Report

Hacking River
Stormwater Management Plan

For

Wollongong City Council
Sutherland Shire Council

September 2000

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GLOSSARY

CDS	Continuous Deflector Separators
clastic	sediments consisting of broken rocks, which have been eroded, transported and deposited at a different site. Characteristically found in the littoral (that between the high and low water marks) zone of the coast
CMC	Catchment Management Committee
DLWC	Department of Land and Water Conservation
DUAP	Department of Urban Affairs and Planning
estuary	The mouth of a river where it broadens into the sea and within which the tide moves, leading to an intermixing of saline and fresh water.
EPA	Environment Protection Authority
HRCMC	Hacking River Catchment Management Committee
HIA	Housing Industry Authority
LEP	Local Environment Plan
NCUCA	National Carpet and Upholstery Cleaning Association
NPWS	National Parks and Wildlife Service
orographic	the type of precipitation resulting from the uplift of an airstream by a topographic barrier
REP	Regional Environmental Plan
RTA	Roads and Traffic Authority
RSA	Rail Services Authority
SEPP	State Environmental Planning Policy
shoal	a bank of coastal sediment that rises almost to the surface of the sea, thereby creating a navigation hazard.
SPCC	State Pollution Control Commission
SSC	Sutherland Shire Council
stratification	the formation of distinct temperature layers in a body of water
SWC	Sydney Water Corporation
TCM	Total Catchment Management
WQOs	water quality objectives

1 Introduction

1.1 Purpose of this Plan

This document is the Draft Stormwater Management Plan (SMP) for the Hacking River Catchment (refer to Figure 1). The Hacking River Catchment has an area of approximately 225 km² and is located between Wollongong and Sydney. The catchment starts in the vicinity of Otford and empties into the Pacific Ocean via Port Hacking. The catchment comprises areas, which are part of the Councils of Wollongong and Sutherland.

The plan has been developed cooperatively by Wollongong City and Sutherland Shire Councils. Sutherland Shire Council being responsible for the largest portion of the catchment, coordinated the preparation of the plan.

The aim of this plan is to improve the management of stormwater within the Hacking River Catchment. The plan contains implementation strategies for Sutherland and Wollongong Councils, the Roads and Traffic Authority (RTA) and other stormwater managers within the catchment.

1.2 Framework for Preparing this Plan

This plan has been prepared to comply with the requirements of a notice issued to Sutherland and Wollongong Councils 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 Hacking River Catchment. There are currently no other plans or reports that provide a framework for this plan.

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

- Environmental Planning & Assessment Act 1979;
- Local Government Act (NSW) 1919;
- 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);
- Port Hacking Plan of Management, 1992;
- Royal National Park Management Plan;

- Wollongong City Council LEP 1990
- Sutherland Shire LEP, 1993;
- draft Sutherland Shire LEP, 1999;
- Sutherland Strategic Plan; and
- draft Shaping the Shire Plan.

The EPA (1997) released a series of proposed interim water quality 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.

1.3 Stakeholder Consultation

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

- Cronulla Precinct Committee;
- Department of Land and Water Conservation (DLWC);
- Department of Urban Affairs and Planning (DUAP);
- Hacking River Catchment Management Committee (CMC);
- Housing Industry Association (HIA);
- Illawong Rural Fire Service;
- Landcom;
- Miranda Precinct Committee;
- Mullaley Properties;
- National Carpet and Upholstery Cleaning Association (NCUCA);
- National Parks and Wildlife Service (NPWS);
- North Cronulla Precinct Committee;
- NSW Environment Protection Authority (EPA);
- NSW Fisheries Department;
- Otford Valley Farm;
- Port Hacking Professional Society;
- Restaurant and Catering Association (RCA);
- Roads and Traffic Authority (RTA);
- State Rail Authority (SRA);
- Sydney Water Corporation (SWC); and
- the 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 preparation of this plan. These meetings discussed management issues and the draft management plan. The outcomes of the community consultation process are included in Appendix 1. Interviews were conducted with Industry members of the HIA, RCA and NCUCA. The outcomes of these interviews are summarised in Appendix 3.

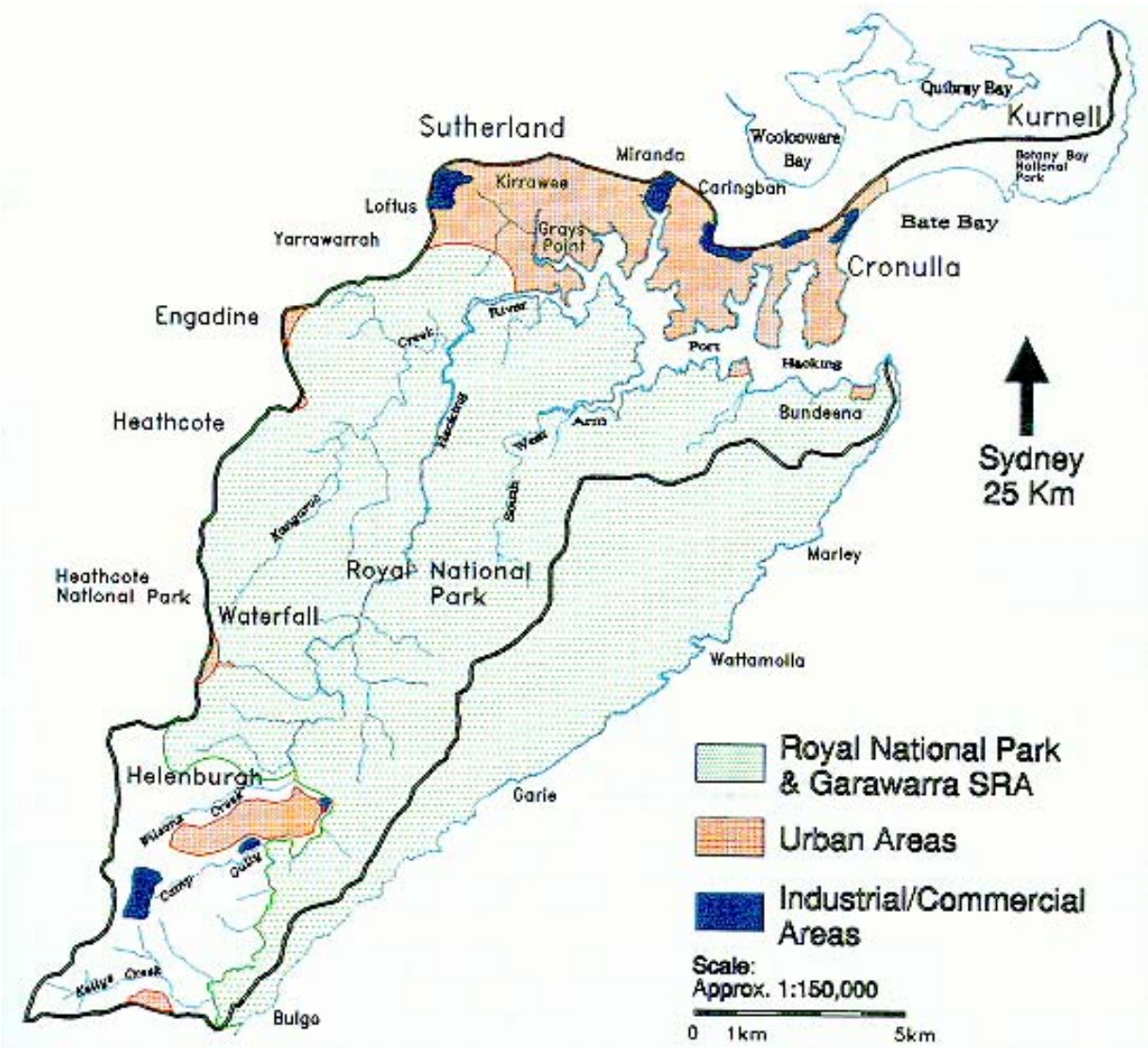

Figure 1 Hacking River Catchment Map

Source: Knowles (1996)

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 and Wollongong City Council undertake most of the planning, construction, maintenance and operation of the stormwater system in the catchment. Sutherland Shire Council undertook a study of the current status of stormwater in the Shire in 1991. The results of this study refer to assets within the whole of the Shire and not just the Hacking catchment, but are useful to gain an idea of the extent of stormwater management involved:

- there are approximately 600 km of stormwater drains both piped and unpiped, in addition to natural watercourses;
- drains outfall through approximately 500 outlets;
- fifteen of the major outlets have large industrial, commercial or retail areas in their catchment areas;
- the 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, trace metals, oils and surfactants; nutrients and sewage.

The Stormwater Quality Study (Sutherland Council, 1991) recommended the following:

1. that a pilot study be undertaken to test 12 drains/creeks for a period of 10 days to determine pollution levels and loadings;
2. that a Stormwater Management Policy be formulated and a Stormwater Management Manual be prepared and submitted to a future council meeting for consideration;
3. that appropriate water quality structures be included as part of drainage designs for works included in future construction programmes, where applicable;
4. that gross pollutant traps and/or other permanent water pollution control measures be incorporated by developers into any major new subdivision;
5. that a further report be prepared when the results of the stormwater pilot study are known; and
6. that a report be submitted to Council addressing the merits of piping open drains/creeks compared with the benefits of maintaining them in an open form.

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. Sutherland Shire Council 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 programme has installed water pollution control devices in several parts of the catchment. The locations and types of existing devices are shown on Figure 2.

Both Councils also have a regular street cleaning programme, which cleans major shopping areas and main streets. Sutherland Shire 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.

Sydney Coastal Councils (1997) 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

State government bodies are responsible for policy coordination (EPA), catchment planning (DLWC), land use planning, education, regulation, road management (RTA), stormwater system management, as well as land and housing development (HIA) (NSWEPA, 1996b). Catchment Management Committees (CMCs) and other coordinating bodies also have a role in stormwater management.

This Stormwater Management Plan aims to outline specific control measures to address stormwater issues and impacts within the Hacking Catchment. This plan provides both short-term and long-term strategies for maintaining and/or improving stormwater quality and other environmental impacts (including flow regime, bank erosion etc) based on catchment issues, incorporating a monitoring programme and review phases to determine its effectiveness.

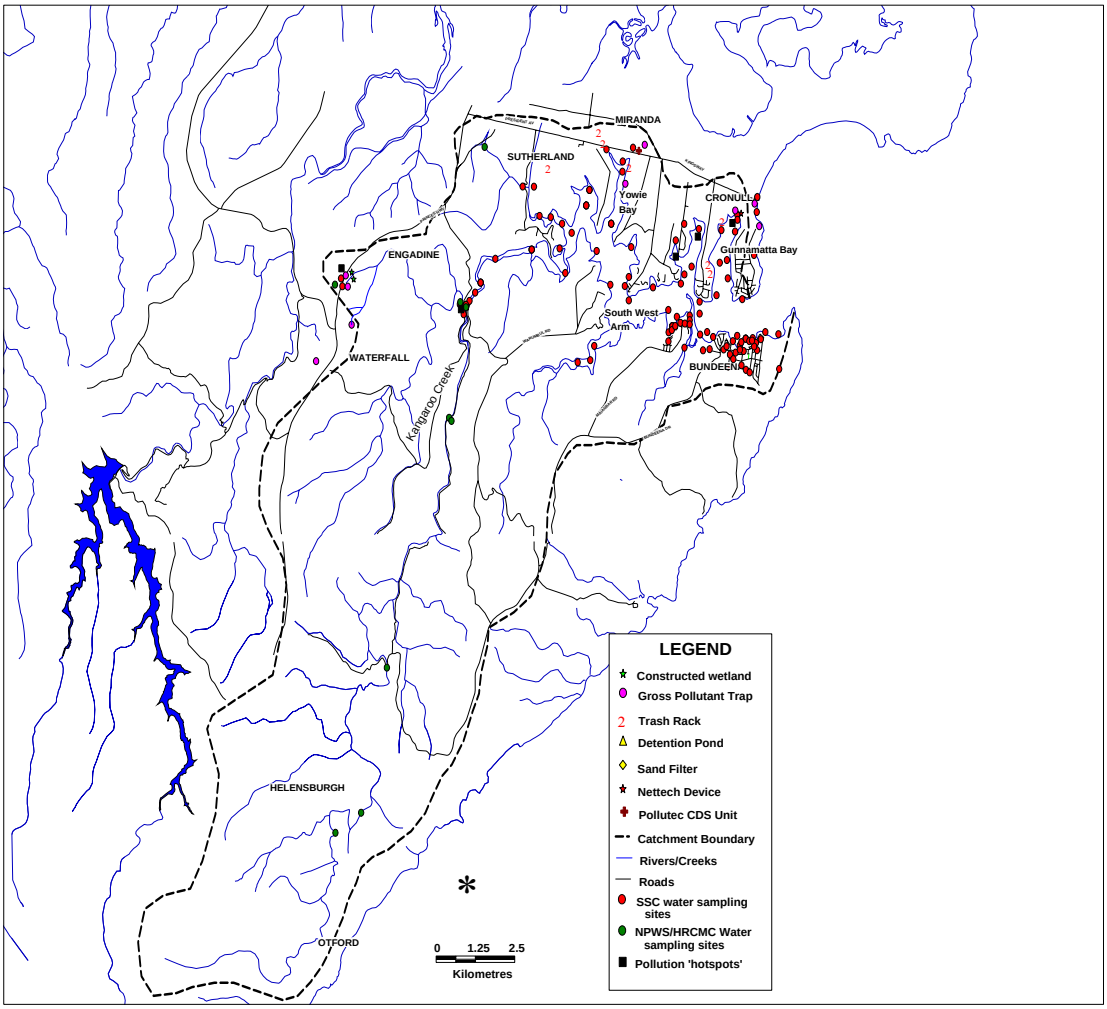

Figure 2 Existing pollution control devices in the Hacking catchment

3 Catchment Description

The Hacking River originates as Kellys Creek located west of Otford and flows in a north-easterly direction through the Royal National Park to the weir at Audley (Knowles, 1996). This section of the catchment is commonly referred to as the Upper Catchment and is predominantly natural bushland apart from the small semi-rural townships of Helensburgh, Otford and Stanwell Tops. A small section of east Heathcote also drains into the river above the weir.

