Georges River

STORMWATER MANAGEMENT PLAN

Sutherland
Hurstville
Kogarah
Rockdale Councils

&

Hurstville City Council

July 1999

SINCLAIR KNIGHT MERZ

Contents

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- Report Production:
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- Report Review:
  Mike Sharpin and Shane Barter, NSW EPA

Executive Summary

The Lower Georges River Stormwater Management Plan (SMP) has been prepared to comply with a directive issued to all NSW Councils by the NSW Environment Protection Authority under Section 12 of the *Protection of the Environment Administration Act*. This directive requires all Councils to prepare catchment specific Stormwater Management Plans for urban areas within their Local Government Areas (LGAs).

The Lower Georges River catchment has an area of approximately 7,300 hectares, comprising Sutherland LGA (57%), Hurstville LGA (13%), Kogarah LGA (20%) and Rockdale LGA (10%).

Within the Lower Georges River catchment Sydney Water Corporation, and the Roads and Traffic Authority (RTA) also have stormwater and land management responsibilities. The EPA has issued notices to these agencies, under the *Clean Waters Regulations*, to participate in the preparation and implementation of the SMP. The Rail Access Corporation (RAC) was not issued a notice by the EPA, however, is still regarded as an obligatory body responsible for stormwater management with the catchment. The RAC has therefore also been involved in the SMP process.

The primary goal of the Lower Georges River Catchment SMP is to:

"facilitate the coordinated management of stormwater within the Lower Georges River catchment, to improve the health and quality of the catchment waterways".

The SMP was prepared in close coordination with Council, RTA, RAC and Sydney Water representatives as well as the EPA. In addition, a series of community involvement workshops as well as two stakeholder workshops were held, all of which were well attended.

The SMP covers the following:

- Catchment Description;
- Existing Catchment Conditions;
- Waterway and Catchment Values;
- Stormwater Management Objectives;
- Stormwater Management Issues;
- Stormwater Management Options;
- Evaluation and Analysis of Options;
- Strategy for Implementation of the SMP;
- Water quality monitoring and modelling; and
- Updating the SMP.

The important points in each of these sections are summarised below.

Catchment Description/Existing Catchment Conditions

Subcatchments

There are nine subcatchments which are identified in this SMP and discussion is generally based on the specifics of each subcatchment as well as at the catchment wide level. Subcatchments are: (A) Kurnell Peninsula; (B) Gwawley Bay; (C) Oyster Bay; (D) Lime Kiln Bay; (E) Gungah Bay; (F) Oatley Bay; (G) Kyle Bay; (H) Kogarah Bay; and (J) Scarborough Ponds/Sans Souci.

Waterways
Within the study area the Georges River is the dominant waterway and divides the Sutherland Shire LGA to the south from the rest of the LGAs to the north. There are numerous estuarine bays on both the north and south sides of the Georges River, the most major of which include Kogarah Bay, Oatley Bay, Lime Kiln Bay, Oyster Bay, Gwawley Bay and Woolooware/Weeney/Quibray Bays. The mouth of the Georges River is located at the south west corner of Botany Bay.

Creeks and drains which flow into the lower Georges River are numerous and generally discharge indirectly into the Georges River through one of the estuarine bays. The Georges River is tidal for its whole length within the study area which starts just downstream of its confluence with Salt Pan Creek at Luguarno Point and ends at Botany Bay.

Landuse
The predominant landuse within the catchment is residential and special uses (63%), followed by open space/environmental protection (33%) and industrial and commercial (12%).

Topography
To describe the topography of the Lower Georges River catchment it is useful to consider it as three separate zones: (1) Foreshore Land around Botany Bay and Woolooware Bay, generally low-lying land which is flat to gently undulating with slopes generally not more than 1%; (2) Georges River Frontage Land, steep sloped gullies are common with slope greater than 15% and small cliff faces which drop into or just back from the waterway; and (3) Land away from the Georges River, the ridges of the catchment with gently to moderately undulating slopes in the order of 3% - 5.

Geology & Soils
The study area lies on three main geological types, Hawkesbury sandstone, Wianamatta shale and Alluvium. The predominant soil groups within the study area north of Georges River are the Blacktown and Lucas Heights Residuals, whereas on the south side of the river the predominant inland soil group is the Gymea Residuals. The majority of the Lower Georges River catchment contains no known occurrences of acid sulphate soil materials. The Rockdale and Kurnell areas contain the largest area of high probability acid sulphate soils down to 3 metres depth.

Rainfall

The average annual rainfall in the study area is between 1000mm and 1100mm.

Water Quality
Generally water quality in the study area is acceptable in dry weather conditions however in wet weather both bacteriological and nutrient concentrations increase.

Modelling undertaken by Sydney Water for the Sewer Overflow Licensing Project has estimated stormwater concentrations to be a major contributor to phosphorous and nitrogen loads whereas sewage overflows are largely the source for high faecal coliform levels.

Sydney Water has also undertaken risk assessments of toxicants at two sites in the Lower Georges River. Twenty three chemicals of potential concern (COPC) to aquatic life were identified at two sites. The majority of these COPCs were sourced to stormwater with chlordanes, chloropyrifos, H_2S, iron and pp-DDT being of most concern.

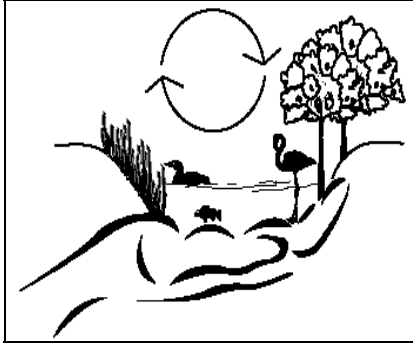
Other issues identified to impact on urban runoff water quality include managerial poor practices, in-effective sedimentation controls on construction sites, and a general lack of awareness in the community of stormwater and the way in which they may impact on the quality of stormwater runoff.

Urban Bushland
Significant areas of urban bushland exist in the Lower Georges River catchment. The larger areas include the Kurnell Peninsula (Towra Nature Reserve) and Oatley Park, Oatley as well as stands of mangroves in the estuarine reaches.

Waterway and Catchment Values
Waterway and catchment values for Lower Georges River were developed through a series of seven community workshops and in conjunction with the Lower Georges River Stormwater Management Committee (LGRSMC). Values and priorities were identified in accordance with the importance the community placed on their waterways. Three types of values were identified: ecological, social and economic.

The values identified to be of primary importance across the whole catchment are presented below.

Primary Values/Goals for the Lower Georges River Catchment

	Healthy Aquatic Ecosystems "…to encourage the existence and health of aquatic ecosystems as a whole within the catchment waterways and surrounding areas." *
3	Increase and Maintain Visual Amenity "…to make the waterways, foreshore and catchment areas look more natural and pleasant to the eye, without the presence of man-made things, especially litter."
)	Increase Awareness and Education "…use the waterways, foreshore and catchment areas and its associated aquatic life for the education of students of schools and scientific institutions as well as increasing the awareness of the stormwater issue amongst the community."

* aquatic ecosystem includes aquatic animals such as fish and frogs, aquatic and riparian vegetation such as reeds and water lilies, and water associated wildlife such as wading birds - all of which are part of a habitat critical to the survival of individuals and the ecosystem as a whole.

Secondary and Tertiary goals were also identified, the details of which are provided in **Section 4**.

Stormwater Management Objectives

Stormwater management objectives were developed to protect the desired waterway and catchment values. Short and long term objectives were set for each of the values. These objectives were based on the principles of ecologically sustainable development, which requires the integration of environmental and economic considerations.

Stormwater treatment targets were also set to quantify the treatment measures required to achieve each of the objectives. Treatment targets for both developed areas and areas under development were set.

Stormwater Management Issues
Stormwater management issues within the catchment were identified from discussions with Council officers, stakeholders and the community and from existing documentation. In addition, specific "hot-spots" within the study area were identified through catchment inspections. Some of the major issues include:

- Catchment & waterway erosion and sediment deposition;
- Litter ;
- Elevated nutrient and faecal bacteria concentrations, particularly in estuary reaches which are not flushed well by tidal action following rain events;
- Reduction in areas of urban bushland and riparian vegetation;
- Elevated levels of suspended solids;
- Degraded aquatic and riparian habitats;
- Sewer overflows and exfiltration; and
- Managerial Poor Practices.

Stormwater Management Options
A number of stormwater management options were identified to address the stormwater management issues and to meet the stormwater management objectives. A combination of non-structural and structural options were considered. Non structural options include: educational measures, planning controls, studies and assessments etc. Structural options include: litter traps, constructed stormwater wetlands, vegetation planting, bank stabilisation etc.

Evaluation and Analysis of Options
The identified stormwater management options were ranked using a simplified cost-benefit analysis which was developed in close coordination with councils and agencies. The ranking methodology included consideration of the following cost and benefit categories:

- Cost Categories:
  - Capital Cost; and
  - Lifetime Maintenance Cost;
- Benefit Categories:
  - Target Pollutant (relative harm & public perception of removal);
  - No. of Pollutants
  - Effectiveness of Option in achieving the stormwater management objectives; and
  - % Catchment Area Benefited.

Overall catchment wide stormwater management options were ranked with each Council's specific individual options to identify those with higher priority..

Strategy for Implementation
Separate implementation strategies were developed for each Council and other stormwater managers, from the ranked list of options. Each strategy

includes only those actions for which the corresponding stormwater manager has total or partial responsibility for implementation.

Information contained within each strategy includes:

- time frame for implementation, WHICH IS SUBJECT TO THE AVAILABILITY OF COUNCIL AND GOVERNMENT GRANT FUNDING AT THE RESPECTIVE STAGES OF THE FIVE YEAR PROGRAM;
- priority within council for implementation;
- council structure and responsibility diagrams; and
- position of the SMP in Council's planning process.

Separate implementation strategies were also developed for Sydney Water Corporation, Roads and Traffic Authority (RTA), RAC/State Rail and EPA. A summary of the financial year and expenditure for each stormwater manager is provided below.

Summary of Five Year Implementation Costs

Stormwater Manager	1st Year		2nd & 3rd Years		4th & 5th Years		Total
	Capital ($)	Maint. ($)	Capital ($)	Maint. ($)	Capital ($)	Maint. ($)	
Sutherland Shire Council	1,541,390	266,205	317,210	660,600	142,700	683,440	3,611,545
Hurstville Council	1,416,710	434,040	73,560	900,020	557,920	1,019,830	4,402,080
Kogarah Municipal Council	1,495,160	118,600	740,700	328,300	1,778,000	506,400	4,967,160
Rockdale City Council	75,800	35,050	310,200	121,500	989,000	257,900	1,789,450
Sydney Water Corporation*	122,000	46,000	10,000	86,000	1,280,000	124,000	1,668,000
RTA	Refer to Table 9.9						405,479
RAC/ State Rail*	1,202,000	301,500	80,000	603,000	20,000	608,000	2,814,500
EPA*	85,000	28,500	-	54,000	-	57,000	224,500

* full cost shown - apportionment of costs between parties needs to be agreed to at implementation stage.

Water quality monitoring

Both short and long term water quality monitoring is recommended by this plan. Water quality monitoring should be undertaken on a catchment wide basis to assess the effectiveness of the implementation strategy against the specified performance indicators in **Section 10**.

On-going Stormwater Management

Updating the SMP

Stormwater management is a continuous process. Preparation of the Lower Georges River SMP is only the first stage in the stormwater management process. Following the preparation of the SMP the stormwater

management options are implemented, as per the Implementation Strategy, and then monitored and reviewed. This review process is used to update and revise the SMP. The stormwater management cycle then continues.

Revision of the SMP is to be undertaken in two ways, over different time periods, as follows:

- Revise/re-issue council and agency Implementation Strategies.
  The implementation strategies form the basis of Council and Agency stormwater works programs. The strategies are dynamic, changing as works are completed, additional works are required or new issues arise. These strategies should be updated annually.
- Review/revise the SMP document.
  It is important that the SMP document is reviewed and revised regularly to ensure it remains a relevant document. It should be reviewed annually to ensure that the objectives, issues and options identified within the SMP are still relevant. The SMP should be updated as required, but within 3 years from completion or the last revision (with the exception of the Implementation Strategy which is updated yearly as discussed above.)

A coordinated approach including all representatives of the LGRSMC and relevant government agency stormwater managers will be used to drive the on-going stormwater management process in the Lower Georges River catchment.

Document History and Status

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Contents

1. Introduction

1.1 Background

Stormwater management has been predominantly the responsibility of individual local councils. In the Sydney Greater Metropolitan Region there is often more than one council within a particular catchment making a coordinated and integrated approach to stormwater management difficult.

The NSW Environment Protection Authority (EPA) has issued a directive to all Councils, under Section 12 of the *Protection of the Environment Administration Act*, to prepare a catchment specific Stormwater Management Plan for urban areas within their catchment. This is aimed at facilitating a coordinated approach to stormwater management. The NSW Government has made grants available to local councils to assist them in preparing their SMPs.

In addition to Council's, Sydney Water Corporation and Roads and Traffic Authority (RTA) have stormwater and land management responsibilities within the Lower Georges River Catchment. The EPA has issued notices to these agencies under the *Clean Waters Regulations* , to participate in the preparation and implementation of the SMP. The Rail Access Corporation (RAC) was not issued a notice by the EPA, however, is still regarded as an obligatory body responsible for stormwater management with the catchment. The RAC has therefore also been involved in the SMP process.

This SMP is for the Lower Georges River Catchment and has been developed cooperatively by Kogorah, Sutherland, Hurstville and Rockdale Councils. This plan has been prepared to comply with the EPA's Section 12 directive.

The Lower Georges River Catchment has an area of approximately 7,300 ha. This is made up of approximately 57% Sutherland LGA, 20% Kogarah LGA, 13% Hurstville LGA and 10% Rockdale LGA. **Figure 1.1** shows the LGA boundaries for each of the Councils within the study area.

1.2 Purpose of the Lower Georges River Catchment Stormwater Management Plan (SMP)

The primary goal of the Lower Georges River Catchment Stormwater Management Plan is to facilitate the coordinated management of stormwater within the Lower Georges River catchment, to improve the health and quality of the catchment waterways. This SMP will assist councils in minimising the future impacts of

urban stormwater on the environment and will address existing stormwater impacts.

The main objectives of the SMP are to:

- identify stormwater management values for the catchment;
- derive stormwater objectives to protect these values;
- identify problems and issues that may compromise these objectives and;
- detail actions and a 5 yr schedule to address these problems and issues.

The SMP must be realistic in its approach in identifying and prioritising cost-effective stormwater management practices specific to the catchment requirements. Short and long term objectives are to be identified with areas suffering the greatest problems targeted first.

The structure of this document is such that the general whole-of-catchment is presented at the beginning of each chapter or issue, followed by a more specific description for each sub-catchment. The definition of each sub-catchment is provided in **Section 2**.

1.3 Stakeholder Consultation

To achieve the objectives of the SMP, it was critical that the SMP be prepared jointly by all councils within the catchment area and in close consultation with relevant government authorities, community groups and other stakeholders.

