches. • Narrowing of channels choked with weed plants or litter.
• level of water quality in the catchment to meet the ANZECC Guidelines for protection of aquatic ecosystems for 100% of the time.	Degraded aquatic ecosystems	• effects of introduced species on aquatic flora and fauna. • decline in environmental water quality. • altered hydrological regime. • destruction and degradation of wetlands/riparian areas. • degradation and sedimentation of natural waterways.
• control weed infestation along Woronora River and its tributaries.	Decline of riparian ecological communities	• clearing of vegetation along waterways. • degradation of natural communities by weed invasion and litter. • reclamation along foreshores, waterways.

7.1 Hotspots

In addition to examining existing data, pollution hotspots were identified through consultation with the Steering Committee, the community and other stakeholders. These are identified in Table 7.2. During the preparation of this plan, these issues were investigated to determine their degree of significance in terms contribution to water pollution. These investigations, in combination with the information gained through consultation, have formed the basis upon which the management options have been developed.

Table 7.2: Problem areas noted from consultation sessions

HOTSPOT	PROBLEM
Point Sources	
Still Creek	Sediment
Walkers Quarry, Still Creek	Sediment
The Crescent	Sediment from Woronora Heights.
Railway line	Litter, oil and grease, herbicide use, weeds.
Woronora Cemetery	Cellophane flower wrapping, rubbish and sediment.
Playing fields at Bangor, Yarrawarrah, Woronora Heights, Sutherland and Bonnet Bay	Sediment, nutrients and litter.
Sydney Water reservoirs at Sutherland	Maintenance cleaning and sludge removal.
Woronora Filtration Plant	Data is needed.
Lucas Heights Science and Technology Centre	Various pollutants, concern over potential risk of radioactive pollution in case of serious incident.
Industrial area at Heathcote	Various pollutants.
Upstream of Woronora Bridge, northern end of Liffey Place.	Sediment, litter.
Heathcote Road crossing of Woronora River	Vehicular traffic and lack of water quality devices.

8 Identification of Potential Management Strategies

A range of management options have been proposed to address the stormwater management issues that were identified during the process of preparing this plan. The proposed actions have been separated into structural and non-structural options. These are summarised in Table 8.1 and are described in more detail in Section 9.

Table 8.1: Potential Management Strategies

NON-STRUCTURAL	STRUCTURAL
Management Issues	
• education of Council staff in Best Management Practices • auditing of Council work practices • placement of signage around catchment about stormwater issues and areas/practices, ie. near construction activities, industrial/commercial areas • increasing and enforcing fines for stormwater pollution for local businesses and construction sites; signposting the penalties or fines for breaches • strategically locate litter bins to reduce litter dropped on roadways and footpaths • review of the effectiveness of the street sweeping program • auditing of Council's stormwater pollution control measures • auditing of local businesses/construction suites and their work practices • emergency spill plans to be developed and maintained as operational by Council. Emergency spill plans to accompany development applications that involve hazardous material.	• install proposed appropriate water quality control structures in most effective locations • improve bank stabilisation and management of foreshore areas • establish regular monitoring and maintenance program for water quality control structures.
Planning Issues	

NON-STRUCTURAL	STRUCTURAL
• review and strengthen planning and development controls to include stormwater requirements • include stormwater requirements in existing and proposed Development Control Plans. Emphasis is to be on reuse and source control • conduct feasibility study on stormwater reuse options • incorporate reuse into planning and development throughout the catchment • investigate potential for inspection of private sewer lines with sale of houses	• increase infiltration measures and amount of pervious surfaces in the catchment, ie. roof drainage and retention, buffer strips, grass swales • retain natural flow and drainage channels throughout the catchment • introduce and maintain feasible stormwater on-site detention and reuse schemes on Council/stakeholder managed land where possible
Bio-physical	
• undertake a Pollution Source Inventory and Catchment Processes Study to further identify existing and potential pollution sources and problem areas. • monitoring program to allow Council to continue to identify existing and potential pollution sources and provide feedback on SWMP effectiveness • set water quality and ecological benchmark criteria for the parameters of the monitoring program. These criteria need to be periodically reviewed as water quality changes with the implementation of stormwater strategies	• restore aquatic habitats • replant and restore riparian vegetation • restore and protect wetland areas • establish riparian and aquatic vegetation with the installation of stormwater controls • control weeds in bushland and riparian areas
Social	
• increase community awareness about the link between land use activities, stormwater quality and the health of the Woronora River • increase community awareness about the link between land use activities, stormwater quality and aquaculture activities in the Woronora River • increase community awareness about the link between land use activities, stormwater quality and recreational use of the Woronora River	• community participation days for planting/creek • open field sites/case studies to demonstrate to the public how stormwater reuse and source control can be integrated with existing and proposed development

9 Evaluation of Potential Management Options

A broad range of structural and non-structural practices are available to address identified stormwater management issues. Table 9.1 provides a list of potential practices which have been identified as potential options to address the identified stormwater management issues for the Woronora River catchment. These issues have been derived from the community consultation process and the identified stormwater management objectives and catchment values.

9.1 Discussion of Structural Management Options

Council has installed Gross Pollutant Traps (GPTs), trash racks and water quality ponds (constructed wetlands) at various locations in the catchment. Information supplied by the Council shows that there are 9 structures in the Woronora River Catchment (see Figure 2). Water pollution control structures have generally been placed utilising local knowledge of known pollution areas. These devices are part of a long term Council program to install trap structures to protect watercourses draining to the Woronora catchment.

There are many structures available to the designer and planner to collect sediment and rubbish that are generated from an urban catchment. Structures can be sorted into the following generic groupings:

- **Trash Racks.** These are simple grill, mesh or rack structures located in the waterway to intercept floating trash. They can quickly become blocked with trash and if not regularly cleaned collected material can be washed away. Nettech devices are another option which is basically a removable net that is placed at the pipe outlet.

- **Gross Pollutant Traps or GPTs**. These are structures that can trap both sediment and trash and usually consist of a silt basin and a trash rack. GPTs can be either small or large, open or enclosed. They should be easily accessed for cleaning and hydraulically designed so that there are no impacts to flow regimes that will result in flooding.

- **Wetlands and Ponds.** These are large constructed ponds that allow water to be detained or retained for a period of time to allow sediment to deposit or settle. Often water plants will further improve water quality by remove some nutrients. Wetlands generally require large areas of land and can be difficult to site in existing urban areas.

While all the above groups of structures will remove or collect pollutants from urban stormwater runoff they are more effective when grouped or used in conjunction with each other. For example, locating a GPT upstream of a wetland will allow the more coarse sediment and floating rubbish to be removed before the wetland.

The type of structure selected for a particular catchment will differ according to the characteristics of that catchment, the pollutants to be trapped, the

drainage system and the available sites. For instance, what works in one catchment may not work in another. Careful consideration should be given to locating structures to ensure that:

- maintenance and cleaning can be carried out easily;
- flow regimes are not altered to cause flooding; and
- the amenity of the local area is not compromised.

Operational

Continuing Council's existing program to install trap structures, further structures are proposed for Sutherland Council's 1999/2000 works program. EPA grants to install additional Nettech Devices will also add structures to the catchment. Currently, there are still a number of urban sub-catchments that drain to the Woronora River that have no pollution control structures in place. There is little doubt that more structural controls both at sources (ie. shopping centres) and on drainage systems will improve water quality. Many sub-catchments are wholly residential, possibly generating fewer pollutants than areas that have commercial and industrial elements within the sub-catchment.

More coordination between planning, design and maintenance of structures is necessary. As the amount of structural controls increases the demand for a share of maintenance budgets will increase. Therefore, Council will need to:

- identify existing maintenance and cleaning costs to allow future increases to be budgeted for; and
- identify maintenance methods and prepare operating manuals for each structure allowing for possible future long term maintenance contracts to be investigated.

Drainage Investigations

While additional structures are proposed there are still many urban catchments that drain to the Woronora River that have no pollution control structures in place. There is little doubt that more structural controls both at sources, ie. shopping centres and on drainage systems, will improve water quality. Many catchments are entirely residential and possibly generating less pollutants than areas which have commercial and industrial elements in the catchment. This being the case structures to treat these areas will differ from area to area:

- identify commercial and industrial areas and determine amount/quality of pollution generated. – integrate existing detailed water quality data with existing landuse data;
- prioritise catchments with highest levels of pollution;
- determine suitable trap type to be installed on trunk system; and

- prepare capital works programs based areas most needing treatment.