The weir at Audley divides the freshwater upper catchment from the mainly estuarine lower reaches of Port Hacking, which eventually drains to Bate Bay and the Pacific Ocean. The land south of the Port is primarily National Park with the small townships of Bundeena and Maianbar located just outside the boundary of the park. The north side of the Port is urbanised, including small pockets of commercial and light industrial landuse.

The Hacking River falls under two classifications in the Clean Waters Act 1970:

Class P Protected Waters – applies to the Hacking River and its tributaries above the weir at Audley and all waters within the Royal National Park. Discharges of effluent into Class P waters are limited to discharges of effluent of high quality.

Class C Controlled Waters – applies to the Hacking River and its tributaries below Audley weir. Effluent discharges into controlled waters are allowed provided treatment for the removal of contaminants is carried out and the discharge will be adequately diluted in receiving waters.

Helensburgh Landcare Group provided the following information on four creeks within the Hacking River catchment where participate in Streamwatch:

Wilsons Creek runs through Garrawarra State Recreation Area except for the area at the head of the creek. This area is subject to run-off from small industrial lots in which activities such as horse stabling, growing Proteas for cut flower market, wholesale nursery bulk soil, compost, mulch etc and kitchen manufacturing. Trail bike riders and horse riders use unsealed tracks in Garrawarra SRA extensively.

Camp Creek is mostly affected by run-off from urban lots. It also runs through the Metropolitan Colliery prior to the sampling site and so could be affected by any run-off from this operation.

Gills Creek most of this sub-catchment is rural, including several horse agistment properties, Symbio Koala Gardens, Binners Egg Farm and Baines concrete batching plant lie within its catchment.

Kellys Creek most of this sub-catchment before the sampling site is bushland. However, it is affected by run-off from a disused sand-mining site, which is now used extensively by trail bikes. Also multitudes of trails

are located within the bushland and are used by horse riders and possibly trail bike riders.

3.1 Land Use

The Hacking River Catchment is located between Sydney and Wollongong and is unique in that over 60% is natural bushland, despite its proximity to these two large urban centres (Knowles, 1996). The Hacking River catchment is used extensively for recreation. The Royal National Park (RNP) and the Garawarra State Recreation Area (GSRA) provide a valuable recreational resource for the metropolitan population and as such the area is heavily utilised. These areas support a diverse range of flora and fauna species. There are also a small number of urban, industrial and commercial areas (refer to Table 3.1).

Table 3.1: Estimated Landuse within the Hacking Catchment

Type of Landuse	Approximate Area (ha)	Approximate % of Total Catchment
Residential	4350	21%
Commercial	70	0.5%
Industrial	680	4%
Special Use	440	1.5%
Open Space	15260	73%

3.2 Topography

The Hacking Catchment has unique physical characteristics. Steep topography is a particular feature of the upper catchment. The Hacking catchment is associated with the Woronora Plateau, which lies east and south of the Cumberland Plain. It is a deeply dissected sandstone plateau with Wianamatta Group shales occurring as thin lenses. Upland swamps are common features towards the coast (Hazleton & Tille, 1990).

The Illawarra escarpment, which incorporates Helensburgh, is on the eastern edge of the Woronora Plateau. The escarpment consists of cliff faces below which lies a large continuous talus mantle on steep slopes of bedrock (Hazelton & Tille, 1990).

3.3 Geology and Soils

The soils are derived from the sandstone and shales of the Hawkesbury Sandstone, Narrabeen and Wiannamatta Groups (refer to Table 3.2). These soils tend to be highly clastic and in conjunction with the steep topography and heavy rainfall of the catchment are easily eroded. The erodibility of the

soils on the catchment is an important consideration concerning the management of the area.

The upper catchment is made up of steep Hawkesbury Sandstone slopes and ridges, with narrow incised valleys and rolling hills (Hazelton & Tilley, 1990).

Table 3.2: Soils types and properties within the Hacking River Catchment

Soil Landscape	Soil Depth	Erosion Hazard	Fertility
Gymea	• shallow to moderately deep, 30-100 cm	high	very low
Hawkesbury	• shallow, <50 cm	moderate to extreme	very low
Bundeena	• shallow to moderately deep, 40-150 cm	high to extreme	very low
Yarrawarrah	• shallow to moderately deep <20 to >50 cm	high	very low
Wollongong	• deep >200 cm	extreme	low to moderate
Watagan	• shallow to deep, 30-200 cm	extreme	low to moderate
Kurnell	• deep >200 cm	extreme	low

Source: Hazelton & Tilley, 1990

3.4 Climate

The Hacking 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 coastal areas of Port Hacking have an annual rainfall of approximately 1200mm. On the coastal plateau, there is an average, annual rainfall of 1470mm (Hazelton & Tilley, 1990). Winds are predominantly westerly with occasional severe storms from the south and south-east.

4 Existing Catchment Conditions

4.1 Hydrology

Sydney Water and the University of NSW have operated a stream gauging station at the causeway on the Hacking River between 1961 and 1992 (Station No. 214340). The average monthly flow recorded at this station is summarised in Table 4.1.

These data indicate that the monthly runoff generally peaks in late autumn and early winter, with a low in summer. Flooding of urban drainage systems can occur in low-lying urban and commercial areas at Cronulla, Caringbah, Miranda, Gymea, Kirrawee, Sutherland and Engadine. The investigation of flooding is beyond the scope of this plan.

Table 4.1 Average Streamflow at Monitoring Station No. 214340 (Megalitres per day) Hacking River

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
jan	47.354			9.074		17.004	69.896			5.786	21.088
feb	99.157		57.412	34.207	103.01		24.981	11.483		51.83	10.336
mar	95.85	92.619							14.815	9.376	23.962
apr	48.634	59.09		73.906	59.239	21.003	91.737	25.511	7.31	66.713	12.918
may		28.115		35.531	44.151	45.459	34.644	53.901	36.544	37.775	
jun	22.174	30.097			78.967	52.303		66.667		26.602	16.347
jul	19.174	68.501	31.447		81.469	21.939	86.613	28.539		16.852	17.02
aug	13.585	29.927		24.533	29.274	15.057	27.28	14.554	10.702	12.66	8.845
sep		16.397	50.538	14.101	24.817		28.258	12.45	7.098	9.923	49.619
oct		48.597	35.552	35.908	161.91	5.193	36.676	12.926	5.669		22.058
nov	12.585	53.2	47.21	26.926	120.344	5.645		11.386	5.921	73.036	7.142
dec		18.681		11.021	26.32	5.948		7.212	2.513	25.358	5.099
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
jan	3.996	48.837	7.489		11.935			27.425	10.03	51.154	19.718
feb	1.165	79.894	7.427	48.683	8.047	15.329			4.704		13.965
mar		59.781	10.153	24.382	16.191	11.214			1.96	63.541	
apr		80.064	77.16	19.678	6.99			288.367	0.2	74.976	
may	134.544	52.399	113.042	24.637	13.374	96.713	184.337	139.201	8.787	46.498	
jun	97.95	47.983	79.588	11.575	9.161	46.778	181.639	79.182			
jul	29.653			9.931	18.727		52.533	40.148	20.666		
aug	16.133	41.909				24.733	30.157		17.392	18.985	
sep	15.352	15.362	23.389	25.659	41.381	45.767		35.522	10.814	11.911	
oct	54.306	11.405	120.461	43.57		12.161	16.189	23.252	6.292	11.2	
nov	21.299		72.084	95.185	74.319	36.586	14.621	9.867	8.69	24.78	
dec	20.575	15.375		20.765	23	33.778				62.966	

4.2 Fluvial Geomorphology

The Hacking River originates as Kellys Creek located just west of Otford and flows in a north-easterly direction through the Royal National Park to the weir at Audley. The Audley weir divides the freshwater upper catchment from the mainly estuarine lower reaches of Port Hacking (HRCMC, 1996).

The upper reaches of the river and its tributaries originate on the Illawarra escarpment and are steep and incised through bedrock, with no floodplain development. As the main channel reaches the rivers middle reaches the gradient of the river lessens and the channels become less incised. On approaching the Port Hacking Estuarine zone the river becomes wide and shallow with extensive sediment deposition in the main channel.

The Port Hacking estuarine zone extends from Bate Bay to the upper reaches of the estuary at Audley Weir. The catchment draining to Port Hacking is relatively small, being approximately 22,500 hectares.

Geographically, the estuarine zone is typical of a drowned river valley with a sand sill overlying the bedrock channel at the entrance between Bate Bay and Lilli Pilli. In this area the waterway is shallow (typically less than 2 to 3 metres deep) and consists of a series of shoals and channels. Further upstream of the shoals is the central section of the estuary and North West Arm. The central section of the estuary and the side embayments beyond the sand sill are deep, with depths 12 metres deep and up to 26 metres deep in the North West Arm.

Shoals occur in the estuary as deltas in two distinct areas: the riverine and marine deltas. The riverine delta is formed by sediment carried down the Hacking River and its tributaries, especially during floods. The marine delta consists of marine sands brought in long ago by the ocean and deposited by wave and tidal action (Public Works Department, 1986).

Sutherland Shire Council (1992) identifies siltation of the riverine delta in the Hacking River from the weir at Audley to opposite Grays Point, which has resulted in the deposition of 10,000 cubic metres of sand per annum. It is assumed that this additional sedimentation has decreased flushing and subsequent dilution of pollutants within the Port (Knowles, 1996).

Flow measurement and modelling indicate that the flushing characteristics of the estuary are adequate to maintain good water quality conditions within the estuary given the relatively small pollutant loads. The Public Works Department estimated a flushing time of two days for the waterway seaward of Burraneer Point. The model predicts reduced flushing times as the distance increases up the estuary, from 1 day near Hungry point, up to 5 days upstream of Burraneer Point, 10 days near Lilli Pilli and greater than 20 days upstream of Gymea Bay.

Freshwater inflows from stormwater result in stratification of the water column in the deeper bays, with the freshwater flowing as a shallow surface layer over the saline estuary water. The major freshwater inflow point is at Audley Weir.

4.3 Water Quality

The water quality in the Hacking River catchment is impacted by various land uses within the catchment, including residential, commercial and industrial (Sutherland Shire Council, 1999). Numerous water quality studies have been carried out in the receiving waters of the Hacking catchment, particularly in the last 10 years, with the vast majority of water quality data collected for Sydney Water.

Since 1994, Sutherland Shire Council has undertaken a biannual stormwater monitoring programme to detect trends in water quality reflecting land use from selected sites in the catchment.

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 Freshwaters (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

Estuarine Waters

Sutherland Council/ Hacking Catchment Management Committee Studies

The Hacking River Catchment Management Committee (HRCMC) in 1996 commissioned a study of the water quality of the Hacking River catchment receiving waters. In general terms, the water quality of the Port Hacking estuary was suitable for recreational activities and protection of aquatic ecosystems (ANZECC, 1992) with water suitable for primary recreational contact on the greater majority of days. Dissolved oxygen levels between 90-110 and turbidity levels of less than 5 NTU are characteristic of the estuary (Sutherland Shire Council, 1992).

The estuary is flushed by tidal activity, particularly the lower estuary, however, at times flushing is described as poor, taking up to 30 days (Knowles, 1996).

Relatively degraded water may be found in the upper estuary and upper areas of embayments including Fishermans Bay, North West Arm, Gunnamatta Bay and Yowie Bay. The degraded waters at Fishermans Bay are likely to be the result of the absence of sewerage reticulation in the area with septic systems leaking into groundwater and creeks ultimately discharging into Fishermans Bay (Knowles, 1996).

Degradation of water at other sites in the upper estuary and embayments is likely to be the result of discharges from stormwater drains and polluted creeks. The low volumes of runoff from known point and diffuse pollution sources generally result in localised impacts on the receiving waters. During dry weather dilution and tidal action ensure low levels of pollutants

throughout the estuary. Increased runoff volumes associated with wet weather may intensify these impacts. However, flushing of the estuary following rainfall results in a rapid decrease in pollutant levels. (Knowles, 1996).

Sydney Water Studies

Studies from 1991-1996 by Sydney Water have consisted of differing sampling regimes (See table 4.2). These studies revealed that water quality is good in Port Hacking and the number of pollution incidences increases upstream (Sydney Water, 1996 and 1997). Audley Weir recorded the most pollution events but water quality met the recreational use guidelines (ANZECC 1992) 90% of all sampling days (AWT Ensight, 1997a).

Table 4.2: Summary of Water Quality Studies undertaken by Sydney Water

Year (Study was Conducted)	Number of sites sampled	Wet weather sampling	Dry weather sampling
1991	34	yes	yes
1992	34	yes	yes
1993	12	yes	yes
1994	12	yes	yes
1995-1996	not specified	yes	yes

Source: S. Biddulph, 1998

From the data collected, it was concluded that water quality in the estuary was generally favourable for recreational activities with bacteria levels below guideline criteria on greater than 90% of all sampling days (including wet weather).