Consultation throughout the SMP preparation process included:

- Initial workshop with the Lower Georges River Catchment Steering Committee (LGRCSC) - 15th September 1998
- Meeting with the LGRCSC (1st Draft - Description of Existing Conditions) - 27th October 1998
- Community “Values and Issues” Workshops :
  - Rockdale City Council - 2nd November 1998
  - Sutherland Shire Council - 10th November 1998
  - Hurstville Council - 16th November 1998
  - Kogarah Municipal Council - 17th, 18th & 24th November 1998
- Stakeholder Workshop #1 (Issues Paper) - 9th February, 1999
- Public Exhibition of Issues Paper - January/February 1999
- Public Exhibition of Draft SMP - 13th May - 10th June, 1999
- Stakeholder Workshop #2 (Draft SMP) - 1 June, 1999

The organisations represented on the LGRCSC are listed below. All councils and a number of government agencies were included throughout the entire SMP process, as were major catchment stakeholders.

Lower Georges River Catchment SMP Steering Committee Members

- Kogarah Municipal Council
- Sutherland Shire Council
- Hurstville Council
- Rockdale City Council
- Georges River Catchment Management Committee
- Sydney Water
- RTA - Road Transport Authority

Other organisations consulted as part of the stakeholder and community workshops included:

- EPA - Environment Protection Authority
- RAC - Rail Access Corporation
- City Rail/RSA - Rail Services Australia

A listing of community representatives who attended the public workshop is also provided in **Appendix A** as part of the minutes taken at the meetings.

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2. Catchment Description

2.1 Lower Georges Catchment - EPA Definition

The study area boundary as defined in words by the EPA is as follows:

> *"Lower Georges River catchment is defined as that area which drains to the Georges River downstream of the mouths of Salt Pan Creek and the Woronora River on the north and south sides of the River respectively, together with those catchments which drain directly to Botany Bay at points located south of the mouth of the Cooks River, and west of Point Long Nose on the Kurnell Peninsula."* (EPA, August 1998)

Figure 2.1 illustrates the Lower Georges River catchment boundary as well as other features of the study area including subcatchments and major waterways and drains. Each subcatchment is assigned a letter which is used in the description of waterways, drains and catchments below.

2.2 Waterways and Subcatchments

Throughout the Lower Georges River catchment there are numerous natural waterways and estuarine bays, constructed stormwater drains and associated subcatchments. These are illustrated in **Figure 2.1** and are listed below in **Table 2.1** according to each subcatchment and Local Government Area (LGA).

Table 2.1: Summary of Major Waterways, Drains & Bays in the Lower Georges River Catchment

Sub-catchment	LGA	Major Waterways/Drains	Estuarine Bays
A (Kurnell Peninsula sub-catchment)	Sutherland	◻ All foreshore drainage	◻ (Botany Bay) ◻ Towra Point Aquatic Reserve which includes: – Quibray Bay – Weeney Bay – Woolooware Bay
B (Gwawley Bay sub-catchment)	Sutherland	◻ Gwawley Creek - discharges to Gwawley Bay ◻ also foreshore drainage directly into Lower Georges River	◻ Gwawley Bay
C (Oyster Bay sub-catchment)	Sutherland	◻ Oyster Creek - discharges to Oyster Bay ◻ also foreshore drainage directly	◻ Oyster Bay ◻ Coronation Bay ◻ Carina Bay ◻ Scylla Bay

		into Lower Georges River and other bays	

cont'd next page

Table 2.1: Summary of Major Waterways, Drains & Bays in the Lower Georges River Catchment (cont'd)

Sub-catchment	LGA	Major Waterways/Drains	Estuarine Bays
D (Lime Kiln Bay sub-catchment)	Hurstville	◻ Boggywell Creek - discharges to Lime Kiln Bay ◻ un-named drainage courses through the Hurstville G.C and Oatley Heights Park reserve - discharges to Lime Kiln Bay ◻ also foreshore drainage directly into Lower Georges River and Edith Bay	◻ Edith Bay ◻ Lime Kiln Bay
E (Gungah Bay sub-catchment)	Hurstville Kogarah (minor)	◻ foreshore drainage only directly into Lower Georges River and Bays	◻ Jew Fish Bay ◻ Gungah Bay ◻ Neverfail Bay
F (Oatley Bay sub-catchment)	Kogarah	◻ un-named drainage courses through Moore Reserve and Poulton Park reserve - discharges to Oatley Bay	◻ Oatley Bay
G (Kyle Bay sub-catchment)	Kogarah	◻ foreshore drainage only directly to Lower Georges River and Bays	◻ Shipwright Bay ◻ Kyle Bay ◻ Connells Bay
H (Kogarah Bay sub-catchment)	Kogarah	◻ Kogarah Bay Creek - discharges to Kogarah Bay	◻ Kogarah Bay
J (Scarbor-ough/San Souci sub-catchment)	Rockdale Kogarah (minor)	◻ Scarborough Ponds (wetlands) - discharges to Botany Bay ◻ San Souci Drain No. 1 - drains to Sandringham Bay ◻ San Souci Drain No. 2 - drains to Botany Bay at Riverside Drive ◻ San Souci Drain No. 3 - drains to Kogarah Bay at the south-east most point near the pool	◻ (Botany Bay) ◻ Sandringham Bay

Kurnell Peninsula (Subcatchment A)
The Kurnell Peninsula subcatchment is mainly a foreshore drainage area. Stormwater discharges directly to the mouth of Georges River or the Bays (Botany, Quibray, Weeney or Woolooware Bays - the latter three of which are part of the Towra Point Aquatic Reserve).

Gwawley Bay (Subcatchment B)
The main natural waterway which drains the Gwawley Bay subcatchment is Gwawley Creek. Three large stormwater drains discharge into the upstream end of the creek within the Corea Street Oval recreation park. From there, Gwawley Creek runs approximately 1.7 km through Sylvania to where it discharges into Gwawley Bay (Sylvania Waters) just downstream of Belgrave Esplanade.

Gwawley Creek is tidal from downstream of approximately the intersection of Roma Place and Leichhardt Crescent.

Oyster Bay (Subcatchment C)
Oyster Creek, which is a natural water way, flows approximately 2.5 km from the Illawarra Railway line to Oyster Bay at the bottom of Oyster Gully. The gullies upstream of the Kareela Golf Course discharge directly to Oyster Bay separately to Oyster Creek.

Also included in the Oyster Bay subcatchment are the gullies upstream of Carina and Scylla Bays as well as the foreshore drainage into Coronation Bay.

Lime Kiln Bay (Subcatchment D)
Boggywell Creek discharges into the lower reaches of Lime Kiln Bay and is fed by a linear park catchment area approximately 1.5 km long through Peakhurst. Stormwater discharges into Lime Kiln Bay from a gully originating in Mortdale as well as a large spoon basin which discharges at the downstream end of the Hurstville Golf Course.

Included in the Lime Kiln Bay subcatchment is a small foreshore area just above Edith Bay which discharges directly into the Georges River.

Gungah Bay (Subcatchment E)
The Gungah Bay subcatchment area incorporates Georges River foreshore properties, which discharge to the river through three bays, Jew Fish Bay, Gungah Bay and Neverfail Bay.

The Gungah Bay subcatchment saddles the Hurstville and Kogarah LGA boundary defined by the Illawarra Railway line.

Oatley Bay (Subcatchment F)
Two natural water ways either side of Hurstville Grove flow into Oatley Bay through Moore Reserve and Poulton Park respectively.

Also included in the Oatley Bay subcatchment are the strips of land on both sides of the lower reaches of the bay and a small foreshore area adjacent the Georges River. These areas runoff directly into Oatley Bay and Georges River respectively.

Kyle Bay (Subcatchment G)
This subcatchment area stretches approximately 4 kms along the northern bank of the Georges River from Connells Point to Tom Uglys Point and incorporates Connells Bay, Kyle Bay and Shipwrights Bay. The majority of the runoff from this area is direct foreshore drainage either into the bays or Georges River itself.

Kogarah Bay (Subcatchment H)
The main waterway tributary to Kogarah Bay is Kogarah Bay Creek, which discharges into the bay on the north side of Carss Bush Park. The creek is a constructed open channel downstream of Harold Fraser Reserve and originates at approximately the Bellevue Parade/Blakesley Road roundabout.

Another constructed open channel drains the Beverley Park area and discharges into Kogarah Bay just downstream of Ramsgate Road at the west corner of Claydon Reserve.

Other stormwater runoff discharges into Kogarah Bay are direct from foreshore land including a narrow strip on the Rockdale side.

Scarborough/Sans Souci (Subcatchment J)
There are three major constructed channels which drain the southern portion of this area, Sans Souci Drains No.s 1, 2 and 3. Sans Souci Drain No. 1 discharges into Sandringham Bay while drain 2 discharges to Botany Bay near Stan Moses park and drain 3 passes under Rocky Point Road to discharge in Kogarah Bay near the Kogarah Council Swimming Pool at the south-east most point of the bay. The combined length of these channels is approximately 4.5 kms.

A constructed linear natural wetland area feature located in the middle of Scarborough Park drains the northern portion of this subcatchment. The discharge location for these wetlands, known as Scarborough Ponds, is directly into Botany Bay adjacent Florence Street via three 1350 diameter concrete culverts installed below ground level. The Scarborough Park ponds are prat of the Rockdale wetlands system which run from the Cooks River along Muddy Creek, through Eve Street wetlands, Spring Street wetlands, Bicentennial

Channel ponds, Scarborough Park and through to Sans Souci.

A thin strip of land which runs along the length of Lady Robinsons Beach discharges directly into Botany Bay. This includes Cooks Park between the Cooks River and Bestic Street, east of General Holmes Drive which has three stormwater drains discharging directly into Botany Bay.

2.3 Landuse

The general landuse over the Lower Georges River catchment area as defined by Sydney Water is shown on **Figure 2.2**.

With the exception of the Kurnell Peninsula, the major landuse across the study area is low to medium density residential with substantial sized pockets of open spaces, parks and reserves as well as large industrial areas. The Kurnell Peninsula is predominantly open space and national park reserve areas, however there is a very large industrial (oil refineries) area on the outer zone which accounts for approximately one third of the Kurnell Peninsula. Most of this industrial area is within the Lower Georges River catchment boundary. A small residential area exists north of the industrial area on the foreshore of Botany Bay.

Table 2.2 below summarises the broad scale landuse within the study area according to each subcatchment as defined in **Section 2.1** above.

Table 2.2: Landuse in the Study Area

Subcatchment	**Landuse, ha *(%)***		
	Urban (includes residential & special uses)	Industrial & Commercial	Open Space/ Environmental Protection
A - Kurnell Peninsula	655 *(29)*	502 *(22.2)*	1,100 *(48.7)*
B - Gwawley Bay	766 *(75.9)*	109 *(10.8)*	134 *(13.3)*
C - Oyster Bay	793 *(86.8)*	58.4 *(6.4)*	63 *(6.9)*
D - Lime Kiln Bay	546 *(73.1)*	71.1 *(9.5)*	130 *(17.4)*
E - Gungah Bay	111 *(51.8)*	62.4 *(29.1)*	41 *(19.1)*
F - Oatley Bay	407 *(87)*	7.2 *(1.5)*	59 *(12.6)*
G - Kyle Bay	131 *(68.6)*	0 *(0)*	616 *(32)*
H - Kogarah Bay	604 *(85)*	32.9 *(4.6)*	88 *(12.4)*
J - Scarborough/Sans Souci	594 *(76.9)*	32.7 *(4.2)*	153 *(19.8)*

Total LGR Catchment	3972.6 *(57.1%)*	787.4 *(11.3%)*	2,201.7 (*31.6%*)

Major industrial/commercial areas within the Lower Georges River catchment include:

- Sutherland:-
  - Kurnell Peninsula (Caltex Refinery);
  - Caringbah;
  - Taren Point;
  - Woolooware and Woolooware Bay (Woolooware/Cronulla Golf Courses and shell fish/sea food respectively);
  - Oyster Bay (shell fish/sea food);
  - Kareela (Kareela Golf Course); and
  - Kirrawee;
- Hurstville:-
  - Peakhurst;
- Kogarah:-
  - Mortdale (Hurstville Golf Course)
  - Allawah
  - Beverlly Park (Golf Course)
- Rockdale
  - Kogarah/Ramsgate

Kurnell Peninsula (Subcatchment A)
The major landuse of the outer Kurnell Peninsula is nature reserves (Towra Point Nature Reserve and Botany Bay National Park) and open space, however the landscape is dominated by the Caltex Oil Refinery which is located between the Botany Bay National Park and Quibray Bay. The refinery is the largest industrial area in the Lower Georges River catchment. A small residential area exists just north of the industrial area.

There is a narrow strip of land adjacent Woolooware Bay and within the western edge of the Kurnell Peninsula subcatchment which is mainly occupied by a portion of the large Taren Point and Caringbah industrial zone.

Towards the south of this subcatchment is the Cronulla Railway Line which is surrounded mainly by low-medium residential housing.

Gwawley Bay (Subcatchment B)
The major landuse within the Gwawley Bay subcatchment is low-medium density residential housing. In addition land with Gwawley Bay has been reclaimed and is a residential development known as Sylvania Waters.

The Princes Highway passes through this subcatchment from the Georges River Bridge to Hotham Road adjacent Gymea High School.

A continuous band of open space which runs from the Captain Cook Bride, Taren Point to the Princes Highway south of Sutherland divides the Gwawley Bay subcatchment. This is part of the proposed motorway reserve. On the eastern side of the motorway reserve, the major landuse is industrial at Taren Point.

A large commercial complex (Westfield Shoppingtown) is located on the southern boundary of the subcatchment in Miranda.

Landuse along the Gwawley Bay Creek is mainly residential with some linear open space parks and special uses such as schools. The Georges River foreshore area within the Gwawley Bay subcatchment is predominantly low-medium residential housing.

Oyster Bay (Subcatchment C)
Landuse within the Oyster Bay subcatchment is mainly low-medium residential with significant open space areas throughout the area. There is one large industrial zone within the subcatchment located at Kirrawee on the north side of the Princes Highway.

Oyster Bay Creek begins within Sutherland and continues to Oyster Bay through mostly residential areas separated by interspersed park reserves.

The Kareela Golf Course forms a large portion of the open space zone and is located directly south of Oyster Bay.

The Illawarra Railway Line runs parallel to and is located within the western boundary and at Kirrawee, the Princes Highway cuts through the south east corner of the Oyster Bay subcatchment.

Land directly adjacent the Georges River is mainly low-medium residential housing with regular open space zones/park reserves. Some special use zones also face onto the water, include some schools.

Lime Kiln Bay (Subcatchment D)
Landuse within the Lime Kiln Bay subcatchment is divided approximately equally between residential housing, open space/park reserves and industrial areas.

The open spaces and park reserves line the main drainage tributaries entering Lime Kiln Bay including a linear park along the length of Boggywell Creek. The Hurstville Golf Course is located above the northern tip of Lime Kiln Bay.

North of the Hurstville Golf Course and with approximately twice the area, is a large industrial zone.

The north east corner of the subcatchment, which is bound on the eastern side by the Illawarra Railway Line, contains a Sydney Water stormwater drain which ultimately discharges into Lime Kiln Bay. Small commercial zones exist in the north of this subcatchment but along the Georges River foreshore landuse is approximately evenly divided between residential and open space/park reserve.