Design

The type of structure selected for a particular catchment will differ according to the characteristics of that catchment, the pollutants to be trapped, the drainage system and the available sites. What works in one catchment may not work in another. Detailed investigation of catchments should be conducted to ensure:

- a suitable size and location of proposed structures;
- that flooding impacts are not worsened; and
- prepare designs incorporating access, maintenance and cleaning aspects.

9.2 Discussion of Non-Structural Management Options

Community Awareness

Water quality issues as identified in this plan are influenced by the attitudes and practices of both the local community and visitors to this catchment. Community commitment to, and cooperation in, protecting water quality is to be fostered by programs of awareness, information, participation and demonstrated community leadership by Council (Sydney Coastal Councils, 1997). It is strongly believed that improvements in stormwater quality management will improve with community awareness campaigns that:

- create a broader awareness of the catchment specific issues and problems affecting stormwater quality;
- create linkages within the community's mind between stormwater drains and local waterways;
- raises awareness about issues like the contribution of oils and grease to stormwater pollution from sources like poorly maintained vehicles, etc.;
- target sectors of the community, ie. retailers in commercial centres to take more responsibility for the litter generation from these areas;
- target industrial/trade operators to raise awareness about work activities that contribute to pollution of waterways; and
- encourage community responsibility for the Woronora catchment with Council providing real avenues for an aware community to put into practice their knowledge of pollution reduction measures.

This aspect was highlighted constantly during each community consultation session as an important way to improve stormwater quality within the catchment. Neighbourhood practices that can be incorporated into the awareness campaign include the following:

- the formation of resident action groups to look after specified local sub-catchment or area;
- individual resident initiatives for litter reduction;
- increasing pervious areas for all new developments and any re-developments, eg. gardens, grassed areas, porous pavers etc.;
- encourage indigenous tree planting in gardens and also revegetation of degraded riparian zones/bushland areas;
- mulching in gardens to increase soil moisture and decrease need for watering and fertiliser use;
- encourage car washing on grassed areas or at professional car washing facility;
- driveways, pavements, shopping centre strips, forecourts, etc. should be swept with a broom not a hose;
- prevention of street littering including stencils on drains indicating to which waterway it flows;
- correcting illegal stormwater connections;
- improving garden maintenance. The removal of leaves, etc. from garden areas and gutters is important to prevent them overflowing into the stormwater system. This green waste should be composted or mulched;
- Council is to provide real opportunities for aware members of the community to give effect to their understanding of pollution prevention and control;
- Council to educate residents about the best way to recycle so that paper and plastic bottles don't become a source of pollution; and
- Council to continue to be actively and publicly involved in established environmental programs such as Landcare, Tidy Towns, Rivercare, Streamwatch and Clean Up Australia Day.

Council Staff Awareness and Training

Most pollutants originate within established urban areas from roadways, residential, commercial and industrial activities, or from temporary land disturbances associated with construction activities. Council staff need to be aware of the impact that poor management practices have on the water quality within the catchment.

Education and awareness is also important between Council divisions for all staff to help in understanding the reason for various work related decisions being made internally.

Sutherland Shire Council has initiated a program for an Environmental Educator to work with civil works construction staff. The aim of this program is to improve the awareness and work practices of outdoor staff in regards to sediment and erosion controls.

Total Catchment Management

Total Catchment Management (TCM) is a holistic approach to managing the degradation of the natural environment. TCM has arisen from a need for cost effectiveness from limited public resources and improved understanding of linkages between catchment processes and surface water conditions (Sydney Coastal Councils, 1997).

TCM and Catchment Management Committees are an essential component to implementing change in the way we live with our waterways. CMCs coordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis so as to balance resource utilisation and conservation (*Catchment Management Act, 1989*). Catchment Management Authorities bring together the various government authorities and community groups to manage the catchment on a sustainable basis and ensure that the community is involved in the decision making process.

Planning Policy

Sutherland Council has recently prepared a proposed draft Sutherland Shire LEP for the Shire, including areas of the Woronora catchment. In addition, the draft Woronora Valley Master Plan has been prepared by Council to provide direction and planning strategies. Such documents act as frameworks to base planning decisions on. It is important that the strategies used to direct planning and development also address stormwater issues. Ways of incorporating urban runoff controls include:

- policies which relate to the development of land will require Soil and Water Management Plans to accompany any development application;

- Soil and Water Management Plans are to accompany all development applications/building applications for dwellings, subdivision works and for other activities as required by Council. These plans detail strategies and best management practices to be adopted on-site and integrate with Council policies; and

- Council could introduce a bond to be lodged, which covers any off-site damage resulting from inappropriate development activities.

Auditing

- Council should consider conducting its own internal environmental audits of its properties and of its operations. Alternatively, Council may decide to engage an independent environmental auditor to undertake the work to maintain impartiality. Annual audits of Council staff and work practices will ensure compliance with Best Management Practices.

- Auditing can also monitor whether planning and development controls and the general principles of this plan are properly implemented. Sufficient resources must be allocated to support environmental officers to enable them to issue on the spot fines and/or infringement notices for regulation breaches.

- Council may also consider audits of industrial areas or other identified major sources of polluted stormwater and working with organisations to eliminate identified pollution sources;

- Council can encourage industry and other organisations to conduct their own audits to identify possible water pollution sources and develop control strategies. Information obtained from these audits may be used to identify pollution sources within the Woronora catchment.

Preservation and Retention of Existing Vegetation and Riparian Habitat

The lower catchment has been extensively modified for urban development into residential, commercial and industrial areas. Clearing and developing the natural landscape causes significant changes to the stormwater system resulting in higher surface runoff and increased downslope erosion.

The retention and restoration of natural vegetation and pervious surfaces will more resemble natural runoff processes which assimilate, eliminate and/or prevent pollution (Sydney Coastal Councils, 1997).

Methods for encouraging the retention of native vegetation and riparian habitat include:

- land use requirements are to be established for planned development in order to come to an understanding of the likely impact of the development on natural soil, landform, drainage and vegetative features;

- conflicts between landuse and land capability need to be further identified;

- building regulations are to limit the use of impervious paving materials and enforce this limitation;

- building regulations limit the disturbance of natural vegetation; and

- Council should demonstrate the benefits of construction methods which minimise impervious paving and disturbance to native vegetation in its own works programs.

Emergency Spill Plans

Spills and leaks are considered to be the most significant industry-based sources of environmental pollution. Council needs to maintain a fully operational emergency response capability plan with spill prevention and containment strategies. Council should ensure that Emergency Spill Plans accompany all Development and building applications that involve hazardous substances.

Street Cleaning and Litter Prevention

Street sweeping, litter prevention and pit cleaning are to be performed to best management practices standards and are to form an integral part of the water quality controls adopted in urbanised catchments.

Pollutants easily enter the stormwater system via streets, paved surfaces and gully pits. Physical removal of these by sweeping, shovelling, vacuuming etc is an effective control of pollution from urbanised catchments. Litter and leaves, once washed into the stormwater system can cause blockage in pipes and bacterial growth that are washed into waterways further down the system.

Guidelines from the Sydney Coastal Councils document (1997) include the following:

- suitable locations for removal of pollutants need to be identified eg. litter can be collected in gully pit litter baskets and silt arresters before it enters the main stormwater system;
- community cooperation within the program is to be encouraged;
- appropriate cleaning procedures and frequencies reflecting maximum cost effectiveness are to be established; and
- where flushing is essential for removing blockages, temporary trapping of flushed material is to be carried out.

9.3 Evaluation and Ranking of Potential Management Options

A cost benefit analysis has been conducted on the management options defined as a result of the catchment requirements, hotspots identified and community issues and community values raised during the consultation process. The following tables (Table 9.1 and Table 9.2) include options raised by the community, stakeholders and Council. Table 9.1 defines the ranking criteria and provides a ranking for each potential management option. The costings listed are estimates only, to provide a measure of scale for ranking. It is expected that actual costs will vary considerably (ie. in the case of structural works according to final site location/size, materials used, etc.). An implementation strategy is outlined in Section 10, highlighting priorities, defining time frames for actions and those organisations responsible for the implementation of the management options.

The Cost Benefit Analysis method is based upon that developed by the EPA (1997) and provides a management tool for the ranking of solutions to stormwater problems. Appendix 2 sets out details of the methodology used for the cost benefit analysis.