With the exception of the Hacking River at Audley weir, and the intensive studies carried out at Bundeena/Maianbar, inflows into Port Hacking have not been widely studied. Information collected by Sutherland Shire Council of several inflows into Port Hacking from urban areas have shown that runoff quality is typical of that from other urban areas in Sydney with elevated levels of faecal coliforms, nutrients and some trace metals (Sutherland Shire Council 1996). The source of these pollutants may include industrial discharges, exfiltration from leaking sewer systems, leachate from tips, refuse piles and household discharges. The Hacking River Catchment Management Committee has carried out a study identifying pollution sources within the catchment (Knowles, 1996). The report identifies Cronulla STP as the major pollution source although discharge from the STP is not likely to have a substantial impact on water quality in the estuary. Other major pollution sources identified in the report were sewer overflows, surcharges and leaks, building site runoff, leachate from Helensburgh Sanitary Depot, runoff from Symbio Koala Gardens and non-point source urban runoff.

In wet weather, the volume of pollution associated with these pollution sources increases in magnitude. During wet weather there is also the increased likelihood of pollution from sewer overflow points. These were estimated by modelling to contribute approximately 215 ML per annum (AWT, 1997b) from overflow points in North West Arm, Yowie Bay, Burraneer Bay and Gunnamatta Bay. These overflows discharge infrequently with the majority having a discharge incidence rate of 1 or 2 times per annum (AWT, 1997b). The ecological and human health risk assessment of chemicals in sewage overflows, carried out for Sydney Water, found that chemicals of concern in Port Hacking were chlorpyrifos, diazinon, dieldrin and hydrogen sulphide. These chemicals are more associated with stormwater rather than sewage. (Sydney Water Corporation, 1998).

Non-Tidal Sections

The freshwater section of the catchment is somewhat more degraded than the estuary as reflected in some of the water sampling results (Sutherland Shire Council, 1997) that although water quality is generally suitable for secondary contact activities such as canoeing. The input of nutrients and bacteria from the catchment and the lack of flushing due to the impounding of waters at the weir have resulted in the relatively poor quality of water upstream of the weir.

The non-tidal waterways of the Royal National Park and Garrawarra State Recreation areas can be separated into two groups: waterways and catchments, which have been significantly altered by humans and those that have not, Table 4.3 (Sutherland Council, 1992).

Table 4.3: Characteristics of Non-Tidal Waterways of the Royal National Park and Garrawarra State Recreation Area

Waterways significantly altered by humans	**Waterways not significantly altered by humans**
• can carry significant amounts of pollutants derived from human activities; • can display greatly altered stream flow characteristics (often as a result of urbanisation, or major earthworks); • often drain catchments which contain urban areas, or major transport arteries, or areas grazed by stock etc; • often support wildlife associations which have been significantly changed; and • frequently carry high sediment loads during floods and display abnormally high sediment banks during dry periods.	• display very high water quality, with little or no pollutants or turbidity; • have stream flow characteristics which have not been materially influenced by human activity-drain catchments within which there is little or no development; • support plant and animal (including aquatic associations) which are dynamically balanced; • have few or no introduced plant and animal species (not native to the area); and • display only such sediment as can be attributed to natural processes.

Source: Sutherland Shire Council, 1992

4.3.2 Water Quality Monitoring

In 1994 in response to community concerns about water quality in the catchments managed by Sutherland Shire Council a Strategic Water Quality Monitoring Programme (SWAMP) was initiated. This monitoring is undertaken biannually and from stormwater drains in sub-catchments affected by urban landuses, as shown in Table 4.4 and Figure 3 for sampling locations. Parameters to be tested for each site were chosen according to current landuse activities in the catchment, in order to detect any trends in water quality reflecting landuse (Sutherland Shire Council, 1997).

Table 4.4: Sutherland Shire Council SWAMP Monitoring Sites for the Hacking River

SITE	MAJOR LAND USE INFLUENCES
Gunnamatta Bay GPT	residential/commercial
Burraneer Bay and Dolans Bay	Residential
Yowie Bay East CDS	residential
Yowie Bay West rack	commercial/residential- Westfields
Gymea Bay	Residential
North West Arm	residential
Hacking River	National Park/residential- Helensburgh
Engadine Ave, Engadine	residential- discharges into the National Park
Mianga Ave,Engadine	commercial/industrial
Bundeena Creek	unsewered residential
Savilles Creek	residential/commercial/Sutherland Pool/National Park
Gunnamatta Bay GPT	residential/commercial
Mianga Ave GPT	commercial/industrial
Engadine Ave wetland	residential
Yowie Bay CDS	residential

Source: Sutherland Shire Council, 1997

During the SWAMP study problem pollutants show in over 50% of the study sites Enterococci, Total Nitrogen, Lead, Zinc, Ammonia and Biological Oxygen Demand levels did not meet the ANZECC guidelines. The fact that these waters do not comply with the ANZECC Guidelines is not wholly unexpected. Water quality guidelines for stormwater do not exist and so Sutherland Council is applying the ANZECC Guidelines, which are meant for receiving waters.

The most polluted sites determined from monitoring were North Cronulla Beach; Silverwater Crescent, Miranda; Mianga Ave, Engadine and Cronulla Beach (Sutherland Shire Council, 1997).

High levels of faecal pollution identified during the monitoring reflect sewer inflows, leaks in the stormwater system, illegal or faulty sewer connections and runoff by animal faeces (Sutherland Shire Council, 1997). The other pollutants including Zinc and Lead are sourced from roads and motor vehicles, as well as industrial land uses often associated with motor vehicles (refer Table 4.5).

High BOD levels generally indicate waters flowing from the stormwater drains in the Hacking River and/or its tributaries is oxygen-depleted, potentially affecting aquatic ecosystems in these waterways.

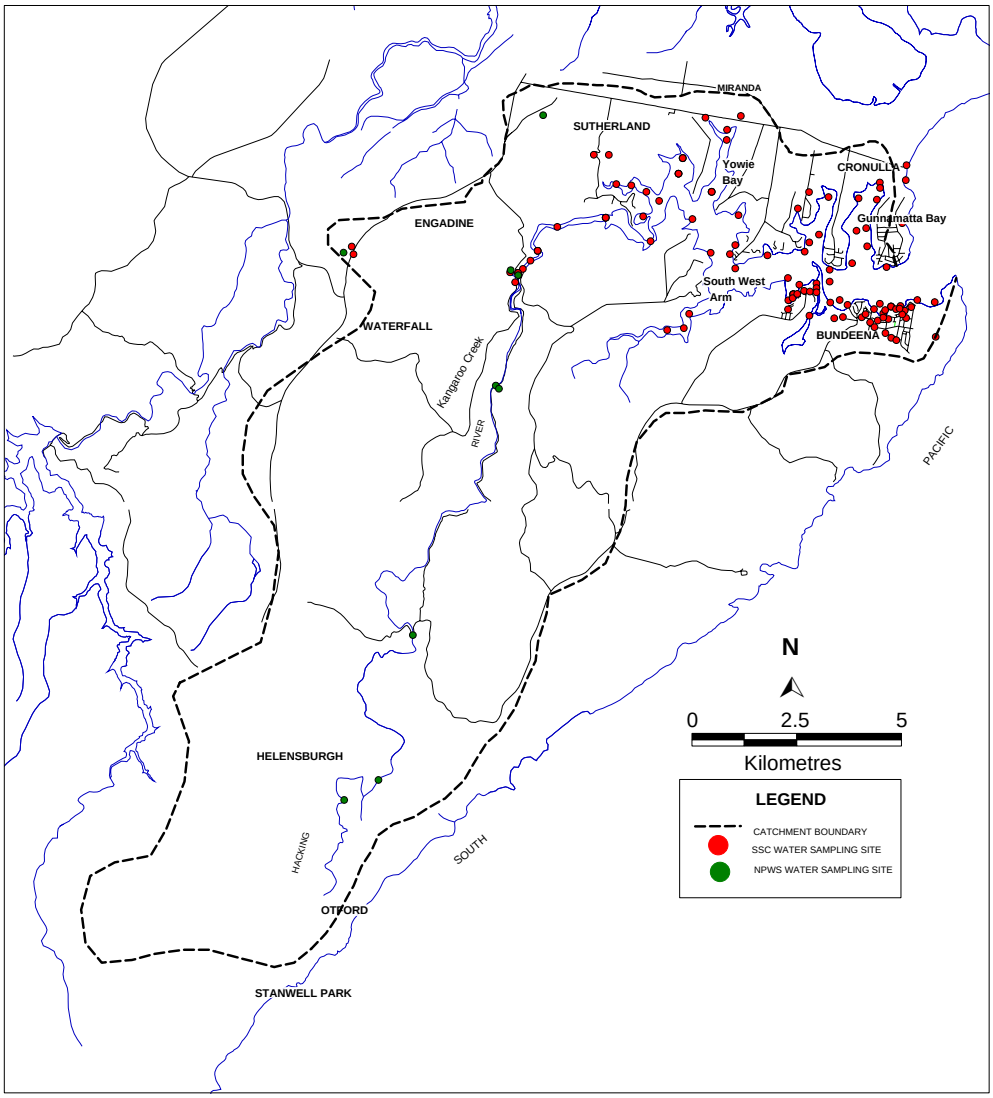

Figure 3 Hacking River catchment water quality-monitoring sites

Table 4.5 Non-Point Source Pollutants Identified in the Hacking Catchment

Sources of Pollution within the catchment	***Main Contaminants of Concern***	***Other potential contaminants***
Urban runoff from roads and gutters	Suspended solids, nutrients, oxygen demanding substances and micro-organisms.	Litter, pesticides, herbicides, traces of fuels, oils and heavy metals (lead, mercury etc)
Runoff from Commercial Areas	Litter, nutrients, fuels, oils and heavy metals	Sediments, pesticides and herbicides
Runoff from Industrial Areas	Grease, oils and heavy metals, nutrients, faecal coliforms.	Sediments, pesticides, herbicides, paints, thinners, solvents
Runoff from Open Space	Sediments, nutrients	Litter and organic matter
Rubbish Dumping	Nutrients, pesticides, herbicides and sediment.	Heavy metals, fuels and oils.
Building Sites	Suspended Solids	Chemicals
Coal Fill-Materials	Suspended solids, sediment	Sulphate
Swimming Pools	Suspended solids, chlorine, copper sulphate and salt.	Nutrients

4.4 National Park Areas

The Royal National Park and Garrawarra SRA make up over 60 % of the Hacking River catchment. An area of national significance (NPWS, 1994), the Royal National Park is the oldest national park in Australia and second oldest in the world. This National Park is under considerable pressure from human activities within the park and from surrounding residential areas. The Royal National Park attracts more than 1.5 million visitors, in addition to a large volume of through traffic each year. The area consists largely of dissected Hawkesbury Sandstone landscape supporting sclerophyll forest and woodlands. There are also areas of heathlands, littoral rainforest and wetlands (Sutherland Shire Council, 1996).

Due to its habitat diversity and cultural significance, NPWS (in conjunction with Hacking River CMC, Helensburgh & District Landcare Group, Audley Field Study Centre, several universities and community groups) are undertaking a long term Community Biodiversity Survey for the Royal National Park. The freshwater macro- invertebrate study results indicate that the water quality in the Hacking River is generally very poor.

Terrestrial invertebrates identified include flies, spiders, ants and crickets. The Broadheaded Snake and the Red-crowned toadlet are present in the park and are listed under the threatened species legislation in NSW. Mammals are common in the area.

4.5 Estuarine and Aquatic habitat

The Port Hacking catchment includes a broad range of aquatic habitat ranging from riffle zones, deep pools and pool edges to saltmarshes, mangroves and seagrass beds.

The upper reaches and tributaries of the Port Hacking River provide freshwater aquatic habitats including wetlands of high conservation significance such as the wetland supported within Still Creek Valley.

Port Hacking itself is an important nursery area for juvenile fish and contains four fish enclosures (Sutherland Shire Council, 1996). Estuarine communities, such as mangroves and saltmarsh, exist in areas above the limit of the low tide and intertidal zones. Port Hacking contains *Posidonia australis* seagrass beds; this species is particularly sensitive to the effects of sedimentation and excessive levels of nutrients that are discharged into the waterway.

The Hacking River catchment is contains potentially important fish habitats, containing stands of mangroves and salt marshes (pers. com. Jack Hannan NSW Department of Fisheries).

Cabbage Tree Basin has an area of approximately 11 hectares of salt marsh. (Sutherland Shire Council, 1992). Smaller pockets occur in Maianbar and Bonnet Bay (Sutherland Shire Council, 1996). These areas have a canopy of grey mangroves (*Avicennia marina)* and river mangroves *(Aegisceras cornculatum*), with samphire (*Sarcocornia quinqueflora),* salt couch (*Sporobolus virginicus)* and sea rush (*Juncus kraussii)* (Sutherland Shire Council, 1992).

Two species of mangroves the grey mangrove (*Avicennia marina)* and the river mangrove (*Aegiceras croniculatum)* are found in Port Hacking (Sutherland Shire Council, 1992).

Pockets of seagrass are also present in the Hacking River and Port Hacking (Sutherland Shire Council, 1996).

The main component of the benthic macrofaunal communities are polychaete worms and crustaceans (crabs, prawns, amphipods and isopods) (Hutchings, 1992). Soldier crabs (*Mictyris longicarpus)* and fiddler crabs (*Uca vocans)* inhabit the estuarine environments. Twenty eight fish species were identified in the *Port Hacking Plan of Management* (SSC,1992*)* including Luderick (Black fish), Sea Mullet, Sand Whiting, Flathead, Mullet and Trevally. However, a much larger number of species inhabit the estuary (pers. com. Jack Hannan- NSW Department of Fisheries).