Gungah Bay (Subcatchment E)
The landuse surrounding Jew Fish Bay is mostly open space/park reserve, whereas residential properties dominate the landscape fronting onto Gungah Bay.

A minor creek tributary entering Gungah Bay is flanked by park reserve to the Illawarra Railway Line.

Oatley Bay (Subcatchment F)
Oatley Bay subcatchment is bound on the western side by the Illawarra Railway Line. A major rail workshop adjacent the railway line is also located within this subcatchment.

Linear open space/park reserves exist along the major tributaries entering Oatley Bay as well as a strip of land parallel with the Illawarra Railway Line extending south from the workshop.

The remaining landuse within this subcatchment is low-medium residential housing with only small commercial zones nestled amongst the urban landscape.

Land fronting onto the Georges River is predominantly taken up by residential properties with regular open space/park reserves in between.

Kyle Bay (Subcatchment G)
Similarly, landuse within Kyle Bay subcatchment is mostly residential with regular open space/park reserves along the Georges River foreshore.

Kogarah Bay (Subcatchment H)
There are two large open space zones within the Kogarah Bay subcatchment which front onto Kogarah Bay. Beverley Park Golf Course is located within the open space zone to the north of Kogarah Bay.

Both open space zones have major stormwater drains which pass through them and discharge into Kogarah Bay. One of these drains is a Sydney Water asset which commences in the north western corner and drains a large industrial zone in Kogarah.

The Illawarra Railway Line runs along the northern boundary and the Princes Highway passes through the middle of this subcatchment from President Avenue, Kogarah to the Georges River Bridge.

Landuse fronting onto Georges River is mainly residential with the exception of the large park reserves mentioned above.

Scarborough/Sans Souci (Subcatchment J)
The dominant landmark within this subcatchment are the Scarborough Park Ponds which run north south down the middle of the Scarborough/Sans Souci subcatchment.

These ponds form a natural stormwater drainage feature to the area and are surrounded by a large linear open space/park reserve.

Linear parks also front onto the Lady Robinsons Beach and Sandringham Bay as well as a constructed stormwater drain (San Souci Drain No. 2) which discharges east of Rock Point.

There are 6 major sites that were formerly used for landfill in this subcatchment at the following locations:

- Kendall Street Reserve - north of Kendall Street
- Kendall Street Reserve - south of Kendall Street
- West of the Leo Smith Reserve and north of Margate Street - this area was filled with dredged material from swampy land
- The area bound by Bay Street, President Avenue, West Botany Street and the Scarborough Ponds
- Cook Park between President Avenue and Robinson Street
- Cook Park between Bestic Street and the Cooks River

The remaining area is predominantly low-medium residential with a large industrial zone located at approximately the middle of the subcatchment on the western boundary between Production Lane and Rocky Point Road. A large industrial zone is also located at the north of the Scarborough Ponds, north of President Avenue which also crosses into the Cooks River catchment.

Urban Bushland

Urban bushland is covered in **Section 3.8.1** together with a map depicting bushland areas within the study area.

2.4 Topography

To describe the topography of the Lower Georges River catchment it is useful to consider it as three separate zones, as below. Slopes are expressed as a percentage and represent the ratio between the rise (or fall) of the land divided by the distance. For instance, a slope of 10% could refer to land which falls 10m over a distance of 100m.

- *Foreshore Land around Botany Bay and Woolooware Bay* - this is generally low-lying land which is flat to gently undulating and is typified by the Rockdale foreshore and Kurnell areas. Much of Kurnell Peninsula within the Towra Point Nature Reserve is subject to inundation during high tides, however, the tip of Kurnell Peninsula is approximately 50 m above

sea level. There are cliff faces on the ocean side of the peninsula, however the slopes are much more gentle back towards Botany Bay and Quilbray and Woolooware Bays. Slopes are generally not more than 1%;

- *Georges River Frontage Land* - topography in these areas is sharply defined by the historical action of tides and floods on the underlying geology. Steep sloped gullies are common and small cliff faces which drop into the waterway or just back from the river frontage occur regularly. Some of the deeper gullies such as those upstream of Oyster Bay, Oatley Bay and Lime Kiln Bay stretch almost to the Lower Georges River catchment boundary. Slopes are commonly greater than 15% in these areas;
- *Land away from the Georges River* - defined by the ridges of the Lower Georges River catchment. These areas more gently to moderately undulating with slopes in the order of 3% - 5% Areas which typify the topography in these areas include Kogarah, Peakhurst, Caringbah and Sutherland.

Descriptions of the Lower Georges River catchment topography according to each sub-catchment follows.

Kurnell Peninsula (Subcatchment A)
The topography of Kurnell Peninsula subcatchment is generally low-lying land which is flat to gently undulating, rising to a cliff face at the eastern most tip at the Pacific Ocean side which is approximately 50 m above sea level. The slopes are much more gentle back towards Botany Bay and Quilbray and Woolooware Bays. Slopes are generally not more than 1%.

Much of Kurnell Peninsula within the Towra Point Nature Reserve is subject to inundation during high tides.

Gwawley Bay (Subcatchment B)
The western portion of the Gwawley Bay subcatchment has steep sloped sides which drain into Gwawley Creek. Slopes in the western portion, adjacent Taren Point, are more gentle and drain to constructed drains, small creeks and wetlands, eventually into Sylvannia Waters and subsequently into Gwawley Bay. The highest point within the subcatchment is approximately 80m above sea level and is located at the south west corner adjacent the Cronulla railway line.

The Georges River foreshore slopes of the subcatchment are very steep where they are directly adjacent the river with slopes in excess of 60 %. Water frontage land in Gwawley Bay inside of Shag Point, however, have

much more gently slopes to the water, less than 6% in some locations.

Slopes in the Gwawley Bay subcatchment range from 10% either side of Gwawley Creek and along the Georges River foreshore, to less than 4% in the western portion adjacent Taren Point.

Oyster Bay (Subcatchment C)
This subcatchment is basically bisected by Oyster Creek. The topography associated with the Oyster Creek gully is very steep with slopes in excess of 60% in some locations.

The banks directly adjacent the Georges River are generally very steep, including the areas around Scyla and Coronation Bays. Slopes in these areas are similar to Oyster Gully.

The highest point is over 100m above sea level at the south west corner of the subcatchment in Sutherland.

Lime Kiln Bay (Subcatchment D)
The topography of the Lime Kiln Bay subcatchment is modified to what it was prior to urbanisation. The deep gullies of Boggywell Creek and the creeks upstream of Lime Kiln Bay have been filled over the years to form the long, wide, gently sloped park land areas that currenltly exist. In some places, the fill is evidently up to 12 metres deep.

The areas above Lime Kiln Bay, throughout the large industrial area and further on in the residential areas, are gently undulating with slopes becoming steeper as you get closer to the Bay.

Slopes directly adjacent the Bay are steeper, in excess of 20% in most locations, however the Bay itself is actually quite shallow and restrictive to marine navigation in the upper reaches.

Gungah Bay (Subcatchment E)
The topography of the Gungah Bay subcatchment typifies the above description of Georges River Frontage Land. Cliff faces and steep slopes in excess of 60% are common around the water frontage with most slopes dropping directly into the water.

Slopes slightly back from the water front are slightly more gently, however most are greater than 10%.

The highest point in the subcatchment is located inside the Rail Service Yards and is just more than 50m above sea level.

Oatley Bay (Subcatchment F)
The topography of Oatley Bay subcatchment has been modified since urbanisation with the steep gullies of Oately Bay being filled to form the now called Moore and Poulton Parks. Side slopes adjacent the filled areas remain steep at more than 40% in most locations whereas the further north you go from the Bay, the more gentle the slopes become.

Cliff faces and steep slopes in excess of 60% directly into the water are common around the water frontage.

Kyle Bay (Subcatchment G)
The Kyle Bay subcatchment topography also typifies the Georges River Frontage Land topography description above.

Kogarah Bay (Subcatchment H)
The bank slopes surrounding Kogarah Bay are generally comparatively gentle with most slopes less than 10%.

There are numerous areas along the water frontage around Kogarah Bay that have been filled and are now golf courses and leisure park lands which have very little slope. The Beverly Park Golf Course is one of these areas. Also, the Kogarah Bay Creek, which is now a concrete lined channel, has been filled for the purposes of a Recreation Park.

Some locations within the subcatchment, where the land builds up to a small localised peak, are quite steep. Slopes in these areas are generally less than 30% with peaks of up to 50m above sea level.

Scarborough/Sans Souci (Subcatchment J)
This subcatchment typifies the topographical description above relating to land around Botany Bay. Slopes are generally less than 1% towards either the Scarborough park wetlands or Lady Robinsons Beach.

The Scarborough/Sans Souci subcatchment is comparatively low lying with the highest point being less than 20m above sea level at the Sans Souci Public School and most of the remaining area less than 5m above sea level.

2.5 Geology and Soil Landscapes

Geology
The study area lies on three main geological types, Hawkesbury sandstone, Wianamatta shale and Alluvium. A brief description of the geology associated with each subcatchment area is given below.

Kurnell Peninsula (Subcatchment A)
Quarternary Marine sediments underlie the mangrove swamp and sand landscapes. Hawkesbury Sandstone underlies the Kurnell headland and Taren Point/Caringbah areas.

Gwawley Bay (Subcatchment B)
Hawkesbury Sanstone underlies the majority of the Gwawley Bay subcatchment landscape.

Oyster Bay (Subcatchment C)
Hawkesbury Sandstone underlies the majority of the Oyster Bay subcatchment including the steep hills adjacent the Georges River water front. Quaternary Marine sediment underlies the area lining Oyster Bay with soils classified as Mangrove Creek (mc).

Lime Kiln Bay (Subcatchment D)
The Wianamatta Group shales underlay the higher landscapes of the Lime Kiln Bay subcatchment with Hawkesbury Sandstone beneath the areas closer to the water front.

Gungah Bay (Subcatchment E)
The Hawkesbury Sandstone group underlies the majority of the Gungah Bay subcatchment with a small pocket of the Wianamatta Group shales located at the eastern boundary beneath the railway line.

Oatley Bay (Subcatchment F)
Oatley Bay subcatchment is underlain mostly by the Hawkesbury Sandstone group surround the bay itself, and the Wianamatta Group shales in the higher areas above the bay.

Kyle Bay (Subcatchment G)
There is a small pocket of Quarternary Sands located above, and to the west of, Connells Bay, but otherwise the Kyle Bay subcatchment is predominantly underlain by Hawkesbury Sandstone. An isolated pocket of the Mittagong Formation exists beneath the eastern side of the subcatchment just above Shipwrights Bay. The Mittagong Formation consists of alternative bands of shale and fine-grained sandstone.

Kogarah Bay (Subcatchment H)
The main area of the Kogarah Bay subcatchment, which lies to the north west of the bay, is underlain by the Mittagong Formation. At the water front and on the east and west sides of the bay, the Hawkesbury Sandstone group is present.

Scarborough/Sans Souci (Subcatchment J)
The Scarborough/Sans Souci subcatchment is made up of disturbed terrain, swampy and siliceous sandy areas, as well as Holocene sands. Quarternary Sands underlay much of this subcatchment.

Soils
A general description of the soil landscapes in the Lower Georges River catchment is provided below and is divided into north and south of the Georges River. The locations of each of these soils, as obtained from DLWC 1:100 000 Soil Landscape Maps (1989) are shown on **Figure 2.3**.

North of Georges River
The predominant soil groups within the study area north of Georges River are the Blacktown and Lucas Heights Residuals.

The Hawkesbury Colluvials line the upper reaches of the river foreshore whereas the Tuggerah/Newport Aeolian soils dominate the Botany Bay foreshore soils. There is also a large area of Disturbed soil north of Rocky Point in Rockdale.

South of Georges River
South of the river, the predominant inland soil group is the Gymea Residuals.

Similarly to the north, the upper reaches of the Georges River banks are lined with Hawkesbury Colluvial soils. There is a very large area of disturbed soil from Sylvannia Waters through the industrial zone at Shell Point to Cronulla.

Soils on the Kurnell Peninsula are mainly Aeolian or disturbed (approximately the industrial zone) and Mangrove Creek Estuarine soils dominate within the Towra Point Nature Reserve.

The main soil landscapes present in each subcatchment area are listed below in **Table 2.3**.

Table 2.3: Soil Landscapes in Each Subcatchment

	Soil Landscape (ref. Table 2.4 for definition of symbols)											
Sub-catchment	**lh**	**bt**	**gn**	**gy**	**ha**	**tg**	**np**	**kn**	**wa**	**mc**	**wg**	**xx**
A		✓		✓				✓		✓	✓	✓
B		✓		✓								✓
C				✓	✓					✓		✓
D	✓			✓	✓					✓		✓
E	✓			✓	✓							
F	✓	✓	✓	✓	✓							✓
G	✓			✓					✓			
H	✓			✓								✓
J				✓	✓	✓	✓		✓			✓

A list of soil landscape characteristics for the whole study area is provided in **Table 2.4**.

Table 2.4: Major Soil Landscapes & Characteristics in the Lower Georges River Catchment

Soil Landscape	Symbol	Soil Depth	Erosion Hazard		Urban Capability
	(ref. Fig. 2.3)		Concentrated Flows	Non-Concentrated Flows	
Lucas Heights Residual	lu	50 - 150cm	Moderate to High	Low to Very High (generally Moderate)	High with appropriate foundation design
Blacktown Residual	bt	<100cm	Moderated to High	Low to Very High (generally Moderate)	High
Glenorie Erosional	gn	<100cm	High	Moderated to High	Low to Moderate
Gymea Erosional	gy	30 - 100cm	High to Extreme	High to Very High	Low to Moderate
Hawkesbury Colluvial	ha	<50cm	Extreme	Moderate to Extreme	Generally not capable
Tuggerah Aeolian	tg	>200cm	Very High to Extreme	Low to Moderate	Low to Moderate
Newport Aeolian	np	>200cm	High	High to Extreme (generally High)	Low to Moderate
Kurnell Aeolian	kn	>200cm	Extreme	Slight	Generally not capable
Warriewood Swamp	wa	>150cm	Moderate to High	Low	Low to Moderate
Mangrove Creek Estuarine	mc	>200cm	Low	Low	Not capable
Wollongong Marine	wg	>200cm	Extreme	Slight to Moderate	Not capable
Disturbed	xx	40-60cm (nth of G.R.) >100cm (sth of G.R.)	Low to High	Low to Extreme	Capable with restrictive conditions

*Soils information from DLWC 1:100,000 Soil Landscape Maps, 1989

Acid Sulphate Soils

The majority of the Lower Georges River catchment contains no known occurrences of acid sulphate soil materials. **Figure 2.3a** shows the extent and type of acid sulphate soils in the study area.

There is a High Probability of encountering acid sulphate soils down to 3 metres below ground level in the upper regions of the freeway reserve corridor (Scarborough Park) in Rockdale, in low lying areas of Kurnell Peninsula (Woolooware, Weeney and Quibray Bays)

and at the top of bays such as Lime Kiln Bay, Gungah Bay, Oatley Bay and Oyster Bay.