Table 9.1 Implementation Strategies

Option			Costs		Benefits						Rank	
No	Authority	Description	Installation	Operating (per year)	Target Pollutant	No. Pollutants	% of Urban Catchments Benefited	Effectiveness	Education Value	Benefit Index	Cost/Benefit Ratio	Rank
		EDUCATION										
1	Council	Education of Council staff in Best Management Practices for stormwater	5,000	1,000	all	8	100	medium	low-medium	3.714	0.5	21
2	Council	Strategically locate litter bins to reduce litter dropped on roadways and footpaths	2,000	5,000	litter	2	20	low	low	0.857	2.3	55
3	Council	Increase community awareness through leaflet in rates notice	2,000	2,000	all	8	60	medium	medium-high	3.714	0.3	8
4	All	Educate community to reduce reliance on plastic shopping bags	10,000	5,000	litter	2	10 -20	medium	medium	2.000	1.5	43
5	All	Campaign aimed at tradesmen/construction industry to increase awareness of requirements and Best Management Practices	10,000	1,000	all	8	100	medium	medium - high	4.286	0.7	26
6	Council	Awareness campaign against car washing on streets, hosing driveways, walkways, etc.	10,000	2,000	nutrients	4	40 - 50	medium	medium – high	3.000	1	32
7	All	Educate non-English speaking residents through multilingual program	25,000	10,000	litter, sediment, nutrients	4	40 - 50	medium	medium	2.714	1.8	49
8	All	Awareness campaign on potential pollution sources directed at managers of shopping centres	5,000	0	litter	2	30 - 40	medium	medium	2.286	0.9	31
9	Council	Encourage, through education and subsidy, the use of compost bins for onsite retention of garden and putrescible refuse	20,000	10,000	nutrients	7	30 - 40	medium	medium	3.000	2.0	51
10	All	Educate community on the planting of native and plant species with low nutrient/water needs	10,000	2,000	weeds, nutrients	5	30 - 40	low - medium	medium - high	2.571	1.2	33
11	All	Prepare guidelines and encourage appropriate application rates of fertiliser on parklands, playing fields and golf courses.	5,000	1,000	nutrients	4	10 - 20	medium	low	1.714	1.2	34
		COUNCIL ACTIONS										
12	Council's Planning Dept.	Review and update development controls. Specify ratio of pervious/impervious services for all new developments or redevelopments, mandatory sediment controls for all works	10,000	1,000	all	8	70 - 80	medium	medium - high	4.286	0.2	4
13	Council	Audit of Council work practices and target improvements	50,000	8,000	all	8	100	medium	medium - high	4.286	1.4	40
14	Council	Co-ordinate stormwater management responsibilities within Council sections	5,000	1,000	all	8	100	high	medium - high	5.000	0.2	1
No	Authority	Description	Installation	Operating	Target	No.	% of Urban	Effectiveness	Education	Benefit	Cost/Benefit	Rank

					Pollutant	Pollutants	Catchment Benefited		Value	Index	Ratio	
15	All	Increase frequency of inspections of local business and construction sites and penalties/fines for stormwater pollution	15,000	15,000	sediment, nutrients, metals, toxins	5	100	medium - high	medium - high	4.143	0.2	5
16	All	Review fine effectiveness	2,000	0	all	8	100	medium	medium	4.000	0.3	6
17	All	Introduce alternatives to fines – eg suspend building license	5,000	1,000	all	8	100	medium - high	medium	4.571	0.2	2
18	Council	Inspection of private sewer lines with sale of houses – Introduce requirement into 176 certificate	70,000	25,000	all	8	20 - 30	medium - high	medium	3.286	0.6	23
19	Council	Review effectiveness of street sweeping program	5,000	2,000	litter, sediment	4	10 - 20	medium	low	1.714	0.6	22
20	Council	Structure monitoring program to include measure of SWMP effectiveness	60,000	60,000	all	8	100	high	low - medium	3.286	2.4	56
21	Council	Provide feedback to community on SWMP effectiveness	5,000	2,000	all	8	100	medium - high	high	5.000	0.4	17
22	Council	Emergency spill plans to accompany development applications that involve hazardous materials	1,000	500	all	8	100	medium	low - medium	3.714	0.3	9
23	Council	Introduce procedures to explain development control requirements to recipients of DA	5,000	5,000	all	8	100	medium - high	medium - high	4.571	0.2	3
24	All	Audit stormwater connections from industrial areas and implement policies to ensure connections are reviewed on sale	25,000	5,000	all	8	20 - 30	medium - high	low - medium	3.000	1.3	37
25	All	Increase infiltration measures and amount of pervious surfaces in the catchment i.e. roof drainage and retention, buffer strips, grass swales implement planning policies to comply	25,000	2,000	water flow, sediment	4	40 -50	medium - high	medium	3.000	1.3	38
26	Council	Develop and implement best practice guidelines for planting native or low nutrient/water usage plant species in urban parks and nature strips	10,000	2,000	water flow, sediment retention	5	10 -20	low - medium	low	1.571	1.9	50
27	Council	Control dog faeces by implementing Companion Requirements	10,000	5,000	nutrients, bacteria	5	10 - 20	medium - high	medium - high	3.000	0.3	11
28		Install hidden video surveillance at well used illegal dump sites (rotational) and prosecute	50,000	25,000	litter, toxins	2	less than 10	low	low	0.714	9.8	51
29	Council	Establish phone hotline to report stormwater management infringements	2,000	15,000	all	8	10 - 20	medium	medium - high	4.285	0.7	27
30	Council	Initiate propagation of endemic riparian and wetland species in Council nurseries	10,000	5,000	weed infestation	5	less than 10	medium	low - medium	2.000	1.5	44
31	All	Co-ordinate weed removal from all drainage lines – incorporate into Council maintenance as well as Bushcare and Landcare groups	10,000	10,000	weeds	5	less than 10	medium - high	medium	2.571	0.8	29
32	Council	Use rebates and mandatory policy to encourage onsite stormwater detention on all new developments: detention ponds, water tanks etc.	5,000	5,000	sediment, water flow,	4	20 – 30	medium - high	medium - high	3.000	0.3	12

No	Authority	Description	Installation	Operating	litter Target Pollutant	No. Pollutants	% of Urban Catchment Benefited	Effectiveness	Education Value	Benefit Index	Cost/Benefit Ratio	Rank
33	Council	Incorporate preservation and enhancement of natural drainage lines and creeks into planning policies and development controls	5,000	2,000	sediment, nutrients, flow velocity	4	less than 10	medium - high	medium	2.429	0.4	18
34	Council	Develop a riparian management plan consistent with all other management plans	10,000	2,000	habitat, sediment, nutrients, weeds	5	less than 10	medium	medium	2.286	1.3	36
35	Council	Co-ordinate all management plans to comply with overall ESD vision	5,000	5,000	all	8	10 – 20	medium - high	low - medium	4.000	0.3	7
36	All	Encourage installation of rainwater tanks to reduce household runoff	5,000	5,000	flow	4	60 -70	medium	medium - high	3.286	0.3	10
37	Council	Increase and fund policing of shire to ensure compliance with stormwater objectives	60,000	60,000	all	8	70 - 80	medium - high	low - medium	3.714	2.2	53
		MANAGEMENT										
38	Council DLWC	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks	2,000	5,000	weeds	5	less than 10	medium - high	medium	2.571	0.3	15
39	Council	Support SWC's implementation of the sewer prioritisation project as part of the Sewer Overflow Licensing Project (SOLP)	2,000	0	nutrients, bacteria	5	100	low	medium	3.000	1.4	13
40	Council, RTA, RSA	Catchment signage raising awareness in recreational areas, shopping centres, waterway crossings, and naming un-named creeks	Up to 10,000	2,000	all	8	100	low - medium	high	2.143	1.5	41
41	Council, NPWS, BFB	Fire trails, hazard reduction burns - guidelines, BMP on erosion control measures, design options for construction to prevent erosion	10,000	2,000	sediment, nutrients	4	10 - 20	medium - high	low	2.000	0.4	45
42	Council	General litter problem – support national and state litter reduction programs, eg. Clean Up Australia	5,000	1,000	litter	2	20 – 30	medium - high	medium - high	2.714	0.4	14
43	CMC	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies	5,000	0	all	8	100	medium - high	medium	4.571	0.4	19
		WATER QUALITY-STRUCTURAL										
44	Council	Maintain 2 existing constructed wetlands	0	10, 000	all	8	10 - 20	high	medium - high	3.857	0.5	20
45	Council	Maintain 7 existing Gross Pollutant Traps	0	5,000 each	litter, sediment	4	50 - 60	high	medium - high	3.857	1.3	35
46	Council	Maintain 4 existing detention ponds	0	2,000 each	sediment	4	20 - 30	high	medium	3.143	0.6	24
47	RTA	Maintain 5 existing pollution control structures	0	2,000 each	sediment	4	10 - 20	high	medium	3.000	0.7	25
48	Council	Regular monitoring and cleaning of gully pits	0	3,000	sediment	4	70 - 80	medium	low	2.571	0.4	16
49	Council	Install and maintain trash rack on Forbes Creek, North Engadine	20,000	3,000	litter	2	less than 10	high	low - medium	2.286	1.7	47