Biodiversity of fish species is very important within Port Hacking and the NSW Fisheries Department has indicated that the catchment supports between 200-500 fish species (pers. com. Jack Hannan, NSW Department of Fisheries. Those species that have been identified in Port Hacking and the lower reaches of the Hacking River including: Snapper (*Chrsophrys auratus),* Tailor (*Pomatomus saltatrix),* Yellowtail (*Trachurus novaezelandiae),* Bream (*Acathpoagrus australis),* Whiting (*Sillago ciliata),* Flathead (*Platycepalus fuscus),* Mulloway (*Argyrosoma hololepidotus)* and three species of Mullet and Leatherjackets (Henry *et al*., 1987).

4.6 Riparian and Foreshore Habitat

The catchment has significant areas of valuable riparian and foreshore habitat within the Royal National Park, Garrawarra SRA and other areas of urban bushland. General habitat types include forest, woodlands, heathland and rainforest.

Forest Areas

Dominant canopy species include turpentine (*Syncarpia glomunifera),* grey ironbark (*Eucalyptus paninculata)* and Sydney blue gum (*E. saligna).*

Open forest occurs throughout the catchment on east or south-facing slopes, along drainage lines or in places with sandy soils (Sutherland Shire Council, 1996). Species include smooth-barked apple (*Angophora costata),* Sydney peppermint (*E. piperita)* and Grey gum (*E. punctata).*

Woodlands

This sandstone ridgetop ecosystem is well represented in the Royal National Park. Canopy species include scribbly gum (*E. haemastoma),* red bloodwood (*E. gummifera),* with shrub cover including heath banksia (*Banksia ericifolia),* dwarf apple (*Angophora hispida),* dagger hakea (*Hakea sp*.) and bushy needlebush (*Hakea sericea).*

The remaining natural vegetation located within the National Parks and Crown land open space areas is classified as woodland (Sutherland Shire Council, 1996). The species found here include scribbly gum (*E. haemastona),* Sydney red gum (*Angophora costata),* old man banksia (*Banksia serrata),* and red bloodwood (*E. gummifera)* with a diverse shrub layer (Sutherland Shire Council, 1996).

Rainforest

Littoral rainforest occurs in the more moist areas of the Royal National Park. Remnant vegetation occurs at Lilli Pilli Point, Burraneer Point, Darook Park and Yowie Bay. Species include celerywood (*Polyscias elegans),* red-fruited olive plum (*Cassine australis)* and corkwood (Sutherland Shire Council, 1996).

Sub-tropical rainforest is found along the Upper Hacking and its tributaries, elements of this are found in Ewey Creek and Gymea Bay. Canopy species include crab apple (*Schizomeria ovata)* and ribbonwood (*Eurpschinus falcata)* (Sutherland Shire Council, 1996).

4.7 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. 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 currently 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.

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.

4.8 Stormwater Contamination Potential of the Hacking Catchment

The catchment area within a given region is responsible for determining the quality of subsequent stormwater runoff with respect to chemical, biological and physical characteristics. In order to determine the potential for contamination of stormwater, we must therefore identify the sources of contamination within the catchment area and assess the extent of contaminant impacts on stormwater quality.

Identification of Contaminant Sources

A contaminant may be defined as a chemical, biological or physical component which influences the quality of the air, water or soils in such a manner that is detrimental to human health or ecosystem functioning. In this case, the quality of stormwater within the Port Hacking Region is predominantly defined by the quality of surface water runoff from the

buildings, structures, and pavement and ground surface within the catchment. On this basis, the development, landuses and activities within a catchment area may be considered to be the predominant sources of potential contamination to stormwater.

A general summary of the types of landuses (and therefore potential sources of water quality pollution associated with landuse activities) within the Hacking catchment area are outlined in Table 3.1 (Section 3.2).

5 Catchment Values

Section 5 provides a summary of the ecological, social and economic values potentially influenced by stormwater management practices within the Hacking catchment.

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. Table 5.1 provides a prioritisation of the identified catchment values for the Hacking catchment.

The following catchment values were identified during the community consultation sessions and through review of *Shaping the Shire 1998-1999* (Sutherland Shire Council, 1999) and *Hacking Plan of Management* (Sutherland Shire Council, 1992).

Environmental Values

Flora and Fauna: The diversity of vegetation in the Hacking catchment provides an attractive setting for residential and recreational activities. This vegetation provides habitat and movement corridors for native mammals, birds and insects. Trees improve privacy in residential areas.

Beaches and Waterways: These contribute to the natural heritage and character of the Hacking Catchment. These are under pressure from urban development of both land and water based activities (Sutherland Shire Council, 1999).

Social Values

Community Involvement: Within the Hacking catchment and the whole of the Sutherland Shire there is a strong sense of community involvement. The local community generally tends to show strong support for local activities that are held throughout the region. The *Shaping the Shire* (SSC, 1999) study indicates that the area is considered to be a healthy and prosperous place to live. A village ethos is still associated with the townships of Bundeena and Maianbar.

Recreational activities: People travel from across Sydney to utilise and enjoy the recreational activities associated with the Hacking catchment. The Royal National Park and Garrawarra State Recreation Area are examples of natural areas that are heavily utilised. Numerous water based activities such as boating and fishing on the Hacking River are popular pastimes in the catchment as well.

Aesthetics: The catchment exhibits large areas of natural bushland and a large number of local parks and reserves.

Economic Values

Tourism: The Royal National Park is a popular destination for tourists from both Australia and overseas. Cronulla Beach and Port Hacking are also popular tourist sites.

Enhanced Land Values Adjacent to Waterways: Property with waterfront aspects or views of the Hacking River or its other tributaries generally has greater monetary value on the real estate market compared to that located further inland in the catchment.

Table 5.1: Desired Catchment Values

Catchment Values	***Priority***
ECOLOGICAL	
• maintenance and restoration of the aquatic ecosystems in the Hacking catchment	High
• diversity of indigenous flora and fauna in the Royal National Park and riparian zones	High
• protection of native flora and fauna	High
• protection of coastal bushland in the Hacking River catchment	High
• retention and restoration of indigenous riparian vegetation along the waterways in the catchment	Medium
• water quality of catchment beaches	High
SOCIAL	
• visual amenity of Hacking River catchment, especially the beaches, National Parks and reserves	High
• water quality in Hacking River and tributaries suitable for secondary contact	High
• visual amenity of the Hacking River and its tributaries	High
• tourism and recreational areas within the catchment	Medium to High
• village ethos for townships of Bundeena and Maianbar	Medium
• strong community values	Medium
ECONOMIC	
• maintain or enhance waterfront property values	Medium
• commercial fishing in Hacking River catchment	High
• more to be spent on environmental programmes	Medium
• tourism	Medium

6 Stormwater Management Objectives

6.1 Ecologically Sustainable Development

Stormwater management in the Hacking River catchment needs to be based on ecologically sustainable development (ESD) principles (EPA, 1997). The decisions we make about community resources need to be put into 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 in the decision-making process. ESD is achieved through the implementation of the following principles and programmes:

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, quantifiable 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: Management 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.
	• long-term and comprehensive water quality and biological monitoring programme 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 Hacking River and its tributaries.
	• minimise the impact of new urban developments on the stormwater system.	• investigate the viability of stormwater reuse within new developments or redevelopments
	• 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).
	• minimise the impact of new urban developments on the stormwater system	• level of water quality in the catchment to meet the ANZECC Guidelines for the protection of aquatic ecosystems for 100% of the time.
	• eliminate sewer overflows and connections from entering waterways.	• stormwater/polluted runoff is to be controlled at its source

Values	Long Term Objectives	Short Term Objectives
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 programmes to be implemented.	• effective community awareness and education programmes 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.	• introduce planning requirements to decrease impervious surfaces on new and existing properties.
ECONOMIC	• integrate re-use 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.
	• regular auditing of boating activities (including commercial) in relation to management of waste and stormwater disposal etc	• decrease boat discharges into the Hacking River
	• meet a level of water quality in the Hacking will meet the standard required by local fishing activities.	• 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 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 – 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

Stormwater management issues identify the factors that currently prevent, or have the potential to prevent the adopted management objectives from being satisfied. The issues of concern for the Hacking Catchment have been determined through community and Council consultation and review of existing information from reports, studies and monitoring programmes. These issues are listed below in Table 7.1.

Table 7.1: Stormwater Management Issues for Hacking Catchment

Short-term Objectives	Issue	Potential Causes
	Management Issues	
improve coordination of stormwater management in the catchment between Council and other stakeholders	lack of communication and coordination between management agencies	• a piecemeal approach to management of stormwater issues.
	lack of integration and information sharing between authorities	• poor communication between authorities; • lack of catchment based delegation of management responsibilities.
	lack of commitment from community and Council to implement necessary changes	• lack of community ownership on water quality issues; and • lack of direction/strategies to improve water quality.
minimise litter, leaf litter etc into the stormwater system	maintenance of stormwater drainage lines	• blocked drainage system; • inadequate system maintenance; • poor litter management; and • lack of regular street cleaning.
audit of local commercial and industrial premises for water/ stormwater management activities	lack of monitoring/auditing of building site compliance	• lack of resources allocated for policing of sites; and • lack of regulatory powers to enforce compliance.
Councils to commit funds to increase developers' understanding of DA consent conditions	lack of understanding from developers/builders of details in conditions of consent	• lack of clarity or explanation of conditions of consent
maintain education of Council staff and work activities regarding stormwater impacting activities	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 abovementioned industries to enforce the adoption of BMPS
introduce and encourage feasible stormwater onsite detention and/or reuse	lack of maintenance systems racks, pits etc	• inadequate resources.

Short-term Objectives	Issue	Potential Causes
schemes	volume and quality of stormwater	• not enough on-site detention and treatment of runoff before it reached receiving waters.
	reuse of stormwater	• incorporating re-use into existing /proposed stormwater systems is regarded as too expensive, complicated or ineffective
	lack of knowledge on pollution contributories from various part of the catchment	• no identification of data gaps to assist monitoring, studies; and • no overall plan to direct water quality improvement strategies.
develop a comprehensive monitoring strategy	lack of site specific data	• no advance planning and identification of data gaps; and • planning doesn't include natural constraints and catchment impacts.
litter reduction feeding into the stormwater system	more efficient management of street cleaning/timing of street cleaning	• inadequate resources with service; • lack of coordination at Council.
	Planning Issues	
review and strengthen planning tools especially regarding new developments and redevelopments	lack of integration of Master and Control Plans and policies for catchment	• lack of coordinated approach; and • no catchment based solutions.
	inappropriate development	• lack of understanding of geological/.environmental capabilities of catchment areas
	lack of effective planning and controls on development	• little emphasis on implementing environmental controls through planning in the past; and • lack of commitment from Councils and other management authorities to introduce, strengthen and enforce major changes.
	reduction of public access	• historical lack of planning development within the riparian and foreshore zones; and • roads and houses built too close to watercourses.
reducing volume of runoff directed into the stormwater system (especially in urbanised areas)	increased runoff into waterways of the catchment/overdevelopment	• new development resulting in increased amounts of impervious surfaces; and • large amounts of sealed surfaces including roads and pathways in the catchment.
introduce new or strengthen existing planning controls to decrease impervious surfaces for new and developments and redevelopments	ratio of impervious and pervious surfaces inappropriate	• unable to monitor and regulate after the development application stage

Short-term Objectives	Issue	Potential Causes
protection of existing riparian and foreshore vegetation	increased levels of channel erosion	• high levels of runoff from urban areas; • deposition of sediment from upstream sources; • poor erosion and sediment control of construction activities; and • concrete channels concentrating flows from upstream into the natural channel.
decrease the contribution of construction activities and polluting runoff associated with urban development	elevated siltation and nutrient concentrations within waterways in the catchment	• poor erosion and sediment control of construction activities; • deposition of sediment from upstream sources; • channel erosion; • washing of cars on roadways; • sewer overflows; and • possible illegal discharges from commercial operations in the catchment.
	Social Issues	
	rhetoric hasn't historically matched action	• lack of coordinated approach; and • no catchment based solutions.
	lack of community interest	• easier to blame government agencies than do something yourself. There is an attitude that 'someone else will fix it'.
catchment waterways to meet ANZECC Guidelines and EPA Interim Guidelines for secondary contact / decrease boat discharges	health risks associated with recreational use of waterways	• increased levels of nutrients and rubbish from urban areas
increase community awareness of stormwater management issues	lack of public awareness and involvement in stormwater management	• inadequate education and awareness of stormwater issues
	Bio-physical Issues	
litter reduction feeding into stormwater system/ siltation traps installed in areas prioritised for work, ensure regularly maintained	low visual amenity throughout the catchment associated with litter and sediment	• litter dumped within the catchment including watercourses, roadways, parks and reserves and the Royal National Park; • litter associated with commercial, industrial and residential areas; and • insufficient number of rubbish and/or litter control.
control weed infestation in riparian areas	degraded riparian and foreshore areas	• removal of vegetation during development; • reclamation of land along watercourses; and • introduction of exotic species.
	weed growth in bushland areas of the catchment	• nutrients

Short-term Objectives	Issue	Potential Causes
changes in Council approach to stormwater management	degraded water quality, particularly in the upper catchment	• runoff from road surfaces; • industrial, agricultural, residential and commercial discharges to stormwater drains; and • domestic animal and garden waste washed into stormwater channels.
reduction of water entering stormwater system from urban areas	high levels of nutrients and bacterial pollution	• sewer overflows; • domestic animal waste; and • high nutrient runoff from developed areas (fertilisers, plant material etc).
catchment waterways to meet ANZECC and EPA Interim Water Quality Guidelines for secondary contact at least 95% of the time	health risks from poor water quality (ie. restricting swimming activities)	• faecal bacteria pollution entering the 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, i.e. sediment, grease, oil.	• ineffectiveness of existing structural controls; • lack of land space to accommodate suitably sized structural controls to contain and treat runoff from large urbanised sub-catchments; and • no identification of best management placement for source control system throughout the catchment.
level of water quality to meet the ANZECC Guidelines for protection of aquatic ecosystems 100% of the time	degraded aquatic ecosystems	• effect of introduced species on aquatic flora and fauna; • decline in environmental water quality; • altered hydrological regime; • destruction and degradation of wetlands/riparian areas; and • degradation and sedimentation of natural waterways.
control weed infestation along Hacking River and tributaries	decline of riparian ecological communities	• clearing of vegetation along waterways; and • degradation of natural communities by weed invasion and litter.
effective community awareness and education programmes to be implemented	litter in watercourses	• poor public awareness of litter contribution to waterway problems; and • a lack of public responsibility and ownership of waterways.
reduction of flow and volume of runoff entering stormwater system	increased volumes of stormwater flow	• increasing spread of impervious surfaces through development of the catchment; • artificial and concrete lined channels; • narrowing of channels choked with weeds or litter; and • old school ideology of removing stormwater from the site a quickly as possible.