There is a Low Probability of encountering acid sulphate soils down to 3 metres below ground level in the Sandringham/Sans Souci areas, particularly on the Botany Bay side. Also low probability acid sulphate soils exist in the urbanised areas of Kurnell Peninsula and a few of the bays adjoining the Georges River on the northern side.

The entire bottom sediments of the Georges River and adjoining estuaries within the study area contain High Probability acid sulphate soils.

2.8 Climatic Conditions

Rainfall

A number of meteorological stations are located within the study area and immediately outside the study boundary. These rainfall stations are operated by the Bureau of Meteorology and Sydney Water and are shown on **Figure 2.4**.

According to the EPA's Preliminary Regional Environment Improvement Plan for Southern Sydney, the average annual rainfall across the Lower Georges River catchment ranges from approximately 1000 mm at the upper reaches of the to 1100 mm near the mouth of the river (Source: EPA, 1994). The rainfall station at Sydney Airport (station no. 066037) has recorded on average an annual rainfall of 1104.2 mm and the Woronora Parade station in Oatley (station no. 066181) has recorded an average annual rainfall of 1117.5 mm. Long term average monthly rainfall data recorded at the Woronora Parade station is given in **Table 2.3**.

Temperature and Evaporation

Evaporation and temperature data from the Sydney Airport (station no. 66037) was also obtained. Long term average monthly evaporation and temperature data recorded at this station are given in **Table 2.4**.

It can be seen from this data that rainfall is at a minimum during the winter months of July to September and at a maximum during the summer months of January to March. Evaporation is lowest during the winter months of July to September and this corresponds with the lowest temperature.

Wind

Broadly, within the Sydney Basin the regional winds affecting the study area are known as the South-westerly Regional Drainage Flow (SWRDF). This contains air flowing down from an area bounded by the Illawarra Escarpment to the east, Mittagong Ridge to the south and the Lake Burragorang region to the west. The local wind formation which has been characterised as the Local Easterly Drainage Flow (LEDF) which travels almost due easterly along the Georges River valley. (Source: EPA, 1994) It is very important to note that these Sydney Basin airflows are not a daily occurrence and therefore circulation of air is not as simple as that described above.

Table 2.5: Average Monthly Meteorological Data

Month	*Average Rainfall Woronora Parade (mm)	#Average Evaporation Rates Sydney Airport (mm)	#Average Air Temperature Sydney Airport (°C)
January	96.9	217	26.2
February	102.2	176.4	26.2
March	109.2	164.3	25.1
April	128.0	123	22.8
May	92.8	89.9	19.9
June	108.0	75	17.4
July	65.8	83.7	16.9
August	79.4	114.7	18.1
September	68.3	144	20.2
October	62.7	176.7	22.3
November	98.6	195	23.9
December	90.8	229.4	25.6
Annual	1,117.5	1,788.5	22.1

Source: Bureau of Meteorology *Data from station no. 066181. #Data from station no. 066037.

Contents

3. Existing Catchment Conditions

This section discusses the extent and condition of stormwater infrastructure in the existing catchment, hydrology, fluvial geomorphology and the general health of the catchment in terms of water quality, aquatic habitat and riparian waterway flora and fauna, in its current condition.

3.1 Stormwater Infrastructure

The stormwater infrastructure throughout the Lower Georges River catchment is managed by either the Councils or Sydney Water.

The major drainage lines and waterways within the study area are shown on **Figure 2.1** above in **Section 2.1**.

Sydney Water Drains
Sydney Water manage two drainage systems within the study area, known as the Kogarah Bay Creek and Lime Kiln Bay drains as shown in **Figure 2.1**. Sydney Water's Kogarah Bay Creek drain is part of the Kogarah Bay subcatchment (H). The Lime Kiln Bay drain is a small portion of the Lime Kiln Bay subcatchment (D) located in its north east corner adjacent the Illawarra Railway Line.

Sutherland Shire Council Drains
Sutherland Council manages all the stormwater drains within the Shire. This includes a vast number of major and minor drain networks which drain either directly to Georges River/Botany Bay or into natural creek lines upstream.

Gwawley Creek (mainly natural) has a special problem of erosion, weeds are presently controlled by poison. Oyster Creek (mainly natural) has a special problem of sedimentation.

Hurstville Council Drains
Hurstville Council manages the majority of the drains located within its council area. There are number of large drainage mains in the form of buried concrete pipes which drain into Lime Kiln Bay from the north. Most of these pipes are buried under fill material that is continually settling and is likely to be damaging the pipes.

The major drains discharging into Lime Kiln Bay from Hurstville are located beneath Gannons Park (Boggywell Ck), the Hurstville Golf Course and Oatley Heights Park.

Kogarah Municipal Council Drains
Kogarah Council manages the bulk of the drainage infrastructure within Kogarah Municipality. This includes 15 sub-catchments within the Municipality that drain to the Georges River mainly via concrete open channels and pipes. There is only one natural creek in the Municipality, that is Poulton Park creek.

Rockdale Council Drains
There are three main constructed drainage lines within Rockdale known as the Sans Souci Drains No.s 1, 2 and 3. As previously mentioned in **Section 2.1** there is also natural waterway drainage system which runs down the middle of Rockdale known as the Rockdale Wetlands corridor, of which an important wetland feature are the Scarborough Ponds.

The Sans Souci Drains, shown on **Figure 2.1** in **Section 2.1** above, discharge into Sandringham Bay (No. 1), Botany Bay (No. 2) and the south-eastern corner of Kogarah Bay (No. 3).

Scarborough Ponds discharges directly into Botany Bay at the southern end of Lady Robinsons Beach through a large concrete culvert buried beneath Florence Street.

In addition, there are numerous minor street drainage pipes which discharge directly into Botany Bay from The Grand Parade and General Holmes Drive.

Rockdale Council has currently installed and in operation 20 gross pollutant traps in the form of litter traps installed in gully pits on stormwater tributary drains to the Scarborough Ponds.

Some of the drains mentioned above for each of the council areas are not illustrated in **Figure 2.1** as a result of limited GIS drainage records available. As each council defines their major drainage network in GIS format in the future, this information can be fed into **Figure 2.1** of the Lower Georges River Stormwater Management Plan.

3.2 Hydrology

The Lower Georges River is an estuary system and is at the downstream end of the larger Georges River. The subject of hydraulics in the Lower Georges River needs to include not only the hydrology of the Lower Georges River catchment but also the upstream catchment hydrology.

The Georges River Catchment
The total catchment size of the Georges River is some 920 square kilometres, only 7.6% of which is contained in the Lower Georges River catchment (appox. 70 square kilometres). The river is almost 100 km in length and originates near Appin on the Illawarra escarpment. From there it flows generally northwards to Liverpool, before turning south east around Chipping Norton then easterly to Botany Bay. There are a number of tributaries to the Georges River, the largest of which is the Woronora River at the upstream end of the Lower Georges River catchment. Other tributaries include O'Hares, Bunbury Curran, Prospect, Cabramatta and

Salt Pan Creeks, all of which are upstream of the Lower Georges River catchment study area.

The Georges River catchment can be divided into two geographical areas. The Woronora Plateau, which is in the south and east, is an area of rugged sandstone outcrops and steep, incised valleys. The Georges River actually begins and ends in this type of terrain. The middle reaches of the river, to the north and west, comprise gently undulating flood plains and broad valley flats, often subject to flooding.

Hydrological conditions have changed considerably across the Georges River catchment since the advent of white man's settlement in the river basin. The main causes of the changes have been deforestation, agricultural activity, urban development as well as commercial/industrial development such as sand mining.

The hydrodynamics of the Georges River is greatly affected by artificial structures such as the Liverpool weir and Chipping Norton Lakes. The Liverpool weir creates a distinct boundary between the salt water estuary and freshwater sections of the river.

Freshwater Section of the Georges River
The Liverpool weir artificially impounds water and creates a pollution trap, particularly in dry weather when water may not overflow the weir into the estuary section.

The freshwater section of the river has generally good water quality during dry weather, however, during wet weather conditions nitrogen and phosphorus levels in tributaries such as Bunbury Curran Creek can reach three times recommended levels (EPA 1994).

Upper Estuary of the Georges River
Downstream of the Liverpool weir is subject to mixed but mainly diurnal tides. The upper section of the estuary, from the Liverpool weir to Salt Pan Creek has the poorest water quality in the Georges River. Tributaries to this section include the Prospect and Cabramatta Creeks which at certain times of the year can be the worst polluted creeks in the whole Georges River system (GRCMC, 1994).

Part of the upper estuary is the Chipping Norton Lakes system which are the product of over thirty years of sand mining. The river channel at this point has been grossly altered and the volume of water storage greatly increased. River flows and tidal flushing through the lakes are much reduced and under certain weather conditions it can now take up to 50 days for the river to be flushed by tidal flows in this section (GRCMC, 1994).

Lower Estuary of the Georges River
The lower estuary downstream of Salt Pan Creek, which is the subject of this stormwater management plan, is subject to a higher level of tidal flushing given its proximity to Botany Bay and the Pacific Ocean.

During dry weather, this increased tidal action off sets the pollution entering from the up stream river system to the point where it is generally considered suitable for swimming, water sports, wading, boating and fishing (EPA, 1994). Tidal flushing is likely to more effective in the main river channel than in the upper reaches of the bays off of the lower Georges River. This is exemplified by the water quality in these bays following wet weather events when pollution is not only entering the study area from the upstream river system, but also from creeks and drains, as well as sewer overflows, often discharging at the head of the bays, furthest away from the tidal action.

The hydrology of the Lower Georges River catchment according to each subcatchment is discussed in more detail below.

Kurnell Peninsula (Subcatchment A)
The hydrology of Kurnell Peninsula is best described as a “spoon basin”. Stormwater run-off drains from the ridges which run from the head of Kurnell Peninsula to Taren Point towards the low-lying bays and foreshore areas, much of which are tidal and subject to inundation.

There are no major natural or man-made drainage channels into the bays, rather the discharge from the subcatchment is fairly evenly spread around the water front and is possibly evenly distributed between piped and surface run-off flows.

Peak flows during a storm event are likely to have a lower intensity and longer duration due to the flat slopes and significant portion of area which is pervious.

Gwawley Bay (Subcatchment B)
The main course of water run-off through the western side of the Gwawley Bay subcatchment is via the natural Gwawley Creek which is fed by a mainly urbanised catchment. Gwawley Creek discharges into the Sylvania Waters developed area and subsequently into the Georges River.

The eastern side of the subcatchment is drained predominantly by two or three constructed drains which flow into the Sylvania Waters developed area and subsequently into the Lower Georges River system. These drains pass through a short section of wetland areas prior to discharging into Sylvania Waters.

Peak flows discharging from the Gwawley Creek are likely to be relatively high compared to those from the drains into Sylvania Waters from the east.

This depends on the percentage area which is impervious, however the slopes are much steeper on the Gwawley Creek side. Longer peak flow durations could be expected from the eastern portion compared to Gwawley Creek.

A flood study was undertaken in 1977 for Oyster Bay Creek and Gwawley Bay Creek was part of a university study by Sarah Townsend in 1995. The latter was aimed at water quality in runoff in relation to landuse in the Sutherland Shire.

As part of the latter study, a water sampling station was located adjacent Leichhardt Crescent just upstream from the Sylvania High School. Results indicated that flow in Gwawley Creek varied from approximately 50 litres per hour (dry weather flow) to approximately 150 litres per hour (wet weather flow) during the course of the study (15/6/95 - 30/8/95). (Townsend, 1995)

Oyster Bay (Subcatchment C)
Oyster Gully collects much of the surface run-off from the Oyster Bay subcatchment. Numerous constructed drains discharge into the Oyster Creek system which discharges into Oyster Bay and subsequently into the Georges River. Constructed drains also discharge directly into the Lower Georges River system.

Higher peak flow intensities with shorter durations could be expected from the Oyster Creek during a storm event. This is mainly due to the steep slopes involved in the catchment, however, it does depend also on the portion of the catchment which is impervious.

Lime Kiln Bay (Subcatchment D)
Lime Kiln Bay receives most of its water from the upstream catchment from major constructed drains. These drains are buried deep in fill material up Boggywell Creek (beneath Gannons Park) as well as the Hurstville Golf Course and Oatley Heights Park.

Due to significant number of major constructed drains collecting run-off from a large area with reasonably steep slopes, it is expected that the intensity of peak flows during a storm event over the Lime Kiln Bay subcatchment would be relatively high with a short duration.

Gungah Bay (Subcatchment E)
The hydrology of this subcatchment is similar to the Kurnell Peninsula, but on a small scale. Surface run-off, or minor constructed drains, collect rainfall in a “spoon basin” shaped catchment and discharge it into the water front foreshore areas. While the discharge would be fairly evenly spread, the foreshore areas are not subject to inundation in the same way the swamp areas within the Towra Point Nature Reserve are on Kurnell Peninsula.

Kyle Bay (Subcatchment G)
Similarly, Kyle Bay is a foreshore “spoon basin” shaped catchment area. No major constructed or natural drains discharge from the subcatchment, however, surface run-off and constructed drain discharge is evenly dispersed around the river and bay frontages.

There is one major constructed drain where discharge may be more concentrated in the Kyle Bay subcatchment. This is located upstream of the north west corner of Shipwrights Bay and is managed by Kogarah Municipal Council.

Kogarah Bay (Subcatchment H)
All the major natural creeks which discharge into Kogarah Bay have been modified since urbanisation. There are three constructed drainage lines discharging into Kogarah Bay from the west and north. One of these is a Sydney Water drain and would collect stormwater from up to one third of the subcatchment. Kogarah Municipal Council manage the other two. All three drains are open channel concrete construction at the discharges points.

During storm events, stormwater discharge into Kogarah Bay would be significantly concentrated from the west and north sides of the Bay as a result of these constructed drains.

Kogarah Bay subcatchment has gentle slopes, however a high percentage impervious area and therefore the peak flow during a storm event is likely to be fairly high with possibly a long duration.

Scarborough/Sans Souci (Subcatchment J)
Due to the low-lying, flat nature of the Scarborough/Sans Souci subcatchment, there are numerous major constructed drains which discharge into either the Georges River or directly into Botany Bay.

Sans Souci is drained by three constructed concrete open channels which discharge to the south. The northern parts of the subcatchment are drained by the constructed wetlands, Scarborough Ponds, which discharge into Botany Bay. Numerous minor drains discharge to Botany Bay along the length of Lady Robinsons Beach.

Lower intensity, but longer duration, peak flows would generally be experienced from this subcatchment due to the very flat slopes.

3.3 Stream Gauging

In 1991 two stream gauging stations were set up in the Lower Georges River by the then Public Works Department. As can be seen in **Figure 3.1** they were located at the Captain Cooks Bridge and Oatley Point.

Detailed flow data and modelling results are contained in the Sydney Water "Water Quality Modelling in the Sydney and Illawarra Region", 1995 report completed as part of the Clean Waterways Programme.