50	Council	Install and maintain trash rack Silver Leaf Row, Menai	20,000	2,000	litter	2	less than 10	high	low - medium	2.286	1.7	48
51	Council	Install and maintain Nettech traps at Woronora Heights	2,000	500	litter	2	less than 10	high	low	1.286	0.8	28
No	Authority	Description	Installation	Operating	Target Pollutant	No. Pollutants	% of Urban Catchment Benefited	Effectiveness	Education Value	Benefit Index	Cost/Benefit Ratio	Rank
		HOTSPOTS - STRUCTURAL										
52	RTA	Install and maintain Gross Pollutant Trap (GPT) on River Road, Woronora (work in progress at the time of this report)	55,000	5,000	litter, sediment	4	less than 10	high	medium	2.857	2.1	52
53	Council	Install and maintain minor GPTs on selected pipe discharges at the Crescent, Woronora	up to 80,000	5,000	litter, sediment	4	less than 10	high	medium	2.857	2.5	57
54	Council	Still Creek – assess potential site locations, install suitable pollution control structures on untreated tributaries down from Menai Road	20,000 – 110,000	5,000	litter, sediment	4	20 – 30	high	medium	3.143	2.2	54
55	Council	Woronora Cemetery – install trash racks or Nettech devices on drainage outlets	5,000	1,000	litter	2	less than 10	high	medium	2.571	0.8	30
56	RTA	Heathcote Road crossing of Woronora River – install traps to treat runoff from road	25,000	2,000	litter, sediment	4	60 - 70	medium - high	low - medium	3.000	1.3	39
57	Council	Heathcote Industrial area – install GPT at discharge to local drainage system	60,000	5,000	litter, sediment, oils, grease, toxins	8	60 - 70	high	medium	4.286	1.6	46
58	Council	Playing fields at Bangor, Yarrawarrah, Woronora Heights, Sutherland and Bonnet Bay: install and maintain perimeter drains before discharge to trunk drainage system	30,000 each	2,000	litter, sediment	4	40 – 50	medium - high	low - medium	2.714	2.9	58
59	Council	Shopping centres, car parks, walkways– install trash racks interceptor pits (also need to include education component: see option no.'s 4, 6, 8)	25,000	2,000	litter	2	20 - 30	high	medium	2.857	1.4	42

*All – refers to all stakeholders including RTA, NPWS, RSA, Georges River CMC, Sutherland Council.

Table 9.2: Options ranking, according to stormwater manager responsible for task

Table 9.2 Options ranking, according to stormwater manager responsible for task

Issue	***No***	Option Description	***Rank***
Responsible Stakeholder – Local Council			
General	14	Co-ordinate stormwater management responsibilities within Council sections	1
	23	Introduce procedures to explain development control requirements to recipients of DA	3
	12	Review and update development controls. Specify ratio of pervious/impervious services for all new developments or redevelopments, mandatory sediment controls for all works[1]	4
	35	Co-ordinate all management plans to comply with overall ESD vision	7
	22	Emergency spill plans to accompany development applications that involve hazardous materials	9
	27	Control dog faeces by implementing Companion Requirements	11
	32	Encourage through rebates and mandatory policy the onsite detention of stormwater on all new developments through pervious surfaces, detention ponds, water tanks, etc.	12
	21	Provide feedback to community on SWMP effectiveness	17
	33	Incorporate preservation and enhancement of natural drainage lines and creeks into planning policies and development controls	18
	19	Review effectiveness of street sweeping program	22
	18	Inspection of private sewer lines with sale of houses – Introduce requirement into 176 certificate	23
	29	Establish phone hotline to report stormwater management infringements	27
	34	Develop a riparian management plan consistent with all other management plans	36
	13	Audit of Council work practices and target improvements	40
	30	Initiate propagation of endemic riparian and wetland species in Council nurseries	44
	26	Develop and implement best practice guidelines for planting native or low nutrient/water usage plant species in urban parks and nature strips	50
	37	Increase and fund policing of shire to ensure compliance with stormwater objectives	53
	20	Structure monitoring program to include measure of SWMP effectiveness	56
Education	1	Education of Council staff in Best Management Practices for stormwater	21
	3	Increase community awareness through leaflet in rates notice	8
	6	Awareness campaign against car washing on streets, hosing driveways, walkways, etc.	32
	9	Encourage, through education and subsidy, the use of compost bins for onsite retention of garden and putrescible refuse	51
	2	Strategically locate litter bins to reduce litter dropped on roadways and footpaths	55
Management	39	Support SWC's implementation of the sewer prioritisation project as part of the Sewer Overflow Licensing Project (SOLP)	13
	42	General litter problem – support national and state litter reduction programs e.g. Clean Up Australia	14
	38	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks[2]	15

Table 9.2 Options ranking, according to stormwater manager responsible for task

Responsible Stakeholder – Local Council (continued)			
Water Quality - Structural	48	Regular monitoring and cleaning of gully pits	16
	44	Maintain 2 existing constructed wetlands	20
	46	Maintain 4 existing detention ponds	24
	51	Install and maintain Nettech trap at Woronora Heights	28
	45	Maintain 7 existing Gross Pollutant Traps	35
	49	Install and maintain trash rack at Forbes Creek, North Engadine	47
	50	Install and maintain trash rack at Silver Leaf Row, Menai	48
Hotspots - Structural	55	Woronora Cemetery – install trash racks or Nettech devices on drainage outlets	30
	59	Shopping centres, car parks, walkways– install trash racks interceptor pits (also need to include education component: see option no.'s 4, 6, 8)	42
	57	Heathcote Industrial area – install GPT at discharge to local drainage system	46
	52	Install and maintain Gross Pollutant Trap (GPT) on River Road, Woronora	52
	54	Still Creek – assess potential site locations, install suitable pollution control structures on untreated tributaries down from Menai Road	54
	53	Install and maintain minor GPTs on selected pipe discharges at the Crescent, Woronora	57
	58	Playing fields at Bangor, Yarrawarrah, Woronora Heights, Sutherland and Bonnet Bay: install and maintain perimeter drains before discharge to trunk drainage system	58
Responsible Stakeholder – NPWS/BFB			
Management	41	Fire trails, hazard reduction burns - guidelines, BMP on erosion control measures, design options for construction to prevent erosion	45
Responsible Stakeholder – DLWC			
Management	38	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks[2]	15
Responsible Stakeholder – Catchment Management Committee (CMC)			
Management	43	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies	19
Responsible Stakeholder – RTA			
Water Quality - Structural	47	Maintain 5 existing pollution control structures	25
Hotspots - Structural	56	Heathcote Road crossing of Woronora River – install traps to treat runoff from road	39
Responsible Stakeholder – All*			
General	17	Introduce alternatives to fines – e.g. suspend building license	2
	15	Increase frequency of inspections of local business and construction sites and penalties/fines for stormwater pollution	5
	16	Review fine effectiveness	6
	36	Encourage installation of rainwater tanks to reduce household runoff	10
	31	Co-ordinate weed removal from all drainage lines – incorporate into Council	29

Table 9.2 Options ranking, according to stormwater manager responsible for task

		maintenance as well as Bushcare and Landcare groups	
	24	Audit stormwater connections from industrial areas and implement policies to ensure connections are reviewed on sale	37
	25	Increase infiltration measures and amount of pervious surfaces in the catchment, i.e. roof drainage and retention, buffer strips, grass swales implement planning policies to comply	38
Education	5	Campaign aimed at tradesmen/construction industry to increase awareness of requirements and Best Management Practices	26
	8	Awareness campaign on potential pollution sources directed at managers of shopping centres	31
	10	Educate community on the planting of native and plant species with low nutrient/water needs	33
	11	Prepare guidelines and encourage appropriate application rates of fertiliser on parklands, playing fields and golf courses	34
	40	Catchment signage raising awareness in recreational areas, shopping centres, waterway crossings, and naming un-named creeks	40
	4	Educate community to reduce reliance on plastic shopping bags	43
	7	Educate non-English speaking residents through multilingual program	49

[1] Specifically, the Council's Planning Department is responsible for this action.

[2] The responsibility of both the Council and DLWC.

* Refers to all stakeholders including NPWS, RTA, Sydney Water, Sutherland Shire Council, CMC, RSA, DLWC etc.

10 Implementation Strategies

The following table describes the priority actions for the effective implementation of the plan. Following Table 10.1 below, Figure 4 shows how implementation of the Plan will be linked to Council's management planning process.

The schedule for implementation of the stormwater improvement strategies is shown in Table 10.2.