7.1 Hotspots

In additional to examining existing data, pollution hotspots were identified through 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 of contribution to water pollution. These investigations, in combination with the information gained through consultation, have formed the basis upon which management options have been developed.

Table 7.2: Identified hotspots within the Hacking Catchment

Hotspot	***Main Contaminants of Concern***	***Other potential contaminants***
Head of Gunamatta Bay	High bacterial counts	sediment
Oak Park and Shelley Beach swimming pools	High bacterial counts	
Marinas in Gunamatta Bay, Dolans Bay and Burraneer Bay	High bacterial counts and nutrients levels	
Dredging in heads of bays	Sedimentation	metals, nutrients etc
Engadine & Mianga Avenues industrial area, commercial areas and building/construction sites	detergents, paint (metals), chemicals, pesticides	
Kirrawee commercial area	detergents, shop refuse, litter	
Miranda, Kirrawee, Engadine and other shopping centres	litter, sediment	nutrients, metals
Audley Weir and road approached	sediment, metals, nutrients, grease and oil from cars	
Helensburgh Tip	leachate	
Metropolitan Colliery, Helensburgh	sediment, coal refuse	
Symbio Koala Park, Helensburgh	nutrients, sediment, bacterial contamination	
Han-rob dog kennels and cattery, Waterfall	bacterial contamination, nutrients,	sediment
Bate Bay Beaches	nutrients, litter, bacterial contamination (boats/ships)	sediment
Waste Disposal Sites including Helensburgh tip	Landfill leachate may contain high levels of oxygen depleting organic matter, nutrients, bacteria, chloride and ammonia.	Other contaminants may include heavy metals, phenols, organochlorine pesticides, oils, acids and alkalis.
Other licensed discharges – industrial areas or irrigation	Sediments and nutrients	Metals, oils, acids and alkalis.
Housing development Wandella Road and Karimbla Road, Miranda	Sediments, nutrients, litter	
Royal National Park- hazard reduction burning and walking trails	Sediments and nutrients	Litter and oxygen depleting organic matter

8 Identification of Potential Management Options

A range of management options (structural and non-structural) has 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 management options. These are summarised in Table 8.1 and are described in more detail in Section 9.

Section 9.1 evaluates the types of structural management options available including Gross Pollutant Traps (GPTs), trash racks, constructed wetlands and ponds. Section 9.2 provides a discussion on the non-structural management options for the Hacking catchment.

Table 8.1 Potential Management Strategies

Structural	**Non-Structural**
Management Issues	
• install proposed appropriate water quality control structures in most effective locations; • improve bank stabilisation and management of foreshore areas; and • establish regular monitoring and maintenance programme for water quality control structures.	• 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 business 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 programme; • auditing of Council's stormwater pollution control measures; • auditing of local businesses/construction sites and their work practices; and • emergency spill plans to be developed and maintained as operational by Council. Emergency spill plans to accompany development applications that involve hazardous materials.
Planning Issues	
• increase infiltration measures and amount of pervious surfaces in the catchment, ie. roof drainage and retention, buffer strips, grass swales;	• review and strengthening/streamlining of planning and development controls; • increasing of fines for stormwater pollution

Structural	Non-Structural
• retain natural flow and drainage channels throughout the catchment; and • introduce and maintain feasible stormwater onsite detention and reuse schemes on Council/stakeholder managed land where possible.	from local businesses and construction sites; • include stormwater requirements in existing and proposed Development Control Plans. Emphasis is to be on re-use and source control; • conduct feasibility study on stormwater re-use options; • incorporate re-use into planning and development throughout the catchment; and • investigate potential for inspection of private sewer lines with sale of houses.
Social Issues	
• community participation days for planting/creek; • open field sites/case studies to demonstrate to the public how stormwater re-use and source control can be integrated with existing and proposed development.	• increasing community awareness through community education campaigns • auditing of local businesses/construction suites and their work practices • encourage installation of rainwater tanks and use of stored rainwater for non-potable uses
Biophysical Issues	
• restore aquatic habitats; • replant and restore riparian vegetation; • restore and protect wetland areas; establish riparian and aquatic vegetation with the installation of stormwater controls; and • control weeds in bushland and riparian areas	• undertake a Catchment Processes Study and update the existing Pollution Source Inventory prepared 1996 to further identify existing and potential pollution sources and problem areas; • monitoring programme to allow Council to continue to identify existing and potential pollution sources and provide feedback on SWMP effectiveness; and • set water quality and ecological benchmark criteria for the parameters of the monitoring programme. These criteria need to be periodically reviewed as water quality changes with the implementation of stormwater strategies.

9 Evaluation of Potential Management Options

Broad ranges of structural and non-structural practices are available to address identified stormwater management issues. Table 9.2 provides a list of potential practices, which have been identified as potential options to address the stormwater management issues for the Hacking 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

The Councils have installed Gross Pollutant Traps (GPTs), trash racks and water quality ponds (constructed wetlands) in various locations in the catchment. Information supplied by Sutherland Shire Council shows that there are 15 structures in the Hacking River catchment. Water pollution control structures have generally been placed utilising local knowledge of known pollution areas. These devices are part of a long term Council programme to install trap structures to protect watercourses draining to the Hacking River and its tributaries.

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 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 rubbish and usually consist of a silt basin and a trash rack. They can be both small or large, open or enclosed, they should be designed for easy 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 removing some nutrients. Wetlands often require large areas of land, which can be difficult to site in urban areas;

- **Riparian Zones and Grass Swales** These are grass lined channels for conveying runoff often incorporating barriers to reduce runoff velocity. They can be utilised in preference to piped drainage or concrete channels and can provide a sediment removal function by slowing runoff velocities, encouraging sedimentation. Riparian zones are vegetated areas adjacent to watercourses, which are inundated by water during high flows. They provide treatment of overland flow to the watercourse by reducing runoff volume (by infiltration) and velocities; and

- **Litter Control Devices** There are a number of litter control devices that can be used to remove litter and other debris from stormwater including: Litter baskets – wire or plastic basket installed in a stormwater pit to trap rubbish entering the system. Litter booms – floating booms with mesh skits placed across a waterway to collect floating and partially submerged debris and Continuous Deflector Separators (CDS) – devices that separate coarse sediment and litter in a circular separation and containment chamber.

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 more coarse sediment and floating rubbish to be removed before reaching 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. What works in one catchment may not be suitable for another. Careful consideration should be given to locating the structures to ensure that:

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

Continuing Council's existing programme to install trap structures, further structures are proposed for Sutherland Shire Council's 1999/2000 works programme (refer to Table 9.1). EPA grants to install Nettech Devices will also add structures to the catchment. Currently, there are still a number of urban sub-catchments that drain to the Hacking River that have no pollution control structures in place. There is little doubt that more structural control 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.

Urban catchments draining to the Hacking River are well developed and traps have been located on a drainage systems that drain to Yowie Bay (Miranda catchments) and Gunnamatta Bay. Urban catchments not served by traps are those draining from the Sutherland and Kirrawee areas to Gymea Bay and North West Arm. Those catchments particularly require treatment because they have commercial and industrial areas within the catchment. Helensburgh is located in the upper Hacking catchment and should be investigated to locate traps on outlets to streams. Existing coal mining activities are potential point sources of sediment pollution and should be the subject of a detailed investigation.

Table 9.1: Proposed water pollution control devices for Hacking catchment

Location	*Structure Type*
Dolans Bay (in reserve of Parthenia Street),	Gross Pollutant Trap (GPT)
Gymea Bay (in reserve off Ellesmere Road)	GPT
The Avenue, East Heathcote	GPT
Gunnamatta Bay	Nettech trap

Sutherland Shire Council supports the installation of structures to intercept rubbish and silt and is prepared to budget for further traps and their continued maintenance and cleaning programmes. Further awareness of stormwater quality and the implementation of stormwater controls could be assisted by Councils supplying more information on:

- published stormwater design standards or requirements; or
- building controls for construction work.

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 programmes 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 a community awareness campaign that:

- creates a broader awareness of the catchment specific issues and problems affecting stormwater quality;
- creates linkages within the community's mind between stormwater drains and local waterways;
- raising awareness of operators in commercial areas taking ownership of footpath areas and litter etc in gutters;
- educates the community on practices to help improve stormwater quality by designing programmes targeting specific sectors of the community eg. school children, shop keepers, builders, gardeners, etc; and
- encourages community responsibility for the Hacking 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 a specified local sub-catchment or area;

- individual resident initiatives for litter reduction;
- increase requirements for including more 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 the need for watering and fertiliser use;
- encourage car washing on grassed areas or at professional car washing facilities;
- sweeping of driveways 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 flowing 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 become actively and publicly involved in established environmental programmes 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 is to be made aware of the impact that poor management practices have on the water quality within the catchment. On-going training is also imperative for staff to become familiar with best management practices associated with maintenance, construction and emergency works.

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 programme for an Environmental Educator whose role to date has been to work with the outdoor construction staff to improve best practice in regards to sediment and erosion controls.

The level and type of education and awareness of Council maintenance and construction staff is dependent upon their work location eg. outdoor or indoor.

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

Total Catchment Management

Total Catchment Management (TCM) is a holistic approach to preventing pollution. 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 provides better technical-financial opportunities for dealing with the complexity of stormwater pollution more effectively and efficiently within the constraints of a budget. It is the 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 and Development Controls

Sutherland Shire Council has recently prepared a Draft *Local Environment Plan* (LEP) *1999* for the shire that includes strengthening of planning controls for certain areas of land within the Hacking catchment.

Councils are encouraged to develop new or strengthen existing development control plans associated with adopting best management practices to minimise sediment transport from construction sites to receiving waters.

In conjunction with this new LEP the Sydney Coastal Councils (1997) *Stormwater Management Policy and Guidelines* set out the following guidelines:

- policies which relate to the development of land will require Soil and Water Management Plans to accompany any development application;
- Soils 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 to introduce a bond to be lodged which covers any off-site damage resulting from inappropriate development activities.

Monitoring

Monitoring of activities within the Hacking catchment is to be continued and possibly the number of sites increased to maintain a standard, which allows Council to identify problem pollution sources and determine the effectiveness of the management plan (Sydney Coastal Councils, 1997). It is strongly encouraged to collect water quality data from the catchment as part of this process to identify any changes in stormwater quality.

Monitoring programmes should be linked with Council's State of the Environment reporting, included as part of the annual report.

Guidelines for monitoring as suggested by the Sydney Coastal Councils (1997) include the following:

- contractors' compliance with Council's conditions of consent to be monitored;
- monitoring can be used to review implementation of strategies, individual pollution controls, short or long term trends and to identify problem pollution sources within the catchment; and
- Council is to encourage community programmes for the monitoring of discharges and receiving waters of the Hacking catchment.

Auditing

Sutherland and Wollongong Councils need to conduct annual audits of its staff and work practices to ensure that they comply with best management practices. This aims to minimise detrimental impacts on stormwater quality within the Hacking catchment.

Auditing is also to be carried out by both Councils to ensure that planning and development controls and the general principles of this plan are properly implemented. Council needs to allocate sufficient resources and ensure that environmental officers are aware of the relevant legislation and penalties and are able to issue on the spot fines and/or infringement notices for regulation breaches.

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

- Council should consider conducting its own internal environmental audits of its properties and of its operations. Council may decide to engage an independent environmental auditor to undertake the work to maintain impartiality;
- 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;
- Information obtained from these audits may be used to identify pollution sources within the Hacking catchment to assist Council in determining effective stormwater policies; and
- Council could encourage industry and other organisations to conduct their own audits to identify possible water pollution sources and develop control strategies.

Preservation and Retention of Existing Vegetation and Riparian Habitat

The Lower Hacking River has been extensively modified by humans for urban development including residential, commercial and industrial areas. When natural landscapes are modified, significant changes occur to the stormwater pathways which characterise the area. Baseflows, surface depression storage and evapotranspiration are significantly reduced and replaced by much higher surface runoff and downslope erosion (Sydney Coastal Councils, 1997).

The retention of natural vegetation, wetlands and unpaved areas, particularly when linked to infiltration landscaping, and constructed wetlands, will

favour stormwater pathways, which assimilate, eliminate and/or prevent pollution (Sydney Coastal Councils, 1997).

Guidelines set out by the Sydney Coastal Councils report (1997) include the following:

- 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 identified;
- Stormwater Management Plans are to be prepared which reflect natural land features and provide for their retention or alternatively adapt or synthesise their contribution to the water cycle;
- Council to ensure that their building regulations limit the use of impervious paving materials;
- Council to ensure that its building regulations limit the disturbance of natural vegetation;
- Council should in its own works programmes demonstrate the benefits of construction methods which minimise impervious paving and disturbance to native vegetation; and
- Council should encourage construction methods, which minimise disturbance to natural sites.