3.4 Fluvial Geomorphology

In the region of the Liverpool weir, which defines the freshwater and estuarine boundary of the Georges River, there are large amounts of alluvial soil and sand deposits. These sand deposits have been extensively mined creating a significant effect on the quality and configuration of the Lower Georges River section. (GRCCC, pg 2)

From the Liverpool weir, the river meanders in a 9km loop to Milperra where it enters the Hawkesbury sandstone formation which forms a low-lying plateau extending from this area downstream to the Botany Bay entrance. The Lower Georges section of the river takes the shape of a shallow gorge because it is incised in sandstone resulting in steep, rugged slopes. (GRCCC, pg 2)

The Lower Georges River Valley was formed when the sea level was much lower and so now has the characteristics of a drowned valley, having wide channels and extensive bays marking the former tributaries. (GRCCC, pg 3)

3.5 Water Quality

Extensive water quality data is available to describe the receiving water quality in the lower Georges River and Botany Bay. Generally water quality in these areas is acceptable in dry weather conditions however in wet weather both bacteriological and nutrient concentrations increase.

Water quality in the Lower Georges River can be summarised as follows:

- *Dry Weather* - Faecal coliform, phosphorus, nitrogen and dissolved oxygen within acceptable levels.
- *Wet Weather* - Faecal coliform levels exceed recommended levels for primary contact recreation and shellfish cultivation/harvesting but are below the recommended secondary contact recreation guideline. Phosphorus and nitrogen concentrations can increase from 1.5 to 2 times recommended guideline values. (EPA, 1994)

Modelling undertaken by Sydney Water for the Sewer Overflow Licensing Project has estimated stormwater concentrations to be a major contributor

to phosphorous and nitrogen loads whereas sewage overflows are largely the source for high faecal coliform levels. The following sections address in more detail water quality guidelines, the Lower Georges River receiving water quality and water quality of tributaries where data is available.

Sydney Water has also undertaken risk assessments of toxicants at two sites in the Lower Georges River. Twenty three chemicals of potential concern (COPC) to aquatic life were identified at two sites. The majority of these COPCs were sourced to stormwater with chlordanes, chloropyrifos, H_2S, iron and pp-DDT being of most concern.

Figure 3.1 shows the locations of the water quality monitoring sites discussed in the following sections.

Discussion relating to water quality in the following sections is firstly in the context of relevant guidelines. This sets the scene for what levels/concentrations of certain parameters are acceptable in the water for different uses. This is followed by discussion of the known water quality in the mainstream Georges River as well as in the various subcatchments where information is available.

3.5.1 Water Quality Guidelines

ANZECC Water Quality Guidelines
Water quality guidelines have been established by the Australian and New Zealand Environment and Conservation Council (ANZECC) to provide benchmarks for maintaining environmental values within waterways. Environmental values important in the Lower Georges Rivers and which have specific ANZECC water quality guidelines are:

- Primary Contact recreation- water used for activities such as swimming, bathing and direct water-contact sports.
- Secondary Contact recreation - water used for activities such as boating and fishing.
- Visual Use - water used for visual recreation with no-contact activity.
- shellfish cultivation and recreational/commercial fishing; and
- protection of aquatic ecosystems.

ANZECC guideline values for different environmental values and uses are listed in **Table 3.1** and **Table 3.2**.

Recreation
The main risk posed to recreational users is from disease-causing organisms (pathogens) in the waters. In order to assess health risk, recreation has been divided into two categories by ANZECC (1992) and NHRMC (1990). Primary contact recreation includes activities such as swimming, bathing and direct water-contact sports. Secondary contact recreation is defined as activities such as boating and fishing, in which there is a lower chance of swallowing water. These guidelines are based

on two indicator organisms, faecal coliforms and *Enterococci*, which are correlated with the concentration of pathogens.

Table 3.1: Guidelines for the Protection of Human Health

		Primary contact	Secondary contact
Faecal coliforms (cfu/100ml)	ANZECC	150	1000
	NHMRC	200	1000
Enterococci (enterococci orgamisms/100ml)	ANZECC	35	230

The NHMRC (1990) guidelines differ primarily from the ANZECC (1992) guidelines in that geometric means (instead of medians) are used to calculate compliance and that the primary recreation guideline is 200 CFU/100ml rather than 150 CFU/100ml. Reports sourced in this review used NHMRC (1990) guidelines to assess faecal coliform compliance (Van Roo *et al*, 1995) primarily because it allowed an assessment of individual samples rather than a minimum of five samples collected within a month (as ANZECC (1992) stipulates).

Visual Amenity
No measurable indicators of visual amenity have been set by ANZECC. Visual amenity is highly subjective and therefore it is difficult to set measurable indicators.

Harvest of fish, crustaceans and shellfish
The edibility of harvested aquatic life can be directly affected by the concentration of toxicants, bacteria and tainting substances. The ANZECC (1992) guideline for faecal coliforms is that the median concentration should not exceed 14 MPN/100 ml in the surrounding waters, with no more than 10% of samples exceeding 43 MPN/100 ml.

Aquatic Ecosystems
Suspended solids, nutrients, oxygen-demanding materials and toxicants all have the potential to have a deleterious impact on aquatic ecosystems. Investigation of indicators of the health of marine and estuarine ecosystems is in its infancy, whereas for freshwater a number of indicators have been developed (eg. freshwater macroinverebrates). One aspect of ecosystem health that is monitored in many receiving waters is the presence of nuisance algae. In excess concentrations algae can degrade the quality of the environment for other organisms. Limits have been established by ANZECC (1992) for nitrogen and phosphorus, which are indicative with the risk for excessive concentrations of algae. Algal concentrations are measured directly using chlorophyll-a. These guidelines are shown in **Table 3.2.**

Table 3.2: Guidelines for the Minimisation of Nuisance Algae

Pollutant	Fresh water (Rivers & Streams)	Estuaries & Coastal Embayments
Total Phosphorus	10 - 100 μgL^{-1} (50 μgL^{-1} commonly adopted)	No ANZECC guideline
Total Nitrogen	100 - 750 μgL^{-1} (500 μgL^{-1} commonly adopted)	No ANZECC guideline
Phosphate (PO_4)	No ANZECC guideline	5-15 μgL^{-1}
Nitrate (NO_3)	No ANZECC guideline	10-100 μgL^{-1}
Ammonium (NH_4)	No ANZECC guideline	< 5 μgL^{-1}
Chlorophyll-a	1 - 20 μgL^{-1} (20 μgL^{-1} commonly adopted)	1 - 10 μgL^{-1} (10 μgL^{-1} commonly adopted)
Suspended Solids*	10 mgL^{-1} (dry weather) 50-100 mgL^{-1} (wet weather)	No ANZECC guideline

*No ANZECC guideline for this parameter. Values are suggestions only.

Georges River Water Quality Objectives

Water Quality Objectives (WQO's) for the Georges River are in the process of being quantified by the NSW Government. The process of determining WQO's is described in the discussion paper "Proposed Interim Environmental Objectives for NSW Waters" which has been prepared by a government working group including:

- Environment Protection Authority of NSW (EPA);
- Department of Land and Water Conservation (DLWC);
- NSW Agriculture;
- NSW Fisheries; and
- NSW National Parks and Wildlife Service (NPWS).

The discussion paper has identified the following:

- catchment regions, according to the impact each catchment has on the health of the waterway;
- environmental values to be protected for each of the catchment regions which, for the Lower Georges River catchment, includes:
  - Aquatic Ecosystems
  - Primary Contact Recreation
  - Secondary Contact Recreation
  - Visual Amenity
  - Human Consumers of Fish, Crustaceans and Shellfish
- four river health options for WQOs, including:
  - maintain status quo;
  - achieve basic level river health;
  - achieve basic level river health & basic level human uses; and
  - achieve basic level river health & advanced level human uses.

The discussion paper also includes maps showing catchment regions and water quality assessed against potential environmental values. **Figure 4.1**

illustrates these values for the Lower Georges River catchment. No guideline levels are available as a result of this process at this stage.

Mainstream Georges River Water Quality

Extensive water quality monitoring has been undertaken in the Georges River system. The information presented in this report has been taken from a number of Sydney Water (Water Board) reports with the main data sources summarised below.

- *Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme*; Data from this report was collected every 6 days from 1st February 1993 to 31st of March 1994, to characterise bacteriological water quality in Botany Bay, Georges River estuary and Georges River Freshwater.
- *Water Board (1994) Eutrophication Study Georges River (January 1993 - March 1994) Interpretive Report Clean Waterways Programme*; This study examined the variations in nutrient concentrations and algal biomass within the Georges River. Samples were taken at approximately 12 day intervals.
- *Australian Water Technologies (1996) Surveillance Monitoring Georges River, Final Interpretive Report 28/01/93 to 02/01/96;.* This study was to determine the bacteriological, nutrient and algal status of waterways as part of the Clean Waters Programme. The relationship between rainfall and some water quality parameters were also analysed. Samples were taken every 12 days with faecal coliform samples being taken every 6 days between January 1993 and April 1994.
- *Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report.* The Harbourwatch part of this program collects samples every 6 days to assess the suitability of harbour areas for swimming.

These reports not only contain information relating to the Mainstream Georges River, but also in the numerous Bays along its length. For the purposes of this report, water quality information in the Bays from the Sydney Water reports has been separated from the mainstream water quality data and is grouped with other information available from Councils in each of the relevant subcatchment sections.

The mainstream Georges River has two water quality monitoring stations within the Lower Georges River catchment, one located at Lugarno (station number G06/Ge06) at the head of the system, and the other at the Captain Cook Bridge (station number G03/Ge03).

Existing data and discussion with respect to Bacteriological, Chlorophyll-a, Total Phosphorus, Total Nitrogen and Oxidised Nitrogen water quality results at these two locations are provided below. Wet weather pollutant loads and risk assessment are also discussed.

Bacteriological (Faecal Coliforms and Enterococci)

There is extensive Bacteriological water quality data available for the receiving waters of the Lower Georges River catchment. All of this data relates to water quality monitoring sites within bays associated with particular subcatchments rather than mainstream Georges River. Reference needs to be made to each particular subcatchment discussed on the following pages for faecal coliforms and enterococci data.

It is useful, however, to note some general comments at this stage:

- In general, the NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report;
- Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml as discussed above. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml.;
- Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml.

Chlorophyll-a

Sampling undertaken for the Clean Waterways Programme found chlorophyll-a concentrations at sites within the study area was very low and always below the ANZECC (1992) guidelines of 10 µg/L, as shown in **Table 3.3**.

Table 3.3: Chlorophyll-a concentrations in the Georges River

:Location	mean (µg/l)	90th percentile (µg/l)
Taren Point (Ge03)	2.8	4.7
Lugarno (Ge06)	2.7	7.0

Data taken from Water Board (1994) Eutrophication Study Georges River (January 1993 - March 1994) Interpretive Report Clean Waterways Programme

Total Phosphorus

The percentage of sampling days when total phosphorous concentrations complied with the guideline value of < 50 µg/L for wet and dry weather is shown in **Table 3.4**.

At Lugarno 77% and 86% of measured total phosphorus concentrations in wet and dry weather, respectively, were less than 50 µg/L.. However, it must be noted that generally total phosphorus concentrations exceeded the guideline value by less than 10 ug/L. This site is likely to be impacted by dry and wet sewer overflow from Salt Pan Creek and further upstream, discharge from Holsworthy STP and stormwater from surrounding catchments.

At Taren Point, all measured total phosphorus concentrations were less than 50 µg/L.

Generally high concentrations in dry weather are associated with industrial discharges or dry weather sewer overflows such as exfiltration.

Table 3.4: Total Phosphorus concentrations and % compliance in the Georges River

Location	summary statistics		Compliance	
	mean	90th percentile	wet weather % sampling days TP<50µg/l	dry weather % sampling days TP<50µg/l
Taren Point (Ge03)	25	41	100	100
Lugarno (Ge06)	35	57	77	86

Data taken from Water Board (1994) Eutrophication Study Georges River (January 1993 - March 1994) Interpretive Report Clean Waterways Programme
Percentage compliance with ANZECC (1992)

Total Nitrogen
The guideline value of 0.5 mg/L for total nitrogen (TN) was not exceeded at the sites sampled during 1993-1994, in either wet or dry weather sampling as can be seen from **Table 3.5** to **Table 3.8.**

Table 3.5: Total Nitrogen concentrations and % compliance in the Georges River

Location	Summary Statistics		Compliance	
	mean	90th percentile	wet weather % sampling days TN< 0.5 mg/l	dry weather % sampling days TN<0.50 mg/l
Taren Point (Ge03)	0.19	0.29	100	100
Lugarno (Ge06)	0.27	0.35	100	100

Data taken from Water Board (1994) Eutrophication Study Georges River (January 1993 - March 1994) Interpretive Report Clean Waterways Programme
Percentage compliance with ANZECC (1992)

Oxidised Nitrogen
The water quality criterion of 0.10 mgL-1 for Oxidised Nitrogen (NOx) was exceeded on 15% of wet weather sampling days during at the lower estuary site at Lugarno as shown in **Table 3.6**. All oxidised nitrogen concentrations complied with ANZECC (1992) guidelines at Taren Point. Generally NOx in the study area was low with the highest concentrations of NOx recorded in the upper estuary above Salt Pan Creek, which is outside the study area.

Table 3.6: Oxidised Nitrogen concentrations and % compliance in the Georges River

Location	Summary Statistics		Compliance	
	mean	90th percentile	% wet weather sampling days NOx<0.1mg/l	% dry weather sampling days NOx<0.1mg/l
Taren Point (Ge03)	0.01	0.01	100	100
Lugarno (Ge06)	0.02	0.09	85	100

Data taken from Water Board (1994) Eutrophication Study Georges River (January 1993 - March 1994) Interpretive Report Clean Waterways Programme

Other Mainstream Georges River Water Quality Information
An analysis of long term data collected from 1966 to 1990 was the subject of a report by the Water Board (1992). For the purposes of this document data from this report is only of historical interest and has not been summarised. The catchment area has changed greatly in this time including increasing levels of urbanisation and major changes to the treatment of sewage such as the diversion of dry weather sewage effluents from Glenfield STP to the Malabar Ocean Outfall.

An interesting conclusion of the study was that while nutrient levels decreased dramatically with the diversion of effluent from Glenfield STP, bacterial levels have increased with time, particularly following the diversion to the ocean outfall system. Within the Lower Georges River, this resulted in an increase in mean faecal coliform levels between 1970 and 1990 of 10 to 50 CFU/100ml at Taren Point and of 10 to 100 CFU/100ml at Lugarno.

Increases in faecal coliforms levels are likely to be the result of greater urbanisation of catchments which would contribute to both sewer overflow and stormwater pollution of waterways.

Pollutant Loads
Wet weather pollutant loads were modelled as part of the Sydney Water Sewage Overflows Licensing Project (SOLP) for Lower Georges River and Botany Bay, and are presented in **Table 3.7**. While the catchments used in the modelling do not correspond exactly to those within the Lower Georges River SMP, the estimated loads give an indicative of the contribution of stormwater and sewer overflows to pollutant loadings. Sewer overflows can be seen as the major contributor to faecal coliform pollution in system, contributing on average 71% of faecal coliforms. In terms of nutrients, stormwater makes the major contribution to loads with over 90% of nitrogen and phosphorus originating from this source.