Table 10.1: Summary of priority implementation strategies

Management Issues
• establish an inner Council working group to meet every 2-3 months: comprised of Stormwater Manager, representative from Planning, Maintenance, Environment services.
• Council Stormwater Manager to detail a funding program and set up a timetable for implementation of structural options within 6 months of acceptance of the Stormwater Management Plan.
• establish a Stormwater Steering Committee with representatives of each of the key stakeholders: Catchment Management Committee; Sydney Water; Council; State Rail Authority; Roads and Traffic Authority; Environment Protection Authority; and National Parks and Wildlife Service to meet every 6 months. The committee will share information (e.g. water quality results, status of implementation of plan etc).
• Stormwater Plan Steering Committee to start with a joint agreement on a program of works for the next three years. Where applicable the agreed works should continue to be in consultation with all stakeholders.
• Sub-catchment areas with little or no water pollution control structures are Forbes Creek, Loftus Creek and tributaries in Lucas Heights, Menai, Engadine and the urbanised portions of Heathcote. These areas should be given priority when considering structural works.
• program of works should include selected sites to be used as case studies to trial different techniques for treating stormwater quality and flow. The results from these trials can be used to generate guidelines for the best approach to stormwater control in different situations.
• Council's Environmental Services to conduct a Pollution Source Inventory within 12 months of acceptance of this plan. This study will investigate and identify pollution sources, determining how much pollutant is being generated from each source and relate it to land use activities in the catchment context. This detailed information can then be used to decide on the most appropriate locations for water quality sampling as well and providing further information for prioritising future works such as those listed in this stormwater plan.
• Council Stormwater Manager to initiate audit of Council practices to improve Council performance and awareness within 12 months of acceptance of the Stormwater Management Plan.
• Councils' Stormwater Manager, Community Liaison Officer and Environment Services to collaborate on awareness campaigns aimed at schools: project based.
• Council: review current monitoring locations, broaden scope of water quality monitoring program to include sites that monitor bioindicators, e.g. macroalgae or macrofauna in Heathcote creek, tributaries into Heathcote Creek, Forbes Ck. and higher up in catchment.
• Council/SW Manager: initiate audit of industrial and commercial premises in conjunction with awareness campaign

with 12 months of acceptance of Stormwater Management Plan.
• Council Stormwater Manager to report to Steering Committee every 6 months on deliverables to date.
Planning Issues
• to review and strengthen Council's planning and development controls to include stormwater requirements and limitations to the extent of vegetation clearance, ie. no clearance in 20 m buffer of main tributaries.
• Council planning department to develop step by step brochure on DA requirements including descriptions of sediment controls: where and how to place them, details on vegetation removal, etc. within 6 months of acceptance of Stormwater Management Plan (refer to Figure 4).
• include stormwater requirements in existing and proposed Development Control Plans. Emphasis of requirements is to be on reuse, infiltration and source control (refer to Figure 4).
• enforce requirements for infiltration measures and amount of pervious surfaces in proposed developments, ie. roof drainage and retention, buffer strips, grass swales.
• encourage existing development/housing to incorporate more stringent stormwater controls.
• retain natural flow and drainage channels throughout the catchment.
• conduct feasibility study on stormwater reuse options. incorporate reuse into planning and development throughout the catchment.
• introduce and maintain feasible stormwater on-site detention, infiltration and reuse schemes on Council/stakeholder managed land where possible.
Social Issues
• "Creek Rescue" programs: encourage local Bushcare groups and schools. Support through Council, CMC assistance and publicity about achievements.
• Develop Urban Bushland Action Plan: prioritise areas for works and develop plans to gain funding.
• open field sites/case studies to demonstrate to the public how stormwater reuse and source control can be integrated with existing and proposed development
Bio-physical Issues
• undertake a Catchment Processes Study to gain a better understanding of the dynamics that affect water quality and ecological systems
• further develop Council's monitoring program to continue to identify existing and potential pollution sources and provide feedback on SWMP effectiveness
• set water quality and ecological benchmark criteria for the parameters of the monitoring program. These criteria need to be periodically reviewed as water quality changes with the implementation of stormwater strategies

Figure 4. Integration of stormwater actions into Council's planning processes

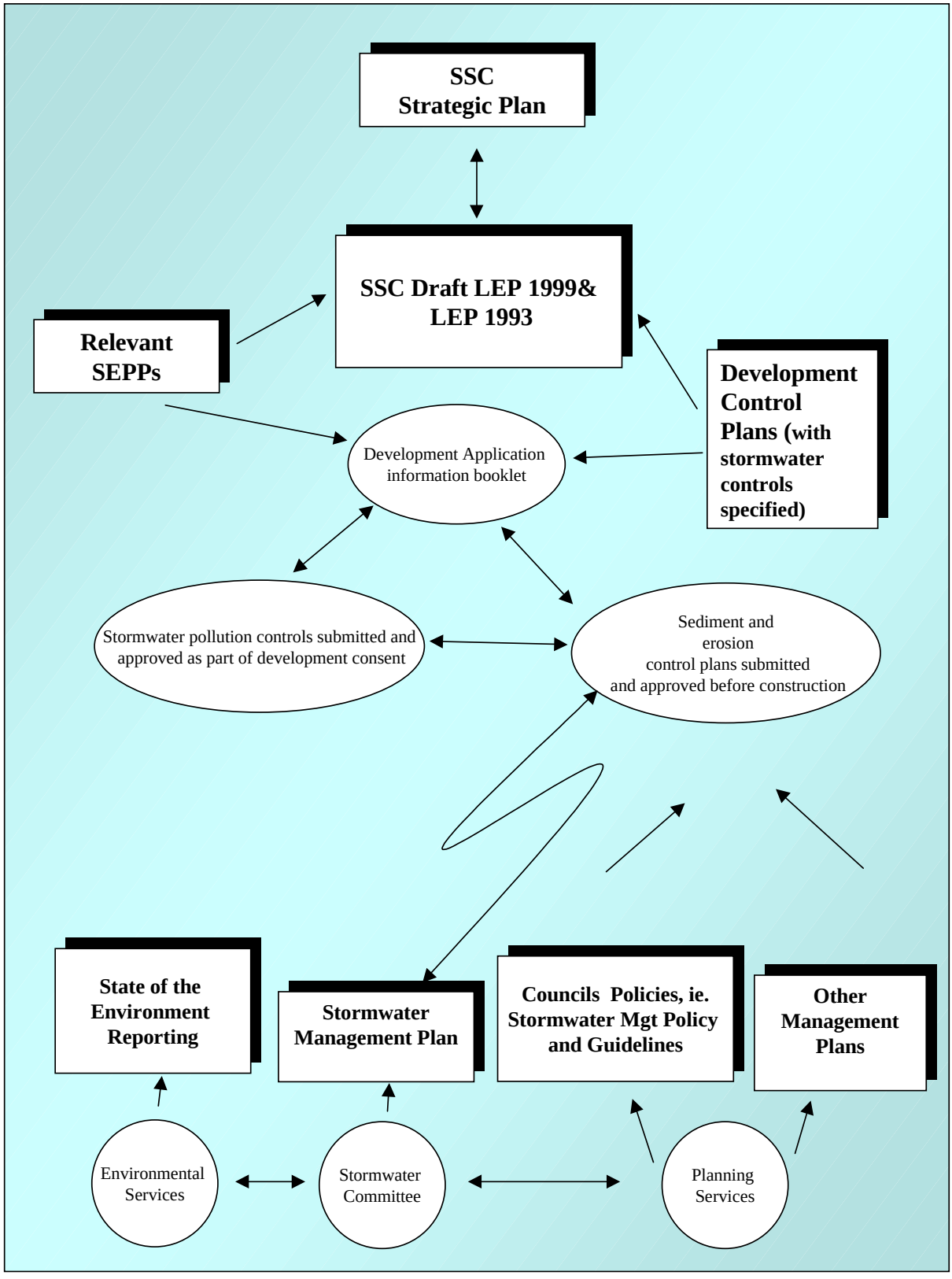


Table 10.2: Proposed schedule for the implementation of potential management strategies for the Woronora catchment