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 applications that involve hazardous substances.

Guidelines set out in the Sydney Coastal Councils report (1997) include the following:

- prevention strategies which emphasise risk management and target high risk situations are to be developed; and
- emergency response procedures are to be prepared which have effective strategies for:
  - equipment acquisition and accessibility;
  - community education and information;
  - operator training and exercises; and
  - operator and public safety.

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 programme is to be encouraged;
- appropriate cleaning procedures and frequencies reflecting maximum cost effectiveness are to be established;
- street and gully flushing are to be phased out as these practices contribute to pollution of receiving waters; 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 9.2 and Table 9.3) outline the options in detail, define the ranking criteria and provide a ranking for each potential management option (summarised in Table 10.1). An implementation strategy has been developed (Table 10.2) in consultation with key stakeholders to define 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 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			Education										
1	1-3	Council	Education of Council staff in Best Management Practices for stormwater	5,000	1,000	all	8	100	medium	low-medium	3.7	0.3	8
2	current	Council (WCC & SSC's Parks & Waterways Division)	Strategically locate litter bins to reduce litter dropped on roadways and footpaths	2,000	5,000	litter	2	20	low	low	0.9	2.3	51
3		Council	Increase community awareness through leaflet in rates notice	10,000	10,000	all	8	60	medium	medium-high	3.7	0.3	9
4	5	All* (WCC & SSC's Environment Division)	Educate community to reduce reliance on plastic shopping bags	10,000	5,000	litter	2	10 -20	medium	medium	2.0	1.5	40
5	5	Council (WCC & SSC's Environment Division)	Awareness campaign against car washing on streets, hosing driveways, etc.	10,000	2,000	nutrients	4	40 - 50	medium	medium – high	3.0	1.0	32

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
		and EPA											
6		All*	Educate non-English speaking residents through multilingual programme	10,000	5,000	litter, sediment, nutrients	4	40 - 50	medium	medium	2.7	1.8	44
7		Council, EPA	Encourage, through education and subsidy, the use of compost bins for on-site retention of garden and putrescible refuse	20,000	10,000	nutrients	7	30 - 40	medium	medium	3.0	2.0	47
8	5/ current	All* (WCC & SSC's Environment Division & Parks and Waterways Division)	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	2.6	1.2	33
9	current	All* (WCC & SSC's Parks and Waterways Division)	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	1.7	1.2	34
			Council Actions										

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
10	5	Councils' 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	4.3	0.2	4
11	3	Council (WCC & SSC's Parks & Waterways Division)	Audit of Council work practices and target improvements	50,000	8,000	all	8	100	medium	medium - high	4.3	1.4	38
12	3	Council	Co-ordinate stormwater management responsibilities within Council sections	5,000	1,000	all	8	100	high	medium - high	5.0	0.2	1
13	1-3	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	4.1	0.2	5
14	1-3	All*	Review fine effectiveness	2,000	0	all	8	100	medium	medium	4.0	0.3	6
15	1-3	All*	Introduce alternatives to fines	5,000	1,000	all	8	100	medium - high	medium	4.6	0.2	2

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			– eg suspend building license										
16	1-3	Council, SWC	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	3.3	0.6	26
17	1-3	Council	Review effectiveness of street sweeping programme	5,000	2,000	litter, sediment	4	10 - 20	medium	low	1.7	0.6	25
18	5	Council (WCC & SSC's Environment Division)	Structure monitoring programme to include measure of SWMP effectiveness	60,000	60,000	all	8	100	high	low – medium	3.3	2.4	52
19	5	Council (WCC & SSC's Environment Division)	Provide feedback to community on SWMP effectiveness	5,000	2,000	all	8	100	medium - high	high	5.0	0.4	18
20	3	Council (WCC & SSC's Planning Division)	Emergency spill plans to accompany development applications that involve hazardous materials	1,000	0	all	8	100	medium	low - medium	3.7	0.3	10
21	3	Council (WCC &	Introduce procedures to explain development control	5,000	5,000	all	8	100	medium - high	medium - high	4.6	0.2	3

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
		SSC's Planning Division)	requirements to recipients of DA										
22	1	Council, RTA,	Maintain 3 existing constructed wetlands	0	10,000	nutrients, bacteria	4	10 - 20	medium - high	low - medium	2.3	0.9	30
23	1	Council, RTA	Maintain 5 existing GPTs	0	5,000 each	sediment, litter	4	20 - 30	medium - high	low - medium	3.3	1.9	43
24	1	Council, RTA	Maintain 7 existing trash racks	0	1,000 each	litter	2	20 - 30	medium - high	low - medium	2.1	0.9	31
25	1	Council	Maintain 1 existing Nettech device	0	1000	litter	2	less than 10	medium - high	low - medium	1.9	0.5	24
26	1	Council	Maintain 1 existing CDS unit	0	2,000	sediment, litter	4	less than 10	medium - high	low - medium	2.1	0.5	21
27	1-3	Council	Regular monitoring and cleaning of gully pits	0	30,000	sediment	4	70 - 80	medium	low	2.6	0.4	16
28	1-3	Council	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	3.0	1.3	36
29	1-3	Council	Increase infiltration measures and amount of pervious surfaces in the catchment i.e. roof drainage and retention,	25,000	2,000	water flow, sediment	4	40 -50	medium - high	medium	3.0	1.3	37

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			buffer strips, grass swales implement planning policies to comply										
30	1-3	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, nutrients	5	10 -20	low - medium	low	1.6	1.9	46
31	3	Council (WCC & SSC's Planning Division)	Control dog faeces by implementing Companion Requirements	10,000	5,000	nutrients, bacteria	5	10 - 20	medium - high	medium - high	3.0	0.3	12
32		Council	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	0.7	9.8	57
33	1-3	Council	Establish phone hotline to report stormwater management infringements	2,000	15,000	all	8	10 - 20	medium	medium - high	4.3	0.7	27
34	current	Council (WCC & SSC's	Initiate propagation of endemic riparian and wetland species in Council nurseries	10,000	5,000	weed infestation	5	less than 10	medium	low - medium	2.0	1.5	41

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
		Parks & Waterways Division)	for wholesale to the public.										
35	current	Council (WCC & SSC's Parks & Waterways Division)	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	2.6	0.8	29
36	1-3	Council	Encourage through rebates and mandatory policy the on-site detention of stormwater on all new developments through pervious surfaces, detention ponds, water tanks etc.	5,000	5,000	sediment, water flow, litter	4	20 – 30	medium - high	medium - high	3.0	0.3	13
37	3	Council (WCC & SSC)	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	2.4	0.4	19
38	current	Council (WCC & SSC)	Develop a riparian management plan consistent with all other management	10,000	2,000	habitat	5	less than 10	medium	medium	2.3	1.3	35

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			plans										
39	3	Council (WCC & SSC)	Co-ordinate all management plans to comply with overall ESD vision	5,000	5,000	all	8	10 – 20	medium - high	low - medium	4.0	0.3	7
40	3	All*	Encourage installation of rainwater tanks to reduce household runoff	5,000	5,000	flow	4	60 -70	medium	medium - high	3.3	0.3	11
41	1-3	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	3.7	2.2	49
			Management										
42	current	Council (WCC & SSC) and DLWC	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks	2,000	5,000	weeds	5	less than 10	medium - high	medium	2.6	0.4	17
43	1-3	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	3.0	0.3	14
44	1-3	CMC	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies	5,000	0	all	8	100	medium - high	medium	4.6	0.4	20

Table 9.2 Management Strategies for the Hacking catchment

				Costs			*Benefits*					*Rank*	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			Water Quality-Structural										
45	1-2	Council	Install and maintain GPT at Dolans Bay	63,000	4,000	litter, sediment	4	less than 10	high	medium	2.9	2.5	53
46	1-2	Council	Install and maintain GPT at Gymea Bay	55,000	3,000	litter, sediment	4	less than 10	high	medium	2.9	2.1	48
47	1-2	Council	Maintain GPT at The Avenue, East Heathcote	0	3,000	litter, sediment	4	20 - 30	high	medium	3.1	1.9	45
48	1-2	Council	Install and maintain Nettech trap at Gunnamatta Bay	2,000	500	litter	2	less than 10	high	low	1.3	0.8	28
			Hotspots										
49	1	All* – NPWS	Church of England Conference site in Royal National Park – investigation required	3000	1000	odour							
50	1	Council, NPWS	Audley Weir – investigation into reports of frothing and other pollution	3,000	1,000	nutrients, sediment, etc.	4	20 – 30	medium	low - medium	2.1	0.5	22
51	1-3	Council	Industrial areas at Gray Street Sutherland and Kirrawee – Install and maintain GPT or similar traps at pipe discharge points	60,000 each	4,000 each	sediments, litter	4	less than 10	medium	low - medium	1.9	4.3	56

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
52	1-3	All*	Shopping Centre car parks, etc. install GPTs at discharge points to drainage systems	25,000 each	2,000 each	litter, sediment, grease, oil	6	10 - 20	medium - high	low - medium	2.6	3.9	55
53	1-3	RTA	Road approaches to Audley weir lack water management or sediment control devices – install and maintain	60,000	4,000	sediment, litter	4	less than 10	medium	low - medium	2.1	2.3	50
54	1-3	Council	Mianga Avenue and Engadine Avenue – automobile service industry and commercial activities – maintain 2 GPTs and already constructed wetlands	0	15,000	sediment, oil, grease, litter	6	less than 10	medium - high	low - medium	2.6	2.7	54
55	1-2	All *– EPA	Han-Rob dog kennels and cattery – control animal faeces – EPA control	3,000	1,000	bacteria, nutrients	5	less than 10	medium	low - medium	2.0	0.5	23
56	1-3	NPWS, RFS	Hazard reduction burns – install siltation dams and measures before road drainage discharges to creeks and streams	20,000	5,000	sediment, nutrients	4	20 - 30	medium - high	low	2.1	1.4	39
57	1-3	NPWS	Fire trails - install siltation dams and measures before road drainage discharges to	30,000	10,000	sediment, nutrients	4	10 - 20	medium - high	low	2.0	2.0	42

Table 9.2 Management Strategies for the Hacking catchment

				Costs			***Benefits***					***Rank***	
No	***Schedule for initiation (years)***	***Authority***	***Option Description***	***Installation***	***Operating (per year)***	***Target Pollutant***	***No. Pollutants***	***% of Urban Catchment Benefited***	***Effectiveness***	***Education Value***	***Benefit Index***	***Cost/Benefit Ratio***	***Rank***
			creeks and streams										
58	1-3	Council	General litter problem – support national and state litter reduction programmes, eg. Clean Up Australia	5,000	1,000	litter	2	20 – 30	medium - high	medium - high	2.7	2.7	15

*All – refers to all stakeholders including RTA, NPWS, RSA, Sutherland Council, Wollongong Council, Rural Fire Services (RFS)

Table 9.3 Options ranking, by options description

Option Category	No	Option Description	Rank
Responsible Stakeholder – Local Council			
General	12	Co-ordinate stormwater management responsibilities within Council sections	1
	21	Introduce procedures to explain development control requirements to recipients of DA	3
	10	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
	39	Co-ordinate all management plans to comply with overall ESD vision	7
	20	Emergency spill plans to accompany development applications that involve hazardous materials	10
	31	Control dog faeces by implementing Companion Requirements	12
	36	Encourage through rebates and mandatory policy the on-site detention of stormwater on all new developments through pervious surfaces, detention ponds, water tanks, etc.	13
	27	Regular monitoring and cleaning of gully pits	16
	19	Provide feedback to community on SWMP effectiveness	18
	37	Incorporate preservation and enhancement of natural drainage lines and creeks into planning policies and development controls	19
	25	Maintain 1 existing Nettech device	24
	17	Review effectiveness of street sweeping programme	25
	16	Inspection of private sewer lines with sale of houses – Introduce requirement into 176 certificate	26
	33	Establish phone hotline to report stormwater management infringements	27
	22	Maintain 3 existing constructed wetlands	30
	24	Maintain 7 existing trash racks	31
	38	Develop a riparian management plan consistent with all other management plans	35
	11	Audit of Council work practices and target improvements	38
	34	Initiate propagation of endemic riparian and wetland species in Council nurseries	41
	23	Maintain 5 existing GPTs	43
	30	Develop and implement best practice guidelines for planting native or low nutrient/water usage plant species in urban parks and nature strips	46
	41	Increase and fund policing of shire to ensure compliance with stormwater objectives	49
	18	Structure monitoring programme to include measure of SWMP effectiveness	52
Education	1	Education of Council staff in Best Management Practices for stormwater	8
	3	Increase community awareness through leaflet in rates notice	9
	5	Awareness campaign against car washing on streets, hosing driveways, etc.	32
	7	Encourage, through education and subsidy, the use of compost bins for on-site retention of garden and putrescible refuse	47
	2	Strategically locate litter bins to reduce litter dropped on roadways and foot-paths	51
Management	43	Support SWC's implementation of the sewer prioritisation project as part of the Sewer Overflow Licensing Project (SOLP)	14
	42	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks[2]	17
Water Quality – Structural	48	Install and maintain Nettech trap at Gunnamatta Bay	28
	47	Install and maintain GPT at The Avenue, East Heathcote	45
	46	Install and maintain GPT at Gymea Bay	48
	45	Install and maintain GPT at Dolans Bay	53