Table 3.7: Wet weather pollutant loads for Lower Georges River

Pollutant Contributors	Stormwater	Sewerage Overflows
Annual Load of Total Phosphorus (tonnes/year)	22.6	2.0
Annual load of Total Nitrogen (tonnes/year)	140	15
% contribution to faecal coliforms in average rainfall event	29%	71%
% load contribution to total phosphorus	92%	8%
% load contribution to total nitrogen	91%	9%

Data taken from Sydney Water and Sinclair Knight Merz (1998) Sewerage Overflows Licensing Project Environmental Impacts Statement. Georges River and Southern Beaches Geographic Area (1998).

Risk Assessment
As part of Sydney Water's Ecological and Human Health Risk Assessment (ERA) study for the SOLP project, the risks to human health and ecological systems from chemicals in sewage overflows and stormwater were evaluated (SKM & Sydney Water 1998).

Two sites in the study area, one at Tarens Point downstream of Captain Cook Bridge (site 30) and the other at Brighton Le Sands in Botany Bay (site 31), were assessed in this study. At these sites 23 chemical of potential concern (COPCs) in terms of ecological risk were identified for chronic exposures and 5 COPCs were identified for acute exposures.

Exposure concentrations of the receiving water were calculated over a 10 year time period using computer models to predict stormwater and sewerage overflow discharge. **Table 3.8** shows how many days over the 10 year modelled that chronic exposures were estimated. The majority of exceedances modelled were attributed to stormwater. Chronic exposure concentrations of the chemicals, chlordanes, chloropyrifos, H2S, iron and pp-DDT were modelled to occur on greater than 10% of days.

Table 3.8: Days chronic exposure over 10 years at Taren Point and Brighton Le Sands

Chemical	Total Days Exceedence in '10' Years During Wet Weather Events			
	Taren Point (site 30)		Brighton Le Sands (site 31)	
	stormwater & sewer overflows	stormwater	stormwater & sewer overflows	Stormwater
aldrin	39	35	38	34
alpha-BHC	7	5	9	6
aluminium	*	*	*	*
arsenic	2	2	3	2
barium	116	115	115	114
chlordanes	423	422	461	457
chlorpyrifos	712	697	*	991
copper	158	149	155	146
diazinon	280	270	283	265
dieldrin	302	293	308	294
endrin	195	190	202	197
guthion	103	100	104	101
heptachlor	70	67	76	74
heptachlor-epoxide	18	15	20	16
hydrogen sulfide	445	440	518	492
iron	483	483	631	629
lead	308	307	310	307
pp-DDD	121	118	120	117
pp-DDT	432	428	476	464
tin	114	111	114	110
TSS	36	30	35	27
vanadium	131	130	133	132
zinc	110	108	112	110

The risk evaluation for Brighton Le Sands also indicated a potential risk to aquatic life from exposure to chemicals in sewerage overflows and stormwater reaching the Bay. Again, the potential risk to aquatic life at this site was found to be dominated by stormwater. No human health risks were found from the incidental ingestion of water while swimming or wading during or soon after a storm event at either of these sites

A description of existing water quality data within each subcatchment is provided below.

Kurnell Peninsula (Subcatchment A)

There are two monitoring sites located in the receiving waters associated with this subcatchment and six monitoring sites located in catchment waterways. The locations of these sites can be seen in **Figure 3.1** and are briefly as follows:

- GR09 - Woolooware Bay (receiving water site)
- GR07 - Silver Beach (receiving water site)
- SSC01 - Production Road
- SSC02 - Endeavour Road
- SSC03 - Resolution Drive
- SSC04 - Leagues Club Channel
- SSC05 - Elouera Road Channel
- SSC06 - Sir Joseph Banks Drive

Data for the receiving water monitoring sites is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme, AWT (1996) Surveillance Monitoring, NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report, and also Sydney Water Corporation (1997) Environmental Indicators Monitoring Report.

Data for the catchment waterways monitoring sites is sourced from the Sutherland Shire Council who have been monitoring since 1994 as part of their "Strategic Water Monitoring Programme". Sites are monitored for 10 weeks at a time, generally overt he summer and winter periods.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.9**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.9: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Silver Beach (GR07)	100	100	100
Woolooware Bay (GR09)	97	100	94

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.9,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was greater than 90%, indicating only sporadic faecal contamination in dry and moderate conditions.

Monitoring data for faecal coliforms at Woolooware Bay is also available for 1994 - 1996 as shown in **Table 3.10** below.

Table 3.10: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Jan 1994 - Jan 1996)

	Dry (< 5mm in previous 2hrs)	Moderate (5mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Woolooware Bay (GR09)	100	100	91

Data taken from Australian Water Technologies (1996) Surveillance Monitoring Georges River, Final Interpretive Report 28/01/93 to 02/01/96.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.11.**

Table 3.11: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Silver Beach (GR07)	5	5	8
Woolooware Bay (GR09)	12	11	39

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data for Silver Beach is presented in **Table 3.12** below.

Table 3.12: Receiving Waters - Percentage compliance for faecal coliforms in the Lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Silver Beach (GR07)	100	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is

often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data for Silver Beach is presented in **Table 3.13** below.

Table 3.13: Percentage Compliance for enterococci in the Lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Silver Beach (GR07)	75	100	100	95	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From comparing the information presented in **Table 3.12** and **Table 3.13** above, non-compliance of enterococci levels is generally greater than non-compliance of faecal coliforms.

Median faecal coliform density in the Lower Georges River has also been measured over different rainfall events, as shown in **Table 3.14** below.

Table 3.14: Receiving Waters - Median faecal coliform density in the Lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Silver Beach	0	0	2	40

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

The most recent water quality data available from Sydney Water is summarised in the Environmental Indicators Report (1997). Estuarine receiving waters were sampled once a month with wet weather samples (>25mm) collected three times a year. Data collected for Woolooware Bay (GR09) is summarised below in **Table 3.15**.

Table 3.15: Woolooware Bay water quality data July 1996 to June 1997

	Faecal Coliforms (CFU/100ml)	**Total Phosphorus** (µg/l)	**Cholorophyll -a** (µg/l)	**Total Uncombined Ammonia** (mg/l)	**Oxidised Nitrogen** (mg/l)	**Total Nitrogen** (mg/l)
Wet	1200	40	2	0.05	0.09	0.40
Dry	4	22	not sampled	0.01	0.01	0.17

Data taken from Sydney Water Corporation (1997) Environmental Indicators Monitoring Report

As can be seen from **Table 3.15** above, all parameters are present in higher concentrations during wet weather conditions.

Catchment Water Monitoring Sites for Kurnell Peninsula
Summary information on water quality monitoring results from the catchment waterways of Subcatchment A is provided in **Table 3.16**.

Table 3.16: Kurnell Peninsula Catchment Waterway Monitoring Sites - Summary Information

Site (SSC Reference No. - refer Figure 3.1)	**Subcatchment**	**Major Characteristics**	Parameters of Most Concern *
SSC01. Production Road	Kurnell Peninsula	Industrial	Ammonia, Lead, Zinc
SSC02. Endeavour Road	Kurnell Peninsula	Industrial	-
SSC03. Resolution Drive	Kurnell Peninsula	Industrial	-
SSC04. Leagues Club Channel	Kurnell Peninsula	Golf Course - Landfill	-
SSC05. Elouera Road Channel	Kurnell Peninsula	Residential/Commercial	Dissolved Oxygen, Lead, Total Suspended Solids
SSC06. Sir Joseph Banks Drive	Kurnell Peninsula	Oil Refinery/Industrial	Oil & Grease

* based on information supplied by Sutherland Shire Council, 1998 (parameters quoted are those for which this site was amongst the five highest of all 45 sites examined across the whole of SSC)
(Source: Sutherland Shire Council, 1996)

Gwawley Bay (Subcachment B)
There is one monitoring site located in the receiving waters associated with this subcatchment and three monitoring sites located in catchment waterways. The locations of these sites can be seen in **Figure 3.1** and are briefly as follows:

- GR10 - Sylvania Waters (receiving water site)
- SSC34 - Sylvania Waters 1 - Gwawley Creek
- SSC35 - Sylvania Waters 2 - Silverwater Road
- SSC36 - Sylvania Waters 3 - Parraweena Road

Data for the receiving water monitoring sites is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme.

Data for the catchment waterways monitoring sites is sourced from the Sutherland Shire Council who have been monitoring since 1994 as part of their "Strategic Water Monitoring Programme". Sites are monitored for 10 weeks at a time, generally overt he summer and winter periods.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.17**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.17: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Sylvania Waters (GR10)	100	100	78

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.17,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was 100%. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a significant decrease in compliance, with a 22% drop in compliance evident at GR10.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.18.**

Table 3.18: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Sylvania Waters	7	17	49

(GR10)			

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Catchment Water Monitoring Sites for Gwawley Bay
Summary information on water quality monitoring results from the catchment waterways of Subcatchment B is provided in **Table 3.19**.

Table 3.19: Gwawley Bay Catchment Waterway Monitoring Sites - Summary Information

Site (SSC Reference No. - refer Figure 3.1)	Subcatchment	Major Characteristics	Parameters of Most Concern *
SSC34. Sylvania Waters 1 - Gwawley Creek	Gwawley Bay	Residential - sedimentation concern	Total Suspended Solids
SSC35. Sylvania Waters 2 - Silverwater Road	Gwawley Bay	Residential - sedimentation concern	Ammonia, Copper, Total Nitrogen, Total Phosphorus, Zinc
SSC36. Sylvania Waters 3 - Parraweena Road	Gwawley Bay	Commercial/Industrial - sedimentation concern	-

* based on information supplied by Sutherland Shire Council, 1998 (parameters quoted are those for which this site was amongst the five highest of all 45 sites examined across the whole of SSC) (Source: Sutherland Shire Council, 1996)

Catchment waterway monitoring site number SSC35 has previously been identified by the Sutherland Shire Council as a hot-spot with recorded levels of Total Phosphorus, Total Nitrogen and Ammonia well in excess of guidelines throughou the sampling period.

Oyster Bay (Subcatchment C)
There are two monitoring sites located in the receiving waters associated with this subcatchment and five monitoring sites located in catchment waterways. The locations of these sites can be seen in **Figure 3.1** and are briefly as follows:

- GR12 - Oyster Bay (receiving water site)
- HW06 - Como Baths (receiving water site)
- SSC29 - Oyster Bay West
- SSC30 - Carina Bay (Tivoli Esplanade)
- SSC31 - Carina Bay Reserve
- SSC32 - Scylla Bay
- SSC33 - Kareela Golf Course

Data for the receiving water monitoring sites is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme, AWT (1996) Surveillance Monitoring, NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report, Water Board (1994) Eutrophication Study Georges River Interpretive Report Clean Waterways

Programme and also Sydney Water Corporation (1997) Environmental Indicators Monitoring Report.

Data for the catchment waterways monitoring sites is sourced from the Sutherland Shire Council who have been monitoring since 1994 as part of their "Strategic Water Monitoring Programme". Sites are monitored for 10 weeks at a time, generally overt he summer and winter periods.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.20**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.20: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Oyster Bay (GR12)	100	92	75

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.20,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was 100% or greater than 90%, indicating only sporadic faecal contamination in dry and moderate conditions. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a significant decrease in compliance, to less than 80% compliance at GR12.

Additional sampling of the Oyster Bay site until 1996 (See **Table 3.21**) showed very similar results as those obtained above. With the Lower Georges River, major wet weather sources of contamination include stormwater discharge from urban and industrial areas and sewage overflows.

Table 3.21: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Jan 1994 - Jan 1996)

	Dry (< 5mm in previous 2hrs)	Moderate (5mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)

Oyster Bay (GR12)	98	100	75

Data taken from Australian Water Technologies (1996) Surveillance Monitoring Georges River, Final Interpretive Report 28/01/93 to 02/01/96.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.22.**

Table 3.22: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Oyster Bay (GR12)	12	31	71

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beachwatch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.23** below.

Table 3.23: Receiving Waters - Percentage Compliance for faecal coliforms in the Lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Como Baths (HW06)	100	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.24** below.

Table 3.24: Receiving Waters - Percentage Compliance for enterococci in the lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Como Baths (HW06)	59	76	72	86	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From comparing the information presented in **Table 3.23** and **Table 3.24** above, non-compliance of enterococci levels is generally greater than non-compliance of faecal coliforms.

Enterococci levels have also been monitored in the catchment waterways and are discussed further on in this section.

Median faecal coliform density in the Lower Georges River has also been measured over different rainfall events, as shown in **Table 3.25** below.

Table 3.25: Receiving Waters - Median faecal coliform density in the Lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Como Baths	7	25	100	150

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Chlorophyll-a in Receiving Waters of Oyster Bay subcatchment
Sampling undertaken for the Clean Waterways Programme found chlorophyll-a concentrations at sites within the study area was generally very low. The site monitored at Oyster Bay (GR12) between January 1993 to January 1996 never exceeded 20µg/L of chlorophyll-a.

Total Phosphorus in Receiving Waters of Oyster Bay subcatchment
Total phosphorus results at Oyster Bay (GR12) between 1994 and 1996 are presented below in **Table 3.26**. While the site at Oyster Bay did not exceed the guidelines for total phosphorus (<50µg/l), when these results were compared to sites in the upper catchment sampled during the same period, concentrations of TP in the lower estuary around Oyster bay were higher than those in the upper estuary during dry weather.

Generally high concentrations in dry weather are associated with industrial discharges or dry weather sewer overflows such as exfiltration.

Table 3.26: Receiving Waters - Geometric mean total phosphorus concentrations (µg/l) over different weather conditions (January 1994 to January 1996)

Location	dry <10mm	moderate 10-20mm	wet>20mm
Oyster Bay (GR12)	29	36	30

Data taken from Australian Water Technologies (1996) Surveillance Monitoring Georges River, Final Interpretive Report 28/01/93 to 02/01/96. See append

Total Nitrogen in Receiving Waters of Oyster Bay subcatchment
Table 3.27 below presents the estimated geometric mean for total nitrogen concentrations for different weather conditions at the Oyster Bay monitoring site (GR12). This data shows that there is a minor increase in concentration occurring with increased rainfall.

Catchment Waterway Monitoring Sites for Oyster Bay
Summary information on water quality monitoring results from the catchment waterways of Subcatchment C is provided in **Table 3.27**.

Table 3.27: Oyster Bay Catchment Monitoring Sites - Summary Information

Site (SSC Reference No. - refer Figure 3.1)	Subcatchment	Major Characteristics	Parameters of Most Concern *
SSC29. Oyster Bay West	Oyster Bay	Residential/Industrial	Oil & Grease
SSC30. Carina Bay (Tivoli Esplanade)	Oyster Bay	Residential	-
SSC31. Carina Bay Reserve	Oyster Bay	Residential - landfill	Enterococci
SSC32. Scylla Bay	Oyster Bay	Residential - landfill	-
SSC33. Kareela Golf Course	Oyster Bay	Residential	BOD, Enterococci

* based on information supplied by Sutherland Shire Council, 1998 (parameters quoted are those for which this site was amongst the five highest of all 45 sites examined across the whole of SSC) (Source: Sutherland Shire Council, 1996)

Lime Kiln Bay (Subcatchment D)
There is only one water quality monitoring site located in this subcatchment and it is located in the receiving waters at the mouth of Lime Kiln Bay. The location of this site is illustrated in **Figure 3.1** and is briefly as follows:

- GR17 - Lime Kiln Bay (receiving water site)

Data for this site is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme.