Ref No	Schedule for initiation (years)	Expenditure and Financial Year (1st year often includes both installation & operating costs)			Responsible Authority	Option Description
		first year	second-third year	four- fifth year		
EDUCATION						
1	1-3	6,000	2,000	2,000	Council	Education of Council staff in Best Management Practices for stormwater
2	1-3	7,000	10,000	10,000	Council	Strategically locate litter bins to reduce litter dropped on roadways and footpaths
3	1-3	4,000	4,000	4,000	Council	Increase community awareness through leaflet in rates notice
4	5	15,000	10,000	10,000	All	Educate community to reduce reliance on plastic shopping bags
5	5	11,000	2,000	2,000	All	Campaign aimed at tradesmen/construction industry to increase awareness of requirements and Best Management Practices
6	5	12,000	4,000	4,000	Council	Awareness campaign against car washing on streets, hosing driveways, walkways, etc.
7	3	35,000	20,000	20,000	All	Educate non-English speaking residents through multilingual program
8	1-3	5,000	0	0	All	Awareness campaign on potential pollution sources directed at managers of shopping centres
9	3	30,000	20,000	20,000	Council	Encourage, through education and subsidy, the use of compost bins for onsite retention of garden and putrescible refuse
10	current	12,000	4,000	4,000	All	Educate community on the planting of native and plant species with low nutrient/water needs
11	current	6,000	2,000	2,000	All (SSC's Parks & Waterways Division	Prepare guidelines and encourage appropriate application rates of fertiliser on parklands, playing fields and golf courses.
COUNCIL ACTIONS						
12	5	11,000	2,000	2,000	SSC's Planning Dept.	Review and update development controls. Specify ratio of pervious/impervious services for all new developments or redevelopments, mandatory sediment controls for all works
13	3	58,000	16,000	16,000	SSC Parks & Waterways Division	Audit of Council work practices and target improvements
14	3	6,000	2,000	2,000	Council	Co-ordinate stormwater management responsibilities within Council sections
15	1-3	30,000	30,000	30,000	All	Increase frequency of inspections of local business and construction sites and penalties/fines for stormwater pollution

Table 10.2: Proposed schedule for the implementation of potential management strategies for the Woronora catchment

Ref No	Schedule for initiation (years)	Expenditure and Financial Year (1st year often includes both installation & operating costs)			Responsible Authority	Option Description
		first year	second-third year	four- fifth year		
16	1-3	2,000	0	0	All	Review fine effectiveness
17	1-3	6,000	2,000	2,000	All	Introduce alternatives to fines – eg suspend building license
18	1-3	95,000	50,000	50,000	Council	Inspection of private sewer lines with sale of houses – Introduce requirement into 176 certificate
19	1-3	7,000	4,000	4,000	Council	Review effectiveness of street sweeping program
20	5	120,000	120,000	120,000	Council	Structure monitoring program to include measure of SWMP effectiveness
21	5	7,000	4,000	4,000	Council	Provide feedback to community on SWMP effectiveness
22	3	1,500	1,000	1,000	Council	Emergency spill plans to accompany development applications that involve hazardous materials ($/application)
23	3	10,000	10,000	10,000	SSC's Planning Division	Introduce procedures to explain development control requirements to recipients of DA
24	1	30,000	10,000	10,000	All	Audit stormwater connections from industrial areas and implement policies to ensure connections are reviewed on sale
25	1-3	27,000	4,000	4,000	All	Increase infiltration measures and amount of pervious surfaces in the catchment i.e. roof drainage and retention, buffer strips, grass swales implement planning policies to comply
26	1-3	12,000	4,000	4,000	SSC's Parks & Waterways Division	Develop and implement best practice guidelines for planting native or low nutrient/water usage plant species in urban parks and nature strips
27	3	15,000	10,000	10,000	SSC's Planning Division	Control dog faeces by implementing Companion Requirements
28	5	75,000	50,000	50,000		Install hidden video surveillance at well used illegal dump sites (rotational) and prosecute
29	1-3	17,000	30,000	30,000	Council	Establish phone hotline to report stormwater management infringements
30	1-2	15,000	10,000	10,000	SSC's Parks & Waterways Division	Initiate propagation of endemic riparian and wetland species in Council nurseries
31	1	20,000	20,000	20,000	All	Co-ordinate weed removal from all drainage lines – incorporate into Council maintenance as well as Bushcare and Landcare groups
32	1-3	10,000	10,000	10,000	Council	Encourage through rebates and mandatory policy the onsite detention of stormwater on all new developments through pervious surfaces, detention ponds, water tanks etc.

Table 10.2: Proposed schedule for the implementation of potential management strategies for the Woronora catchment

Ref No	Schedule for initiation (years)	Expenditure and Financial Year (1st year often includes both installation & operating costs)			Responsible Authority	Option Description
		first year	second-third year	four- fifth year		
33	3	7,000	4,000	4,000	Council	Incorporate preservation and enhancement of natural drainage lines and creeks into planning policies and development controls
34	1-2	12,000	4,000	4,000	Council	Develop a riparian management plan consistent with all other management plans
35	3	10,000	10,000	10,000	Council	Co-ordinate all management plans to comply with overall ESD vision
36	5	10,000	10,000	10,000	All	Encourage installation of rainwater tanks to reduce household runoff
37	1-3	120,000	120,000	120,000	Council	Increase and fund policing of shire to ensure compliance with stormwater objectives
MANAGEMENT						
38	current	7,000	10,000	10,000	SSC's Parks & Waterways Division) DLWC	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks
39	1-3	2,000	0	0	Council	Support SWC's implementation of the sewer prioritisation project as part of the Sewer Overflow Licensing Project (SOLP)
40	1-3	up to 12,000	4,000	4,000	all	Catchment signage raising awareness in recreational areas, shopping centres, waterway crossings, and naming un-named creeks
41	1-3	12,000	4,000	4,000	Council, NPWS, BFB	Fire trails, hazard reduction burns - guidelines, BMP on erosion control measures, design options for construction to prevent erosion
42	1-2	6,000	2,000	2,000	Council	General litter problem – support national and state litter reduction programs, eg. Clean Up Australia
43	1-3	5,000	0	0	CMC	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies
WATER QUALITY- STRUCTURAL						
44	1	10,000	20,000	20,000	Council	Maintain 2 existing constructed wetlands
45	1	5,000 each	10,000 each	10,000 each	Council	Maintain 7 existing Gross Pollutant Traps
46	1	2,000 each	4,000 each	4,000 each	Council	Maintain 4 existing detention ponds
47	1	2,000	4,000	4,000 each	RTA	Maintain 5 existing pollution control structures

Table 10.2: Proposed schedule for the implementation of potential management strategies for the Woronora catchment

Ref No	Schedule for initiation (years)	Expenditure and Financial Year (1st year often includes both installation & operating costs)			Responsible Authority	Option Description
		first year	second-third year	four- fifth year		
		each	each			
48	1	3,000	6,000	6,000	Council	Regular monitoring and cleaning of gully pits
49	1-2	23,000	6,000	6,000	Council	Install and maintain trash rack on Forbes Creek, North Engadine
50	1-2	22,000	4,000	4,000	Council	Install and maintain trash rack Silver Leaf Row, Menai
51	1-2	2,500	1,000	1,000	Council	Install and maintain Nettech trap at Woronora Heights
HOTSPOTS - STRUCTURAL						
52	1-3	60,000	10,000	10,000	RTA	Install and maintain Gross Pollutant Trap (GPT) on River Road, Woronora (work in progress at the time of this report)
53	3	Up to 85,000	10,000	10,000	Council	Install and maintain minor GPTs on selected pipe discharges at the Crescent, Woronora
54	3-5	25,000 – 115,000	10,000	10,000	Council	Still Creek – assess site locations, install GPTs on untreated tributaries
55	1-3	6,000	2,000	2,000	Council	Woronora Cemetery – install trash racks or Nettech devices on drainage outlets
56	1-2	27,000	4,000	4,000	RTA	Heathcote Road crossing of Woronora River – install traps to treat runoff from road
57	1-3	65,000	10,000	10,000	Council	Heathcote Industrial area – install GPT at discharge to local drainage system
58	3	32,000 each	4,000 each	4,000 each	Council	Playing fields at Bangor, Yarrawarrah, Woronora Heights, Sutherland and Bonnet Bay: install and maintain perimeter drains before discharge to trunk drainage system
59	1-3	27,000	4,000	4,000	Council	Shopping centre – install trash racks interceptor pits

11 Monitoring and Revision of Plan

In response to community concerns about water quality in the catchments managed by Sutherland Council, a Strategic Water Quality Monitoring Program (SWAMP) in 1994. This monitoring is undertaken biennially from stormwater drains in sub-catchments affected by urban landuse. Generally about 40-45 sites are sampled throughout the Sutherland Local Government Area.

The data collected over the past four years provides a reasonable indication of existing water quality within the catchment. There are data gaps since the sampling regime was not continuous. Samples were taken in a random manner, at non-regular intervals in an effort to maximise detection of pollution events (Sutherland Council, 1997). This data will be useful for future comparison in determining the effectiveness of the works and strategies implemented as part of this plan.