Table 9.3 Options ranking, by options description

Option Category	No	Option Description	Rank
Responsible Stakeholder – Local Council (continued)			
Hotspots	58	General litter problem – support national and state litter reduction programmes, e.g. Clean Up Australia	15
	50	Audley Weir – investigation into reports of frothing and other pollution[3]	22
	53	Road approaches to Audley weir lack water management or sediment control devices – install and maintain[4]	50
	54	Mianga Avenue and Engadine Avenue – automobile service industry and commercial activities – maintain 2 GPTs and already constructed wetlands	54
	51	Industrial areas at Gray Street Sutherland and Kirrawee – Install and maintain GPT or similar traps at pipe discharge points	56
Responsible Stakeholder – NPWS			
Hotspots	50	Audley Weir – investigation into reports of frothing and other pollution[3]	22
	56	Hazard reduction burns – install siltation dams and measures before road drainage discharges to creeks and streams	39
	57	Fire trails - install siltation dams and measures before road drainage discharges to creeks and streams	42
	49	Church of England Conference site in Royal National Park – investigation required	
Responsible Stakeholder – DLWC			
Management	42	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks[2]	17
Responsible Stakeholder – Catchment Management Committee (CMC)			
Management	44	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies	20
Responsible Stakeholder – RTA			
Hotspots	53	Road approaches to Audley weir lack water management or sediment control devices – install and maintain[4]	50
Responsible Stakeholder – CDS			
General	26	Maintain 1 existing CDS unit	21
Responsible Stakeholder – Owners			
Hotspots	55	Han-Rob dog kennels and cattery – control animal faeces	23
Responsible Stakeholder – All*			
General	15	Introduce alternatives to fines – eg suspend building license	2
	13	Increase frequency of inspections of local business and construction sites and penalties/fines for stormwater pollution	5
	14	Review fine effectiveness	6
	40	Encourage installation of rainwater tanks to reduce household runoff	11
	35	Co-ordinate weed removal from all drainage lines – incorporate into Council maintenance as well as Bushcare and Landcare groups	29
	28	Audit stormwater connections from industrial areas and implement policies to ensure connections are reviewed on sale	36
	29	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	37
Education	8	Educate community on the planting of native and plant species with low nutri-ent/water needs	33
	9	Prepare guidelines and encourage appropriate application rates of fertiliser on parklands, playing fields and golf courses	34
	4	Educate community to reduce reliance on plastic shopping bags	40
	6	Educate non-English speaking residents through multilingual programme	44
Hotspots	52	Shopping Centre car parks, etc., install GPTs at discharge points to drainage systems	55

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

2 The responsibility of both the Council and DLWC.

[3] The responsibility of both the Councils and NPWS.
[4] The responsibility of the RTA.
* Refers to all stakeholders including NPWS, RTA, Sydney Water, Sutherland Shire Council, Wollongong City Council, RSA, DLWC etc.

10 Implementation Strategies

The following table describes the priority actions for both Councils, for the effective implementation of the plan. Following Table 10.1 below, Figure 4 shows how implementation of the Plan will be linked to Sutherland and Wollongong Councils' 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 inter Council working group at each Council to meet every 2-3 months: comprised of Stormwater Manager, representative from Planning, Maintenance, Environment services;
• both Councils' Stormwater Manager to detail a funding programme and set up a timetable for implementation of structural options within 6 months of acceptance of the Stormwater Management Plan;
• EPA may set up a stormwater management webb site where all stakeholders can contribute case studies of management programmes and trials of new devices in an effort to share knowledge;
• establish a Stormwater Steering Committee with representatives of each of the key stakeholders: Catchment Management Committee; Sydney Water; Sutherland Council, Wollongong 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 (eg. water quality results, status of implementation of plan etc) ;
• Stormwater Plan Steering Committee to start with a joint agreement on programme of works for the next three years. Where applicable the agreed works should continue to be in consultation with all stakeholders;
• programme 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;
• both Councils' Stormwater Manager to initiate audit of Council practices to improve Council performance and awareness within 12 months of acceptance of the Stormwater Management Plan;
• both Councils' Stormwater Manager, appropriate Community Officer, Environment Services to collaborate on awareness campaigns aimed at schools: project based.
• both Councils' Environment Services: Review current monitoring locations, broaden scope of water quality monitoring programme to include sites that monitor bioindicators e.g.macroalgae or macrofauna in Hacking River and its tributaries and higher up in catchment;

• review and update (where required) the 1996 Hacking River Pollution Source Inventory;
• both Councils'/SW Manager: to initiate audit of industrial and commercial premises in conjunction with awareness campaign with 12 months of acceptance of Stormwater Management Plan;
• both Councils' Stormwater Manager to report to Steering Committee every 6 months on deliverables to date;
Planning Issues
• to review and strength both Councils' planning and development controls to include stormwater requirements;
• both Councils' 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;
• include stormwater requirements in existing and proposed Development Control Plans. Emphasis of requirements is to be on re-use and source control.
• encourage existing development/housing to incorporate more stringent stormwater controls
• encourage retention of natural flow and drainage channels throughout the catchment
• conduct a feasibility study on stormwater re-use options, incorporate re-use into planning and development throughout the catchment
• introduce and maintain feasible stormwater on-site detention and re-use schemes on Council/stakeholder managed land
• ensure that any development will enhance the visual character of the shire
• stormwater pollution controls which address soil conservation, stormwater retention, purification are to be required as a condition of consent for development and building applications
Social Issues
• Urban Creek regeneration programmes (named for example "Creek Rescue") to encourage local Butcher groups and schools. Support through Councils, 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 re-use and source control can be integrated with existing and proposed development
Biophysical Issues
• undertake a Catchment Processes Study to gain a better understanding of the dynamics that affect water quality and ecological systems
• incorporate biological indicators into the updated Hacking River Pollution Source Inventory
• tie in macroinvertebrate/biological monitoring of typical urban stream in catchment to gain an understanding of how water quality affect aquatic communities;

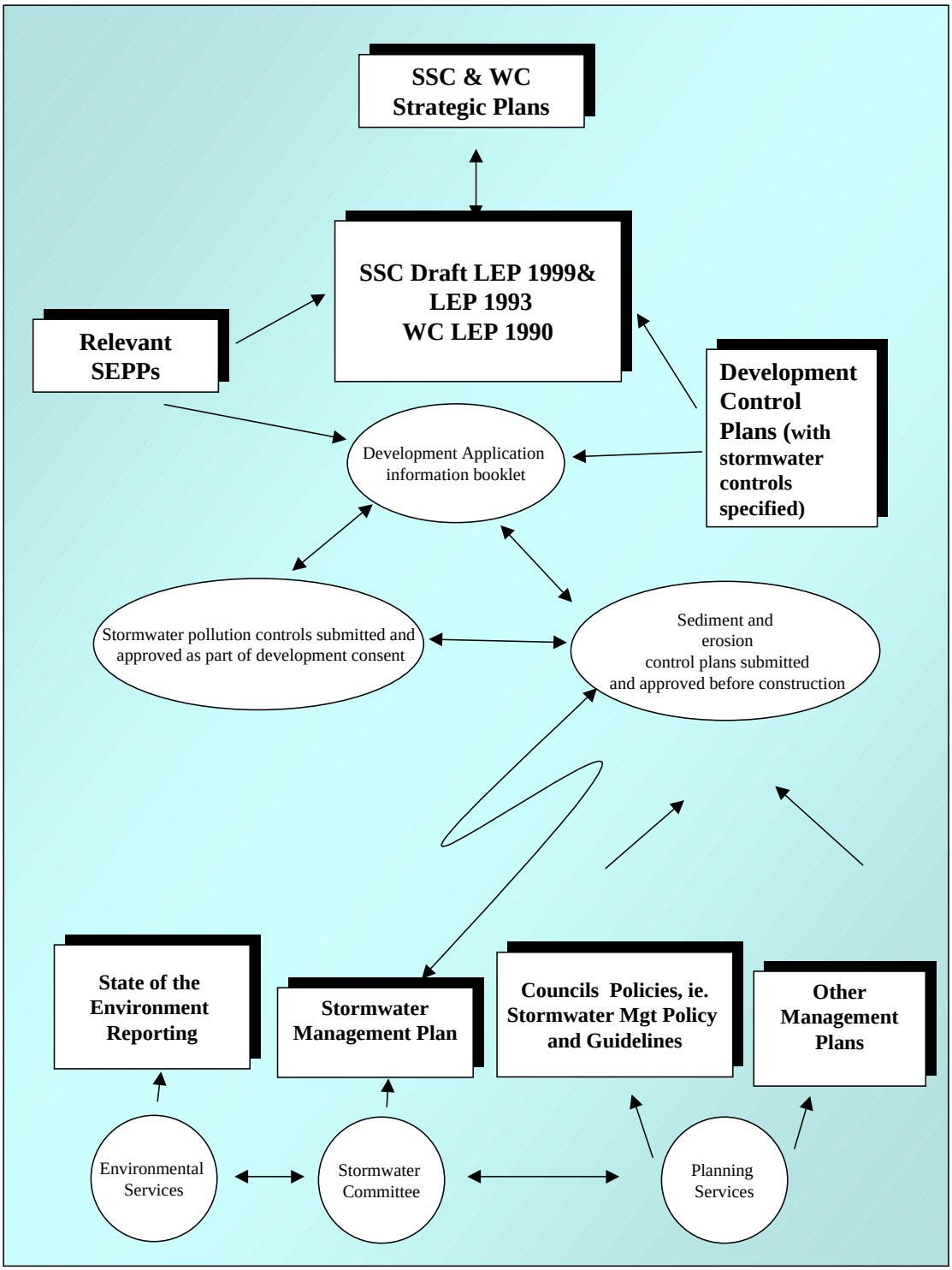

Figure 4 Implementation strategies linked to Councils' Management Planning Processes

Table 10.2 sets out a proposed schedule for the implementation of potential management strategies and an estimate of expenditure over the next five financial years (where applicable).

Table 10.2: Proposed schedule for implementation of potential management strategies for the Hacking 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**	**fourth – fifth year**		
Education						
1	1-3	6,000	2,000	2,000	Sutherland an d Wollongong Councils	Education of Councils staff in Best Management Practices for stormwater
2	current	7,000	10,000	10,000	Sutherland an d Wollongong Councils	Strategically locate litter bins to reduce litter dropped on roadways and footpaths
3	1-3	20,000	20,000	20,000	Sutherland an d Wollongong Councils	Increase community awareness through leaflet in rates notice
4	5	15,000	10,000	10,000	Sutherland an d Wollongong Councils	Educate community to reduce reliance on plastic shopping bags
5	5	12,000	4,000	4,000	Sutherland an d Wollongong Councils, EPA	Awareness campaign against car washing on streets, hosing driveways, etc.
6		15,000	10,000	10,000	All*	Educate non-English speaking residents through multilingual programme
7		30,000	20,000	20,000	Sutherland an d Wollongong Councils, EPA	Encourage, through education and subsidy, the use of compost bins for on-site retention of garden and putrescible refuse
8	5/ current	12,000	4,000	4,000	All* (SSC's Environment Division & Parks and Waterways Division)	Educate community on the planting of native and plant species with low nutrient/water needs
9	current	6,000	2,000	2,000	All* (SSC's Parks and Waterways Division)	prepare guidelines and encourage appropriate application rates of fertiliser on parklands, playing fields and golf courses.
Councils Actions						
10	5	11,000	2,000	2,000	Sutherland and Wollongong Councils' Planning Depts.	Review and update development controls. Specify ratio of pervious/impervious services for all new developments or redevelopments, mandatory sediment controls for all works
11	3	58,000	16,000	16,000	Sutherland and Wollongong Councils	Audit of Councils work practices and target improvements
12	3	6,000	2,000	2,000	Sutherland and Wollongong Councils	Co-ordinate stormwater management responsibilities within Councils sections
13	1-3	15,000	30,000	30,000	All*	Increase frequency of inspections of local business and construction sites and penalties/fines for stormwater pollution
14	1-3	2,000	0	0	All*	Review fine effectiveness
15	1-3	6,000	2,000	2,000	All*	Introduce alternatives to fines – eg suspend building license
16	1-3	95,000	50,000	50,000	Sutherland and Wollongong Councils	Inspection of private sewer lines with sale of houses – Introduce requirement into 176 certificate
17	1-3	7,000	4,000	4,000	Sutherland and Wollongong Councils	Review effectiveness of street sweeping programme
18	5	120,000	120,000	120,000	Sutherland Council	Structure monitoring programme to

Table 10.2: Proposed schedule for implementation of potential management strategies for the Hacking 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	fourth – fifth year		
						include measure of SWMP effectiveness
19	5	7,000	4,000	4,000	Sutherland and Wollongong Councils	Provide feedback to community on SWMP effectiveness
20	3	1,000	0	0	Sutherland and Wollongong Councils (SSC's Planning Division)	Emergency spill plans to accompany development applications that involve hazardous materials
21	3	10,000	10,000	10,000	Councils (SSC's Planning Division)	Introduce procedures to explain development control requirements to recipients of DA
22	1	10,000	20,000	20,000	Sutherland Council	Maintain 3 existing constructed wetlands
23	1	5,000 each	10,000 each	10,000 each	Sutherland Council	Maintain 5 existing GPTs
24	1	1,000 each	2,000 each	2,000 each	Sutherland Council	Maintain 7 existing trash racks
25	1	1000	2000	2000	Sutherland Council	Maintain 1 existing Nettech device
26	1	2,000	4,000	4,000	Sutherland Council	Maintain 1 existing CDS unit
27	1-3	30,000	60,000	60,000	Sutherland and Wollongong Councils	Regular monitoring and cleaning of gully pits
28	1-3	30,000	10,000	10,000	All*	Audit stormwater connections from industrial areas and implement policies to ensure connections are reviewed on sale
29	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
30	1-3	12,000	4,000	4,000	Sutherland and Wollongong Councils	Develop and implement best practice guidelines for planting native or low nutrient/water usage plant species in urban parks and nature strips
31	3	15,000	10,000	10,000	Sutherland and Wollongong Councils	Control dog faeces by implementing Companion Requirements
32		75,000	50,000	50,000	Sutherland and Wollongong Councils	Install hidden video surveillance at well used illegal dump sites (rotational) and prosecute
33	1-3	17,000	30,000	30,000	Sutherland Council	Establish phone hotline to report stormwater management infringements
34	current	15,000	10,000	10,000	Sutherland and Wollongong Councils	Initiate propagation of endemic riparian and wetland species in Councils nurseries for wholesale to the public.
35	current	20,000	20,000	20,000	Sutherland and Wollongong Councils	Co-ordinate weed removal from all drainage lines – incorporate into Councils maintenance as well as Bushcare and Landcare groups
36	1-3	10,000	10,000	10,000	Sutherland and Wollongong Councils	Encourage through rebates and mandatory policy the on-site detention of stormwater on all new developments through pervious surfaces, detention ponds, water tanks etc.
37	3	7,000	4,000	4,000	Sutherland and Wollongong Councils	Incorporate preservation and enhancement of natural drainage lines and creeks into planning policies and development controls