There was no water quality data available from Hurstville Council for either the receiving waters or catchment waterways at the time of writing this report.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.28**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.28: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Lime Kiln Bay (GR17)	100	100	75

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.28,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was 100%. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a significant decrease in compliance, to less than 80% at GR17.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.29.** As per the previous compliance information, **Table 3.29** shows that the faecal coliform density increases significantly when there is greater than 10mm of rainfall in 72 hrs (ie. wet weather event).

Table 3.29: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Lime Kiln Bay (GR17)	8	19	73

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Gungah Bay (Subcatchment E)

There are two water quality monitoring sites located in this subcatchment and both are receiving water sites. The location of these sites is illustrated in **Figure 3.1** and briefly are as follows:

- GR14 - Neverfail Bay (receiving water site)
- GR16/HW5 - Jewfish Bay (receiving water site)

Data for these sites is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme as well as the NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report.

There was no water quality data available from Hurstville Council for either the receiving waters or catchment waterways at the time of writing this report.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.30**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.30: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Neverfail Bay(GR14)	100	100	88
Jewfish Bay (GR16/HW5)	100	100	75

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.30,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was 100% at both sites. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a decrease in compliance at both sites, with GR16 below 80% compliance.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.31.**

Table 3.31: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Neverfail Bay(GR14)	10	24	50
Jewfish Bay (GR16/HW5)	6	15	58

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.32** below for the Jew Fish Bay Baths monitoring site only.

Table 3.32: Receiving Waters - Percentage Compliance for faecal coliforms in the lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Jew Fish Bay Baths (GR16/HW5)	88	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.33** below for the Jew Fish Bay Baths monitoring site only.

Table 3.33: Percentage Compliance for enterococci in the lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Jew Fish Bay Baths (GR16/HW5)	69	52	81	95	81

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From the information presented in **Table 3.32** and **Table 3.33** above, non-compliance of enterococci levels is much greater than non-compliance of faecal coliforms.

Median faecal coliform density in the Jew Fish Bay Baths site has also been measured over different rainfall events, as shown in **Table 3.34** below.

Table 3.34: Receiving Waters - Median faecal coliform density in the Lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Jew Fish Bay Baths	4	19	100	100

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Oatley Bay (Subcatchment F)
There is one water quality monitoring site located in the receiving waters and five sites in the catchment waterways of this subcatchment. The location of these sites is illustrated in **Figure 3.1** and, briefly are as follows:

- GR13/HW7 - Oatley Bay Baths (receiving water site)
- KMC01 - East Pipe, Moore Reserve
- KMC02 - West Pipe, Moore Reserve
- KMC03 - Centre of Moore Reserve
- KMC04 - Wetland end of Moore Reserve
- KMC05 - North end of Moore Reserve

Data for the receiving water site is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme, as well as the NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report.

Data for the catchment waterway sites is sourced from the Kogarah Municipal Council.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.35**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.35: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Oatley Bay (GR13/HW7)	98	92	69

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.35,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was less than 100% but still greater than 90%, indicating only sporadic faecal contamination in dry and moderate conditions. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a significant decrease in compliance, with GR13/HW7 dropping to below 70%.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.36.**

Table 3.36: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Oatley Bay (GR13/HW7)	7	19	75

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th

April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.37** below.

Table 3.37: Receiving Waters - Percentage Compliance for faecal coliforms in the Lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Oatley Bay Baths (GR13/HW7)	84	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.38** below.

Table 3.38: Receiving Waters - Percentage Compliance for enterococci in the Lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Oatley Bay Baths (GR13/HW7)	53	43	81	95	90

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From the information presented in **Table 3.37** and **Table 3.38** above, non-compliance of enterococci levels is much greater than non-compliance of faecal coliforms. On two occasions in 1995/1996, compliance with primary contact recreation guidelines for enterococci was at approximately 50% of the time, or less.

Median faecal coliform density in the Oatley Bay Baths site has also been measured over different rainfall events, as shown in **Table 3.39** below.

Table 3.39: Receiving Waters - Median faecal coliform density in the lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Oatley Bay Baths	2	15	90	250

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Catchment Water Monitoring Sites for Oatley Bay
Some water quality monitoring has been done in the Moore Reserve area of the Oatley Bay subcatchment. Water quality monitoring sites for the Kogarah Council are shown on **Figure 3.1**.

Data for the two major stormwater pipes in Moore Reserve reveal that Total-N was up to 70-times and Total-P was up to 20-times above the guideline levels (Groundwater Technology, 1995). BOD values ranged between 2 and 820 ppm. A summary of these results suggests excessive contents of zinc, copper and lead in the stormwater.

Sampling was also performed in 1998 in Moore Reserve. The sampling site was the northern end of the eastern major pipe. Results show excessive levels of Total-N, Total-P, faecal coliforms, Chl-a, Amm-N and Lead.

Table 3.40 below summarises water quality information available from sites within the Kogarah LGA in this subcatchment.

Table 3.40: Oatley Bay Catchment Waterway Monitoring Sites - Summary Information

Site (refer Figure 3.1)	Location & *Subcatchment*	Monitoring Period	Parameters of Most Concern*
KMC01	East Pipe, Moore Reserve *Oatley Bay*	29/3/95 - 9/9/96	Lead, Zinc, Total-N, Total-P
KMC02	West Pipe, Moore Reserve *Oatley Bay*	29/3/95 - 9/9/96	Lead, Zinc, Total-N, Total-P
KMC03	Centre of Moore Reserve *Oatley Bay*	24/4/96 - 7/5/96	Zinc, Total-N
KMC04	Wetland end of Moore Reserve *Oatley Bay*	24/5/96 - 7/5/96	Copper, Zinc, Total-N, Total-P
KMC05	North end of Moore Reserve *Oatley Bay*	30/4/98 - 21/7/98	Lead, Total-N, Total-P, Faecal Coliforms, Chlorophyl-a

* based on information supplied by Kogarah Municipal Council, 1998 (parameters quoted are those for which the mean level was higher than ANZECC criteria this site over the monitoring period)

(Source: Kogarah Municipal Council, 1998)

Kyle Bay (Subcatchment G)
There are two water quality monitoring sites located in this subcatchment and both are receiving waters sites. The location of these sites is illustrated in **Figure 3.1** and, briefly are as follows:

- HW08 - Kyle Baths (receiving water site)
- HW09 - Shipwrights Bay (receiving water site)

Data for these sites is derived from the NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report.

There was no water quality data available from Kogarah Municipal Council for either the receiving waters or catchment waterways of this subcatchment at the time of writing this report.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.41** below.

Table 3.41: Receiving Waters - Percentage Compliance for faecal coliforms in the lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Kyle Baths (HW08)	91	100	100	NR	NR
Shipwrights Bay (HW09)	100	100	100	NR	NR

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the

water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.42** below.

Table 3.42: Receiving Waters - Percentage Compliance for enterococci in the lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Kyle Baths (HW08)	75	81	78	NR	NR
Shipwrights Bay (HW09)	72	91	97	NR	NR

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From the information presented in **Table 3.41** and **Table 3.42** above, non-compliance of enterococci levels is much greater than non-compliance of faecal coliforms.

Median faecal coliform density at the two receiving waters monitoring sites have also been recorded over different rainfall events as presented in **Table 3.43** below.

Table 3.43: Receiving Waters - Median faecal coliform density in the lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Kyle Baths	2	4	100	100
Shipwrights Bay	2	12	25	35

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Kogarah Bay (Subcatchment H)
There is one water quality monitoring site in the receiving waters and one site located in the catchment waterways of this subcatchment. The location of these sites is illustrated in **Figure 3.1** and, briefly are as follows:

- GR11/HW10 - Carss Park Baths/Kogarah Bay (receiving water site)
- KMC06 - Kogarah Bay Creek

Data for the receiving water site is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme, as well as the NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report.

Data for the catchment waterway monitoring site was sourced from Kogarah Municipal Council.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.44**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.44: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Kogarah Bay (GR11/HW10)	98	92	75

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.44,** when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was less than 100% but still greater than 90%, indicating only sporadic faecal contamination in dry and moderate conditions. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a significant decrease in compliance, to less than 80% compliance GR11/HW10.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.45.**

Table 3.45: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Kogarah Bay (GR11/HW10)	6	14	30

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.46** below.

Table 3.46: Receiving Waters - Percentage Compliance for faecal coliforms in the lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Carss Point Baths (GR11/HW10)	100	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.47** below.

Table 3.47: Receiving Waters - Percentage Compliance for enterococci in the lower Georges River

Site	Enterococci				
	Summer 1995-96 %	Winter 1996 %	Summer 1996-97 %	Winter 1997 %	Summer 1997-98 %
Carss Point Baths (GR11/HW10)	91	100	97	95	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From the information presented in **Table 3.46** and **Table 3.47** above, non-compliance of enterococci levels is much greater than non-compliance of faecal coliforms.

Median faecal coliform density at the Carss Point Baths monitoring site has also been recorded over different rainfall events, as presented in **Table 3.48** below.

Table 3.48:Median faecal coliform density in the lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	0-5mm	5-10mm	>10mm
Carss Point Baths	2	3	30	110

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Catchment Waterway Monitoring Sites in Kogarah Bay subcatchment
Some water quality monitoring has been done in the Kogarah Bay subcatchment. Water quality monitoring sites for the Kogarah Council are shown on **Figure 3.1**.

Two sets of data from Kogarah Bay Creek subcatchment during dry weather reveal Total-P up to 100 times and Total-N up to 10 times over guideline levels (Naji, 1996). No data is available on BOD, turbidity, lead and other heavy metals, hydrocarbons, litter types, litter volume and sediment loads in this catchment. There is no data on bacterial load in stormwater for the waterway site.

Table 3.49 below summarises water quality information available from sites within the Kogarah LGA in the study area.

Table 3.49: Kogarah Bay Water Quality Monitoring Sites - Kogarah Council Tributaries

Site (refer Figure 3.1)	Location & *Subcatchment*	Monitoring Period	Parameters of Most Concern*
KMC06	Kogarah Bay Creek *Kogarah Bay*	Not Available	Total-P, Total-N

* based on information supplied by Kogarah Municipal Council, 1998 (parameters quoted are those for which the mean level was higher than ANZECC criteria this site over the monitoring period)
(Source: Kogarah Municipal Council, 1998)

Scarborough/Sans Souci (Subcatchment J)
There are numerous water quality monitoring sites for this subcatchment. Nine sites are receiving water monitoring sites, predominantly in Botany Bay and four sites are catchment waterway monitoring sites. The location of these sites is illustrated in **Figure 3.1** and, briefly are as follows:

- GR02/HW1 - Kyeemagh Baths (receiving water site)
- GR03/31 - Brighton Baths (receiving water site/ERA site)
- GR04 - Monterey Baths (receiving water site)
- GR05 - Ramsgate Baths (receiving water site)

- GR06/HW12 - Dolls Point Baths (receiving water site)
- HW11 - Sandringham Baths (receiving water site)
- HW04 - South Ramsgate (receiving water site)
- HW05 - North Ramsgate (receiving water site)
- HW02 - Brighton Le Sands (receiving water site)
- RCC01 - Culver Street
- RCC02 - Marshall Street
- RCC03 - President Avenue
- RCC04 - Bicentennial Park

Data for the receiving water monitoring sites is derived from the Water Board (1995) Interpretive Report as part of the Clean Waterways Programme, as well as the NSW EPA (1997) Beachwatch and Harbourwatch 1997 Season Report. Receiving water monitoring site number GR03/31 doubles up as and ERA site (Environmental Risk Assessment).

Rockdale City Council provided the data for the catchment waterway data which was originally sourced from a southern Cross University (1997) research project.

Bacteriological (Faecal Coliforms and Enterococci)
The NHMRC (1990) guideline of 200 CFU/100ml has been chosen as the criteria to compare faecal coliform results for the purpose of this report.

The following tables present the data available for faecal coliforms and enterococci for the years 1993 to 1997.

The percentage of days on which the geometric mean of faecal coliforms was less than 200 CFU/100ml for dry , moderate and wet sampling days is presented in **Table 3.50**. This has been expressed as the percentage compliance of each site with the NHMRC guideline.

Table 3.50: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Feb 1993 - March 1994)

Location	Dry (< 2mm in previous 72hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Kyeemagh Baths (GR02/HW1)	100	100	78
Brighton Baths (GR03/31)	100	100	78
Monterey Baths (GR04)	100	100	89
Ramsgate Baths (GR05)	100	100	89
Dolls Pt. Baths (GR06)	100	100	94

*Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994) Clean Waterways Programme.

As can be seen in **Table 3.50**, when less than 10mm of rain fell in the previous 72 hrs (ie. dry or moderate conditions) the percentage of days which complied with primary recreation guidelines was 100% at all sites. When greater than 10 mm of rain fell in 72 hrs (ie. wet weather conditions), there was a decrease in compliance at most sites, with the sites showing the largest decrease (to less than 80% compliance) being GR02/HW1 and GR03/31.

Additional sampling of the Kyeemagh site until 1996 (See **Table 3.51**) showed very similar results as those obtained above except during wet weather. At Kyeemagh Baths the percentage of wet weather sampling days which complied between 1994 and 1996 were lower than those measured between 1993 and 1994, due to larger rainfall events and the operation of the major sewer overflow at the SWSOOS Muddy Creek crossing.

With the Lower Georges River, major wet weather sources of contamination include stormwater discharge from urban and industrial areas and sewage overflows. The contribution of each source is further reviewed in **Table 3.51**.

Table 3.51: Receiving Waters - Percentage of days when faecal coliforms less than 200 CFU/100ml (Jan 1994 - Jan 1996)

	Dry (< 5mm in previous 2hrs)	Moderate (5mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
Kyeemagh Baths (GR02)	100	100	59

Data taken from Australian Water Technologies (1996) Surveillance Monitoring Georges River, Final Interpretive Report 28/01/93 to 02/01/96.

An estimate of the geometric mean faecal coliform density for dry, moderate and wet weather at each site is shown in **Table 3.52.**

Table 3.52: Receiving Waters - Geometric mean faecal coliforms in CFU/100ml (Feb 1993 - March 1994)

Location	Dry (<2mm in previous 2hrs)	Moderate (2mm - 10mm in 72 hrs)	Wet (> 10mm in 72 hrs)
	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)	Geometric Mean (in CFU/100ml)
Kyeemagh Baths (GR02/HW1)	5	6	42
Brighton Baths (GR03/31)	5	6	22
Monterey Baths (GR04)	5	6	13
Ramsgate Baths (GR05)	5	5	15
Dolls Pt. Baths (GR06)	5	7	15

Data taken from Water Board (1995) Interpretive Report Faecal Coliform Monitoring Program Georges River and Botany Bay (January 1993 - March 1994). Clean Waterways Programme

Data from the Beach watch and Harbourwatch Report (EPA 1997) describes the monitoring carried out between 1st October 1996 to the 30th April 1997. This program covered both the Lower Georges River and Botany Bay. It should be noted that the compliance criteria used for this report differs from the 200 CFU/100ml used for the previous data presented. Beachwatch considers that waters are unsuitable for swimming if the rolling mean faecal coliform density exceeds 150CFU/100ml or if 1 out of the 5 samples equals or exceeds 600 CFU/100ml. This data is presented in **Table 3.53** below.