The monitoring program will be continued and be expanded to sampling in each season rather than just summer and winter. Inclusion of flow gauging at each site is also recommended, this would enable Council to undertake computer based hydrological modelling to provide stormwater runoff values and assess proposed structural measures to address identified hotspots. Gauging will also assist in detecting trends in flow volume over the time and season.

The monitoring process is to be assessed and reviewed for its effectiveness every 2 years. New water quality sites are to be added to this program as deemed necessary. Trash racks and GPT's will be monitored while maintenance/cleaning works are carried out. Litter and sediment volume should be recorded and compared between site and those sites over time.

Monitoring of the effectiveness of education programs will continue to be carried out through a series of questionnaires and interviews. Review is to be conducted every two years to assess the effectiveness of the education programs and to reinforce the message to the general community. How and where the questionnaires are carried out will depend on the target audience and the means by which the message was conveyed.

11.1 Revision of Plan and Reporting

The results of these environmental monitoring programs will be reported in Sutherland Council's State of the Environment Reports. In addition, this information will be available to provide valuable input into the refinement and revision of this Stormwater Management Plan in future years.

A position will be nominated, rather than a person, for the co-ordination of the monitoring program and the responsibilities of this new function will be part of the position job description.

For the self-regulatory process to succeed the nominated position will be any other than the Stormwater Manager. As such, there will be more onus on the

Stormwater Manager to implement the SWMP if the auditing process is conducted by another section within Council.

To monitor progress, targets will be set in order for comparisons to be made. To ascertain the effectiveness of the SWMP, Performance Indicators (PIs) will be established for various aspects of the plan and these PIs will be assessed after the first year of implementation and then on a two yearly basis.

The monitoring program will assess four core areas:

- planning;
- water quality;
- pollution control devices; and
- education.

For each area the program will evaluate the level of adequacy and ascertain the need for further improvement.

Table 11.1: Performance Indicators

Task	Responsibility	Performance Indicator
Planning		
Establishment of inner Council working group	Council Stormwater Manager	• Minutes of meetings (quarterly).
Funding program, including a timetable for implementation of structural options	Council Stormwater Manager	• Program to be established within 6 months of the SWMP being accepted.
Establish a Stormwater Steering Committee with representatives from each key stakeholder	Council Stormwater Manager	• Minutes of meetings (half yearly); • SWM to report on deliverables.
Develop a brochure on DA requirements	Planning Department	• Brochure to be completed within 6 months of the SWMP being accepted.
Integrate ESD vision into management plans and policies	Planning Department	• ESD principles to be fully integrated into all policies within 12 months of the SWMP being accepted.
Develop Urban Bushland Action Plan (prioritise areas and funding)	Environmental Science Unit	• Program to be established within 6 months of the SWMP being accepted; • Record of program schedule.
Water Quality		

Task	Responsibility	Performance Indicator
Set baseline for water quality (parameters and year)	Environmental Science Unit	• Benchmark to be established within 12 months of the SWMP being accepted.
Establish water quality targets (based on Healthy Rivers initiative and ANZECC guidelines)	Environmental Science Unit	• Targets to be stated in Council's Environment Policy within 12 months of the SWMP being accepted.
Water quality monitoring	Environmental Science Unit	• Water quality data records.
Reporting of water quality data and whether targets are being achieved.	Environmental Science Unit	• State of Environment Report (annual).
Conduct Pollution Source Inventory	Environmental Science Unit	• Report to be completed within 12 months of the SWMP being accepted.
Initiate monitoring of bioindicators	Environmental Science Unit	• Monitoring to be started within 12 months of the SWMP being accepted; • Record of monitoring results; • State of Environment Report (annual).
Pollution Control Devices		
Set baseline for volume of "rubbish" retrieved from PCDs	Stormwater Manager	• Benchmark to be established within 12 months of the SWMP being accepted.
Establish reduction targets	Stormwater Manager	• Targets to be stated in Council's Environment Policy within 12 months of the SWMP being accepted.
Monitoring of TRs and GPTs	Stormwater Manager	• Maintenance/cleaning schedule; • Data records stating volumes and types of "rubbish" retrieved.
Reporting of volume of "rubbish" retrieved from the PCDs and whether targets are being achieved.	Stormwater Manager	• State of the Environment Report (annual).
Education		
Initiate audit of Council practices to improve performance and awareness	Stormwater Manager	• To be established within 12 months of the SWMP being accepted; • Record of follow-up audits (biannually) to assess continual

Task	Responsibility	Performance Indicator
		improvement; • Record of adequacy of improvements (as required).
Establish an awareness campaign aimed at schools	Stormwater Manager, community liaison officer, Environment Services	• Program to be implemented within 12 months of the SWMP being accepted; • Record of schools attended; • Feedback mechanism (questionnaires).
Initiate audit of industrial and commercial premises in conjunction with awareness campaign.	Environmental Science Unit	• Program to be implemented within 12 months of the SWMP being accepted; • Record of businesses audited; • Outcomes of audits; • Follow-up audits and/or feedback mechanisms (questionnaires) to assess the success.
Creek Rescue Program	Council Stormwater Manager, community liaison officer	• Program to be implemented within 12 months of the SWMP being accepted; • Record of local bushland groups and schools participating; • Record of achievements.

Revision of this plan may be appropriate in the following situations:

- when significant additional monitoring data is available;
- if significant, additional funding for stormwater management becomes available; and
- following the completion of significant additional investigations.

The implementation of this plan and the effectiveness of the proposed management works will need to be continually reviewed. It is recommended that a brief review occur annually and a detailed review every four years.

12 Conclusions

This stormwater management plan has been developed in consultation with Council, stakeholders, industry groups and the local community. The plan sets out the management options necessary to improve aspects of the environment currently impacted from stormwater pollution.

The management options have been developed through an iterative process where hotspots were identified, community issues were raised, industry groups were consulted and community values were assigned to put into context the potential stormwater management options. A mix of structural and non-structural options is outlined with a strong emphasis on community (including Council and stakeholder) education. The inclusion of the 'whole community' approach is fundamental in ensuring an effective, outcomes based plan. The education program can be very effective in at source-control.

Significant improvements in receiving water and receiving environments are envisaged by implementing both short and long term management options outlined in this plan.

It is apparent that to achieve a Total Catchment Management approach to stormwater pollution there needs to be an integrated, cooperative dialogue between key stakeholders including Council, Catchment Management Committees, State Rail Authority, National Parks and Wildlife Service, Roads and Traffic Authority and Sydney Water Corporation. This dialogue must include sharing of information, coordinated approaches to structural and non-structural initiatives and coordination of funding options.

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Appendix 1
Community Consultation Outcomes

Woronora Stormwater Quality Issues

Group 1

- increase in levels of pollutants - litter (macro), nitrates, phosphates heavy metals
- lack of stormwater management - no gross pollutant traps
- increase of sediment off escarpment
- rectify past mistakes - particularly creek lines, changing natural flows
- costs should not be the determining factor for stormwater decision making
- redefine what 'stormwater' should be - (perception that wider community do not understand the term)
- increase monitoring using biological indicators of water quality
- sewerage surcharge - overflows from Sydney Water
- building site silt run-off
- increased impervious surfaces
- reduction of public access
- impact on bushland by redistribution of run-off - *impacts of water contaminants*
- community education and awareness program stepped up, focusing on catchment issues and their responsibilities
- site specific responsibility for stormwater quality and quantity

Priority issues for this group

- increase in impervious surfaces
- need for long-term monitoring using biological indicators of water quality
- increase in levels of pollutants - litter (macro), nitrates, phosphates & heavy metals

Group 2

- urban runoff increase - higher rates of runoff
- rubbish, nutrients, sediments, chemicals in runoff (includes dumping) prevention needed
- industrial and commercial runoff
- Lucas Heights tip - leaching from site
- low level radioactive waste in water (slug let out into sewer system - overload, overflow)
- inefficient source control - especially at the top of escarpment/upper catchment
- efficient maintenance - funding needed of source controls (developers, Councils, Government agencies)
- lack of wetlands - use of artificial ones - need more

- too much impervious surface
- lack of monitoring of water quality control measures
- impacts of pollution of oysters - winter use only due to QX
- monitoring shows excessive (Forbes, Still, Heathcote Creeks), levels of ammonia, copper, enterococci, suspended sediments etc - what actions must be taken to address this?
- excessive algal growth affecting sea grass
- siltation -bury sea grass, contaminated sediment
- health issues- swimming in unsafe areas , risk of viruses and bacteria, ie. consumption of oysters/fish
- effluent overflows in water (wet weather)
- overflows (dry weather) from cracked pipes and joints
- dumping of rubbish
- roadside runoff - sediment, oils and grease
- bushland issues - weeds, litter, fire management - erosion, ash/nutrients wash into water, fish kills, etc.