Table 10.2: Proposed schedule for implementation of potential management strategies for the Hacking 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	fourth – fifth year		
38	current	12,000	4,000	4,000	Sutherland and Wollongong Councils	Develop a riparian management plan consistent with all other management plans
39	3	10,000	10,000	10,000	Sutherland and Wollongong Councils	Co-ordinate all management plans to comply with overall ESD vision
40	3	10,000	10,000	10,000	All*	Encourage installation of rainwater tanks to reduce household runoff
41	1-3	120,000	120,000	120,000	Sutherland and Wollongong Councils	Increase and fund policing of shire to ensure compliance with stormwater objectives
Management						
42	current	7,000	10,000	10,000	Sutherland and Wollongong Councils and DLWC	Co-ordinate local Bushcare groups to reduce weed infestation along Creeks
43	1-3	2,000	0	0	Sutherland and Wollongong Councils	Support SWC's implementation of the sewer prioritisation project as part of the Sewer Overflow Licensing Project (SOLP)
44	1-3	5,000	0	0	CMC	CMC to co-ordinate catchment based management and monitor implementation of stormwater strategies
Water Quality- Structural						
45	1-2	67,000	8,000	8,000	Sutherland Council	Install and maintain GPT at Dolans Bay
46	1-2	58,000	6,000	6,000	Sutherland Council	Install and maintain GPT at Gymea Bay
47	1-2	3,000	6,000	6,000	Sutherland Council	Maintain GPT at The Avenue, East Heathcote
48	1-2	2,500	1,000	1,000	Sutherland Council	Install and maintain Nettech trap at Gunnamatta Bay
Hotspots						
49	1	4,000	2,000	2,000	All* – NPWS	Church of England Conference site in Royal National Park – investigation required
50	1	4,000	2,000	2,000	Sutherland and Wollongong Councils, NPWS	Audley Weir – investigation into reports of frothing and other pollution
51	1-3	64,000 each	8,000 each	8,000 each	Sutherland Council	Industrial areas at Gray Street Sutherland and Kirrawee – Install and maintain GPT or similar traps at pipe discharge points
52	1-3	27,000 each	4,000 each	4,000 each	All*	Shopping Centre car parks, etc. install GPTs at discharge points to drainage systems
53	1-3	64,000	8,000	8,000	RTA, Sutherland and WollongongCouncils	Road approaches to Audley weir lack water management or sediment control devices – install and maintain
54	1-3	15,000	15,000	15,000	Sutherland Council	Mianga Avenue and Engadine Avenue – automobile service industry and commercial activities – install 2nd constructed wetlands and maintain 2 GPTs and already constructed wetlands
55	1-2	4,000	2,000	2,000	All *– EPA	Han-Rob dog kennels and cattery – control animal faeces – EPA control
56	1-3	25,000	10,000	10,000	NPWS	Hazard reduction burns – install

Table 10.2: Proposed schedule for implementation of potential management strategies for the Hacking 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**	**fourth – fifth year**		
						siltation dams and measures before road drainage discharges to creeks and streams
57	1-3	40,000	20,000	20,000	NPWS	Fire trails - install siltation dams and measures before road drainage discharges to creeks and streams
58	1-3	6,000	2,000	2,000	Sutherland and Wollongong Councils	General litter problem – support national and state litter reduction programmes, eg. Clean Up Australia

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

11 Monitoring and Revision of the Plan

In response to community concerns about water quality in the catchments managed by Sutherland Council, a Strategic Water Quality Monitoring Programme (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 and 17 of these sites are located within the Hacking River catchment.

Existing Monitoring

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 Shire 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 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 will be added to this programme 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.

Additional Monitoring

Monitoring of the effectiveness of education programmes will 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 programmes 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.

Monitoring of macroinvertebrate communities at selected sites is to be used to assess ecosystem health and water quality, where considered appropriate.

A position will be nominated, rather than a person, for the co-ordination of the monitoring programme 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 certain targets have to be set in order for comparisons to be made. Therefore, 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 programme will assess four core areas:

- planning ;
- water Quality;
- pollution Control Devices; and
- education.

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

Table 11.1: Performance Indicators for the Monitoring Programme

Task	Responsibility	Performance Indicator
Planning		
• Establishment of inner Council working group	• Council Stormwater Manager	• Minutes of meetings (quarterly).
• Funding programme, including a timetable for implementation of structural options	• Council Stormwater Manager	• Programme 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)	• Environment Services	• Programme to be established within 6 months of the SWMP being accepted; • Record of programme schedule.
Water Quality		
• Set baseline for water quality (parameters and year)	• Environmental Services	• 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 Services	• Targets to be stated in Council's Environment Policy within 12 months of the SWMP being accepted.
• Water quality monitoring	• Environmental Services	• Water quality data records.
• Reporting of water quality data	• Environmental Services	• State of Environment Report

Task	Responsibility	Performance Indicator
and whether targets are being achieved. • Conduct Pollution Source Inventory	• Environmental Services	(annual). • Report to be completed within 12 months of the SWMP being accepted.
• Initiate monitoring of bioindicators	• Environmental Services	• 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	• Environment Services	• Benchmark to be established within 12 months of the SWMP being accepted.
• Establish reduction targets	• Environment Services	• Targets to be stated in Council's Environment Policy within 12 months of the SWMP being accepted.
• Monitoring of TRs and GPTs	• Environment Services	• 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.	• Environment Services	• State of the Environment Report (annual).
Education		
• Initiate audit of Council practices to improve performance and awareness	• Council Stormwater Manager	• To be established within 12 months of the SWMP being accepted; • Record of follow-up audits (biannually) to assess continual improvement; • Record of adequacy of improvements (as required).
• Establish an awareness campaign aimed at schools	• Council Stormwater Manager, community liaison officer, Environment Services	• Programme 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.	• Council Stormwater Manger	• Programme 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 Programme	• Council Stormwater Manager, community liaison officer, Environment Services	• Programme to be implemented within 12 months of the SWMP being accepted; • Record of local bushland groups and schools participating;

Task	Responsibility	Performance Indicator
		• Record of achievements.

11.1 Revision of Plan and Reporting

The results of these environmental monitoring programmers will be reported in both Sutherland Councils and Wollongong 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.

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. Mixes of structural and non-structural options are 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 programme can be a very effective "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 Results

Hacking Catchment Stormwater Quality Issues

Group 1

- population increase
- sewer overflows (leakage) entering stormwater drains
- insufficient monitoring
- identify source of pollution
- lack of baseline scientific information upon which decisions are made
- lack of coordination between authorities
- heavy metals resulting from runoff from the freeway
- increase of impervious surfaces, increase of surface runoff
- 40,000 dogs in catchment - how much poo?
- public awareness is low - increase education campaigns
- sediment from construction sites - need to implement sediment control measures
- council planning policy is considered inappropriate
- Governments funding community based treatment areas (wetlands, GPT's)
- stormwater = community problem

Priority issues for this group

- Sewer overflows (leakage)
- public awareness is low - increase education campaigns
- council planning inadequate

Group 2

- General street rubbish, plastic, droppings, cigarette butts
- Gardening rubbish, Streetscape or private rubbish
- Motor vehicle pollution
- Sewerage infiltration due to aging infrastructure
- Erosion and siltation in public and private land
- Increases in the amount of impervious surfaces in the catchment
- Ineffective controls to limit hard surfaces in the catchment
- Increase in type and amount of development
- Need to address adequacy and capacity of stormwater system
- Untreated discharge from Helensburgh and Otford and Helensburgh Tip
- Decreasing areas on soil and trees to filter pollutants
- Poor and inappropriate planning controls
- Too much high density development
- Ineffective controls to stop polluters and inadequate policies

- Education of community to change attitudes
- Need to stop pollution at the source, rather than treat at the other end, the amount of impervious surfaces.

Priority issues for this group

- Education of community to change attitudes
- Need to stop pollution at the source, rather than treat at the other end, the amount of impervious surfaces.
- Need to address adequacy and capacity of stormwater system
- Untreated discharge from Helensburgh and Otford and Helensburgh Tip

Group 3

- Sewerage
- Septic systems
- Direct Discharge
- Overflows
- At source controls
- Residential sites
- Industrial sites
- Construction sites
- Education Programme
- Community, Industrial and Building
- Building/ Design regulations
- Better design regulations
- incentives for innovative designs
- Management
- policing and maintenance

Priority issues for this group

- At source controls
- Education
- Regulation and controls
- Site Design
- Management and Maintenance
- Dumping and Disposal.
  - chemical waste
  - domestic waste

- personal disposal (small rubbish)

- Maintaining Facilities

Group 4

- Chemical
- pesticides
- inappropriate use and poor registration
- vehicle emissions
- proper end of pipe solutions
- Population Density
- construction Sites
- non-operational service stations (contaminated sites)
- Stream Bank Vegetation Losses
- a chemical cocktail from roads
- corporate cultures of various organisations
- Visual
- Trash and floatables
- Impervious surfaces
- sediment at the head of the bay from catchment erosion and development
- road run-off nutrients (ie flowing into National Parks)
- Point Sources of Pollution
- use of land, horses, pigs etc.
- pollutant traps (no use unless they are serviced)
- Indiscriminate Rubbish Dumping
- planning for urban development
- redesigning old sites to better manage run-off
- environmentally friendly engineering designs
- some form of efficient gross pollutant trap that is regularly serviced
- septic effluent from Maianbar and Bundeena
- Better Education

Priority issues for this group

- Better Education – changing community attitudes
- Impervious surfaces
- sediment at the head of the bay from catchment erosion and development
- road run-off nutrients (ie flowing into national parks)

Stormwater Quality Stakeholder Values
Hacking Catchment

Group 1

Economic

- Recreational
- Tourism
- Real Estate values

Social

- Healthy Environment
- Recreation
- Swimming
- Boating
- Fishing
- Aesthetics
- Turbidity
- Weed growth

Environmental

- Water Quality fit for the above pursuits
- Water quality to meet perceived quality of the National Park

Group 2

- Overall Goal – to return the waterways to its pre-urbanisation quality/ state

Economic

- Tourism
- Fishing Industry
- Other Industries eg ferries, recreational activities
- Property values

Cultural

- ‘Self-image’ – Bronzed Aussie, outdoors type who engage in the social items listed below.
- ‘Village’ ethos of communities such as Bundeena and Maianbar

- ‘God’s Country’
- ‘The Shire’ – self image

Social

- Healthy use of the waterways
- Recreation
- Fishing
- Boating
- Sailing
- BBQ’s and picnics
- safe swimming
- Equity for future generations – share the lifestyle enjoyed by their forbears

Group 3

- Public Health and primary contact areas
- Natural environment health
- -need to maintain a healthy aquatic environment
- Minimise the negative effects of stormwater on all sub-catchments
- Clean waterways are dependent on clean stormwater
- Aim at improving the waterways through responsible management techniques to make the Hacking River a clean pristine waterway

Appendix 2
Ranking Options Methodology

Options Ranking Methodology

The proposed options for management of stormwater in the Hacking 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 assessed 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.

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 & Wollongong Council

HRCMC - Hacking River Catchment Management Committee

EPA - Environment Protection Authority

NSW Fisheries Department

RTA - Roads and Traffic Authority

SRA - State Rail Authority

DLWC Department of Land and Water Conservation

NPWS - National Parks and Wildlife Service

Miranda Precinct Committee

Cronulla Precinct Committee

North Cronulla Precinct Committee

Port Hacking Professional Society

Oyster Farmers Association

Illawong Rural Fire Service;

Otford Valley Farm

Mullaley Properties

DUAP - Department of Urban Affairs and Planning

SWC - Sydney Water Corporation

general public

STRATEGY TYPE: The options have been categorised into:

ED - Education

MAN - Management

ST - Structural

AU - Auditing/Enforcement

(Strategy type has not been indicated in the spreadsheet)

DESCRIPTION: Describes the option.

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, cost is estimated *using a guide of $1000/week/officer*.

COST INDEX: Is the average of the capital and maintenance cost. 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.***

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 – 2250	0 – 10%	1
2251 – 4500	11 –20%	2
4501 – 6750	21 – 30%	3
67501 –9000	31 – 40%	4
9001 – 11250	41 – 50%	5
11251 – 1350	51 – 60%	6

Hectares	Area%	Weighting
1351 – 15750	61 – 70%	7
15751 – 18000	71 – 80%	8
18001 – 20250	81 – 90%	9
20250 - 22500	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.

Ranking of Options

COST/BENEFIT: The cost/benefit ratio 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 option)*	/	***Benefit Index*** *(A higher index indicates a more effective option)*

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