Priority issues for this group

- water quality/pollutants
- source control
- reduction in impervious surface, eg. paving
- intermediate treatments/controls, eg. wetlands
- downstream aquatic habitat damage
- public education
- prioritise protective measures at top of catchment - TCM
- lack of erosion and sediment controls on building sites

Actions to Manage Priority Stormwater Issues – Woronora Catchment

Group 1

Source Control/Whole Catchment Approach

- holding tanks on site – public and private
- siltation traps
- building regulations – enforcement of existing regulations
- decrease impervious surfaces per property
- heavy fines for offenders – public and private
- reduce piping – integrate natural and artificial water courses
- more funding for monitoring and surveillance
- all pipes (4 ft diameter to be fitted with GPTs). Note: there was some discussion relating to dimension of pipes, case by case basis was suggested
- GPTs regularly maintained
- raise public awareness, increases political will and increase funding dollars
- GPTs and/or artificial wetlands (where geographically possible)
- retention and protection of bushland remnants
- name all waterways/creeks/drains and identify on maps for general distribution

Public Awareness

- through fines
- justify the costs of rates by detailing environmental outcomes
- on-going ad campaign, e.g. slip/slop/slap, Clean up Australia
- in all media – talks (schools), newspaper, radio, TV, rate notices – on the rate notices not as separate leaflets
- Neighbourhood Watch – encourage local pride and protection of local creeks and bushland
- public agencies to be exemplary as role models
- support local bushcare groups – Council, NPWS, Landcare
- co-operation between bushcare groups – communication on catchment and sub-catchment levels
- catchment issues to be put on the agenda at local community forums, e.g. Woronora River Residents Environment Action Committee, Woronora Valley Precinct, Woronora Valley Association
- support the Georges River CMC as an avenue for Woronora catchment problems

Group 2

Source Control

- public education
- develop land within its natural resource capacity
- limit further urbanisation
- on-site controls, inspection and regulation by Council
- retention of sustainable buffer zones (bushland, riparian…)
- use of environmentally friendly designs, e.g. less hard engineering/softer options, less impervious surface percentage
- installation of erosion and sediment control measures at building sites
- audit existing housing, estates, etc. for stormwater compliance
- better co-ordination between authorities re: source control and partnerships (NPWS, Councils, RTA etc) for structural controls, strategies, planning, etc.
- roof tanks/reuse water need incentives for older development
- street sweeping rather than the washing
- private sewer lines need inspection and repair at conveyance

Whole Catchment Approach

- retain natural drainage system
- restore drains to more natural functioning creek/ wetlands where feasible
- link this stormwater plan to Georges River REP (Regional Environmental Plan)
- all stakeholders share burden of installation and maintenance costs of GPTs etc
- new development should have no detrimental impacts permitted
- extend buffer zones, conserve bushland
- control mining discharges and spoils
- control animal husbandry runoff
- no development on ridgetops
- co-operation between all authorities in management and public education

Public Education

- encourage recycling/mulching
- use of rain tanks
- media releases regarding prosecution of offenders
- all parts of council not just stormwater section should be involved in the community education
- public meetings/competition/schools

- educate building and other industries through training and audits, BMPs (Building Management Plans)

Catchment Values

Group 1

- good water quality to improve the flora and fauna to encourage a return to the original biodiversity (provide nursery for the greater marine environment).
- improve preservation of the environment for future generations
- preserve the amenity of the river for swimming, boating, fishing and recreation

Group 2

- ability to swim, fish, for boating all days of the year
- aesthetics of the river
- a more healthy aquatic system
- a much better river, improving water quality for fish, swimming and kayaking (but not big boats).
- retain and restore natural bushland remaining on all escarpments
- no more development on river flats/ floodplains
- revival of the oyster industry
- lower pollution input from creeks and roads

Appendix 2
Ranking Methodology

Options Ranking Methodology

The proposed options for management of stormwater in the Woronora River have been assessed on the basis of their costs and benefits. The methodology employed below was developed by the EPA (1997) and provides a management tool for the ranking of solutions to stormwater problems.

The management strategies evaluated in the tables below were derived in consultation with a number of stakeholder groups. The methodology used and a description of the various cost/benefit components are provided in Sections 1.1-1.3. Table 2.1 quantifies the various cost/benefit components while Table 2.2 summarises the outcomes and orders the options according to the results in Table 2.1.

1. Management Options

***OPTION NO.*:** Management option I.D. number – randomly allocated.

***AUTHORITY*:** Indicates the agent responsible for implementing the proposed action. Probability of success is increased if all stakeholders work together.

All	all stakeholders
Council	Sutherland Shire Council
CMC	Georges River Catchment Management Committee
EPA	NSW Environment Protection Authority
DLWC	Department of Land and Water Conservation
RTA	Roads and Traffic Authority
NPWS	National Parks and Wildlife Service
RSA	Rail Services Authority
DUAP	Department of Urban Affairs and Planning
SWC	Sydney Water Corporation

STRATEGY TYPE: The options have been categorised into:

ED	Education
MAN	Management
ST	Structural
AU	Auditing/Enforcement

DESCRIPTION: Describes the option.

2. Costs

CAPITAL: The estimated initial cost incurred with the adoption of the management option. Includes feasibility and structural costs. Table 1.1 includes the relative weighting associated with each cost category.

MAINTENANCE: The estimated cost for on-going maintenance over a 3 – 5 year period.

Table 1.1: Cost Weighting – installation and maintenance/operating

Cost	Weighting
$0-2,000	1
$2,001-5,000	2
$5,001-10,000	3
$10,001-15,000	4
$15,001-20,000	5
$20,001-30,000	6
$30,001-50,000	7
$50,001-75,000	8
$75,001-100,000	9
$100,000+	10

If the implementation of the management option is undertaken on a joint basis, costs should be viewed as approximate total implementation costs. Relevant stakeholders will need to negotiate proportional payments.

Where the implementation of an option requires input from council officers, costs is estimated using a guide of $1000/week/officer.

COST INDEX: Is the average of the capital and maintenance costs. The average is related to the weightings in Table 1.1 where 10 indicates the highest cost option while an index of 1 indicates the lowest cost option. ***This is a relative index.***

3. Benefits

TARGET POLLS: The pollutant most likely to be affected by implementation of the management option. Table 1.2 includes the weighting associated with the relative harm of each target pollutant.

Table 1.2 : Target pollutants and their relative harm

Target Pollutant	Relative Harm
Litter	2
Nutrients	4
Sediment	4
Weeds	5
Bacteria	5
Oil and Grease	6
Organic Matter	7
Heavy Metals	7
Toxins	8

Source: EPA (1998)

NO. OF POLLUTANTS: The number of pollutants likely to be captured or affected by the management option.

AREA: The area that will attract the potential benefits of the management option – described in hectares. Table 1.3 includes the weighting associated with each area category.

Table 1.3: Proportion of catchment benefited by the management option

Hectares	Area%	Weighting
0-1740	0 – 10%	1
1741 – 3480	11 –20%	2
3481 – 5220	21 – 30%	3
5221 – 6960	31 – 40%	4
6961 – 8700	41 – 50%	5
8701 – 10440	51 – 60%	6
10441 – 12180	61 – 70%	7
12181 – 13920	71 – 80%	8
13921 – 15660	81 – 90%	9

15661 – 17400	91 – 100%	10

EFFECTIVENESS: The effectiveness of the option in managing the pollutant.

Table 1.4 includes the weighting associated with each effectiveness level.

Table 1.4: Effectiveness of option in managing the pollutant

Effectiveness	Weighting
Low	1
Medium-Low	3
Medium	5
High-Medium	7
High	10

EDUCATION: The level of education awareness, and consequently enhanced source control, the option will provide to the community. Table 1.5 includes the weighting associated with the level of education awareness.

Table 1.5: Level of education awareness provided by the option

Effectiveness	Weighting
Low	1
Medium-Low	3
Medium	5
High-Medium	7
High	10

BENEFIT INDEX: The sum of the benefits divided by seven (7). Each benefit index will range in value from 1 to 10 with 10 being the most desirable outcome.

4. Ranking of Options

COST/BENEFIT: The cost benefit of an option is calculated by dividing the cost index by the benefit index. The lower the resulting number the more desirable the option.

Cost Benefit Score *(A lower score indicates a more favourable option)*	=	***Cost Index*** *(A lower index indicates a less costly effective option)*	/	***Benefit Index*** *(A higher index indicates a more*

RANK: The overall rank of the option with 1 being the most favourable ranking.