Table 3.53: Percentage Compliance for faecal coliforms in the lower Georges River

Site	Faecal coliforms				
	Summer 1995-96 %	**Winter 1996 %**	**Summer 1996-97 %**	**Winter 1997 %**	**Summer 1997-98 %**
Sandringham Baths (HW11)	100	100	100	100	100
Dolls Point Baths (HW12)	100	100	100	100	100
South Ramsgate (HW04)	100	100	100	NR	NR
North Ramsgate (HW03)	100	100	100	100	100
Brighton Le Sands (HW02)	100	100	100	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

Enterococci data has been reported as studies on the relationship of faecal coliforms levels with pathogen concentrations have shown that there is often a poor correlation especially if the source of faecal contamination is old or in marine or saline environments. Enterococci is regarded as a more accurate indicator of faecal contamination due to its persistence in the water environment. For enterococci, waters may be unsuitable for swimming if the rolling mean enterococci density exceeds 35 CFU/100ml or if 1 out of 5 samples equals or exceeds 100CFU/100ml. This data is presented in **Table 3.54** below.

Table 3.54: Receiving Waters - Percentage Compliance for enterococci in the lower Georges River

Site	Enterococci				
	Summer 1995-96 %	**Winter 1996 %**	**Summer 1996-97 %**	**Winter 1997 %**	**Summer 1997-98 %**
Sandringham Baths (HW11)	100	100	97	100	100
Dolls Point Baths	84	100	97	100	100

(HW12)					
South Ramsgate (HW04)	72	95	78	NR	NR
North Ramsgate (HW03)	78	90	81	100	100
Brighton Le Sands (HW02)	53	95	91	100	100

Data taken from NSW Environment Protection Authority (1997, 1998) Beachwatch and Harbourwatch 1996-1997 & 1997-1998 Season Report

From the information presented in **Table 3.53** and **Table 3.54** above, non-compliance of enterococci levels is greater than non-compliance of faecal coliforms, with a one site (Brighton Le Sands, HW02) complying with primary contact recreation guidelines as low as 50% of the time in the summer of 1995/96.

Median faecal coliform density over different rainfall events has also been recorded, as presented in **Table 3.55** below.

Table 3.55:Median faecal coliform density in the lower Georges River (CFU/100ml) over different rainfall events October 1996 to April 1997

Location	Rainfall in previous 24hrs			
	0mm	**0-5mm**	**5-10mm**	**>10mm**
Sandringham Baths	1	2	8	30
Dolls Point Baths	1	1.5	4	15
South Ramsgate	0	1	-	15
North Ramsgate	0	1.5	10	22
Brighton Le Sands	1	1	30	30 000

data taken from NSW Environment Protection Authority (1997) Beachwatch and Harbourwatch 1997 Season Report

Catchment Waterway Monitoring Sites in the Scarborough/Sans Souci subcatchment

Water quality data is available from a recent university study undertaken in the Scarborough Ponds wetlands (F.Shennan, Southern Cross University, 1997). Sampling sites in the area are shown in **Figure 3.1** and results are summarised in **Table 3.56** below.

Table 3.56: Scarborough/Sans Souci Catchment Waterway Monitoring Sites - Summary Information

Site (refer Figure 3.1)	Location & *Subcatchment*	Monitoring Period	Parameters of Most Concern*
RCC01	Culver Street *Scarborough Ponds*	3/8/97 - 14/9/97	DO, Litter
RCC02	Marshall Street *Scarborough Ponds*	3/8/97 - 14/9/97	DO, Litter

RCC03	President Avenue *Scarborough Ponds*	3/8/97 - 14/9/97	Total-N, DO, Litter
RCC04	Bicentennial Park *Scarborough Ponds*	3/8/97 - 14/9/97	Faecal Coliforms, DO, Litter

* based on information supplied by Rockdale City Council, 1998 (parameters quoted are those for which the mean level was higher than ANZECC criteria at this site over the monitoring period)
(Source: F.Shennan, Southern Cross University, 1997)

The results of Dissolved Oxygen indicate that extremely low levels are present at all sites monitored within the Scaraborough Park area. The accuracy of DO measuring equipment is in question, however, due to the fact that numerous fish species were observed at sites where DO levels would otherwise be toxic to fish. Litter is reported to be a major concern in and on the banks of the wetlands. (F. Shennan, Southern Cross University, 1997)

3.6 Sediment Data

Sedimentation of the Georges River is an important issue when considering stormwater management. In some subcatchments, urban runoff is accountable for up to 90% of suspended solids entering the Georges River. A major source is likely to be from the upstream Georges River catchment where sand extraction occurs and housing developments contribute significant amounts of sediment to stormwater runoff. (EPA, 1994)

Sutherland subcatchments
Erosion from building sites and subsequent sedimentation of waterways is a major problem within the Sutherland Shire. Around 5 - 10 tonnes of soil may be lost from a single site in a major storm event. (Sutherland Shire 1997)

A study of construction sites for compliance with erosion and sedimentation control measures in 1997 showed that 41% had effective sediment control measures, up from 22% in 1996. (Sutherland Shire 1997)

No general sedimentation data as to the extent of sedimentation in the Lower Georges River as a result of activities within the Sutherland Shire was available.

Oatley Bay subcatchment
Oatley Bay had been dredged several times. There is no data regarding rate of sediment deposition. The little information available on sediment quality suggests that the sediment dredged was mainly fine silt.

Kogarah Bay subcatchment
Evidence (Munro *et al*., 1967) indicates that Kogarah Bay was acting as a silt trap for suspended silts and clays brought into the relatively stagnant waters of the Bay from headwater catchments and by the interchange

between the Bay and the Georges River estuary. The 1980 PWD study showed that this Bay was infilling with a siltation rate of 45mm per year average depth over the Bay (PWD, 1988). This means that the Bay should have an average depth of only 400mm at the end of 2000 and no water at the end of 2010. This is of great concern as Kogarah Bay is a pivotal source of recreation, especially for boating and swimming.

Results from the maintenance of a boom located in Beverley Park in the Kogarah Bay subcatchment indicated that 192 kg of sediment was trapped in April 1998. This represents 30% of total substances removed. A later collection in September 1998 found that 5% was trapped.

These results reflect storms that occurred at that time washing topsoil and soil from under homes into the stormwater system. A second boom is currently located at Carss Bush Park however no data is available for it yet.

Scarborough Ponds/Sans Souci subcatchment
Rockdale Council's stormwater infrastructure includes many kilometres of concrete-lined and vegetated earth open drains and creeks which contribute to sedimentation in the Lower Georges River. There is little evidence of erosion of these drains, however they are known to silt up (pers. Comm. Rockdale Council, 1998). This indicates that the source of the sediment reaching the drains and the Lower Georges River is upstream of the drains, from within the catchment.

No data was available at the time of this report which indicates the extent of sedimentation as a result of these drains.

3.7 Aquatic Habitat

Oyster Farms
In 1991 there were 95 oyster leases between Salt Pan Creek and Towra Point, covering an area of 86 ha (EPA, 1994 pg 67). Oyster farming has never been banned in the Georges River, however, since 1995, oyster farm leases have been voluntarily returned to the Risheries Dept. due to deteriorating water quality (pers. comm. GRCMC, 1999).

Quibray Bay is extensively farmed for oysters today (pers. Comm. GRCMC, 1998). This is possible due to the Quibray Bay water body being somewhat protected from flows from the Georges River by Towra Point.

Wetlands
A feature of the Lower Georges River are the numerous wetland ecosystems. Wetlands are ecologically, economically and socially important and help maintain the productivity of catchments and estuaries.

Table 3.57 below lists the wetlands contained on the EPA's Southern Sydney Region (SSR) Wetlands Inventory. The viability and impacts on the wetlands at the time of listing is also provided.

Table 3.57: Lower Georges River Wetlands

Sub-catchment	SSR Wetland No.	Wetland Name	LGA	Classi-fication	Size (ha)	Viability [1]	Impacts [2]
A	232	Mangrove Island	Sutherland	Estuarine	8.5	7	P
A	253	Towra Point	Sutherland	Estuarine	327.9	7	W
A	254	Woolooware Bay	Sutherland	Estuarine	156.2	7	-
A	258	Quibray Bay	Sutherland	Estuarine	105.6	4	MC, W
B	323	Gwawley Park	Sutherland	Estuarine	-	-	-
C	270	Oyster Bay	Sutherland	Estuarine	7.0	3	-
D	220	Edith Bay	Hurstville	Estuarine	0.9	5	-
D	221	Lime Kiln Bay	Hurstville	Estuarine	11.0	4	PW
E	223	Gungah Bay	Hurstville	Estuarine	3.3	4	PW
E	224	Neverfail Bay	Kogarah	Estuarine	0.7	2	PW
F	222	Oatley Bay	Kogarah	Estuarine	4.2	4	PR
J	-	Scarborough Ponds*	Rockdale	Freshwater Reed Swamp**	approx. 10	-	-

(Source: EPA, 1994 - Table 5.8: SSR Wetlands Inventory. Note: wetlands listed have been extracted from a list of wetland compiled by Jay Stricker, 1989 for Nature Conservation Council of NSW and Dept. of Planning.)
* not listed on SSR Wetlands Inventory
** as classified by the State Pollution Control Commission in 1979 (Shennan, 1997). The ponds are in fact weakly tidal and the water is probably brackish.

[1] **Viability**
Guide to the conservation capability of sites
7 - no effective disturbance to wetland function
6 - limited marginal grazing by hoofed animals
5 - limited clearing of margins/light weed invasion
4 - less than 30% reclamation/moderate weed invasion
3 - extensive clearing/30 - 60% reclamation/heavy weed infestation
2 - partial drainage of freshwater wetland or

[2] **Impacts**
B - construction eg. roads, buildings
C - clearing of vegetation
D - drainage of freshwater wetlands
F - stormwater input
G - grazing
I - recent bushfire
L - levee
M - mining, soil/sand extraction
R - reclamation/filling

impoundment of estuarine wetland/60 - 90% reclamation
1 - cultivation, drainage or impoundment affecting more than 90% of wetland area
0 - non functional as a wetland

V - damage from off-road vehicles
W - weed invasion
P - obvious pollution source

3.8 Aquatic and Riparian Flora and Fauna

Kurnell Peninsula subcatchment
Some of the larges remnant stands of mangrove and saltmarsh wetlands in the Sydney region exist along the shores of Quibray, Weeny and Woolooware Bays

These are an important habitat for many species of birds, including migratory wader birds protected under agreements between Australia and Japan (JAMBA) and China (CAMBA) as well as under the United Nations Ramsar Convention (EPA, 1994, pg 94).

Lime Kiln Bay subcatchment
Estuarine Communities:-

- Mangroves - large stands exist at Gungah Bay, Lime Kiln Bay and in the Georges River State Recreation area below Cedar Street, Lugarno. Species include *Avicennia marina* (the Grey Mangrove) and is most common, with the River Mangrove (*Aegiceras corniculatum*) being less common.;
- Saltmarsh (Herbland) - found on the landward side of mangroves and are dominated by low growing herbs and shrubs, which are adapted to deal with high salt levels and high evaporation. Species include *Sarcocornia quinqueflora* and *Suaeda australis* of the Chenopodiaceae (Saltbush Family);
- Rushland - found where flooding by brackish waters is infrequent, extensively on the landward side of the saltmarsh areas and mangroves near Riverwood Park and in Lime Kiln Bay and Gungah Bay. Species include *Phragmites australis* and *Juncus krausii.*
- Casuarina Forest - located on the landward side of the estuarine communitieis are stands of the Swamp Oak (*Casuarina glauca*) are found;
- Paper Bark Swamp - a closed Forest dominated by *Melaleuca linariifolia* with the occasional *Melaleuca styphelioides* is seen on the landward side of estuarine comminutes at Riverwood Park, Lime Kiln Bay and Miles Dunphy Reserve.

(Source: National Trust, NSW - Hurstville Council Survey of Bushland Areas, 1995)

Kyle Bay subcatchment
White (1998) recorded 32 species of birds, 6 species of mammals, 5 species of reptiles and one frog species in the reserves in this catchment. Hall (1998) recorded 55 species of birds at Connells Point, 27 of these were not included in White (1998).

83 species of plants and 12 species of weeds have been recorded.

West *et al*. (1985) registered both mangroves and seagrasses along the eastern edge of Kyle Bay. Connells Bay also contains seagrasses. Shipwrights Bay contains mangroves. Shipwrights Bay and Kyle Bay's mangroves are considered 'Sensitive Aquatic Habitat'.

Oatley Bay subcatchment
Data from Poulton Park indicates that it has the highest fauna diversity. White (1998) has identified fifty-four species of birds, 11 species of mammals, 8 species of reptiles and 4 frog species.

The most recent survey identified 162 species of plants from Poulton Park in 1996 (National Trust, 1996). The Bushcare group is updating this list. A list is also being formed for Moore Reserve.

In 1998 the Gosford Wattle (*Acacia prominens*) was classified as an Endangered Ecological Community under the Threatened Species Conservation Act 1995. This species is found at Moore Reserve, Poulton Park and Letitia Street Reserve.

West *et al.* (1985) observed mangrove coverage in Oatley Bay but no seagrass. According to this study, Poulton Park contained maximum coverage of mangroves.
Most of the mangroves in the Moore Reserve area have been destroyed due to reclamation for rubbish dumps in the past. Oatley Bay's mangrove area is considered 'Sensitive Aquatic Habitat'.

Kogarah Bay subcatchment
A recent survey of fauna within the reserves in this catchment identified 38 species of birds, 7 species of mammals, 5 species of reptiles and one species of frog (White, 1998).

One 1979 survey recorded 82 species of plants and 13 weed species (National Trust of Australia, 1979). No other data is available.

Seagrass was present in extensive areas in Kogarah Bay as described by West *et al*. (1985). The major area covered was the western edge's Townsend Street zone that represented the last major areas of seagrass coverage within the Georges River. About 0.45ha of mangrove was destroyed in the fifties at the Carss Bush Park area – the only mangrove area in this Bay. No salt marsh is present in Kogarah Bay. Based on these habitats, Sydney Water (1998) considers this as 'Sensitive Aquatic Habitat'.

Scarborough/Sans Souci subcatchment
The State of the Environment Report, 1996 - 1997 (SER) for Rockdale City Council states that 18 fish and invertebrate taxa have been collected from

three sites around the Scarborough Ponds wetlands. The constructed, 700 m long concrete culvert which connects the wetlands to Botany Bay below Florence Street does not seem to restrict fish movement to and from the wetlands.

The SER considers the wetlands to be a significant fish nursery habitat due to the lack of such aquatic habitats north of Towra Point within Botany Bay.

The Scarborough Ponds are also considered significant for their role in providing suitable habitat for migratory birds, including some listed under JAMBA and CAMBA conventions.

3.8.1 Urban Bushland

There are significant stands of urban bushland scattered throughout the study area. **Figure 3.3** shows the extent of urban bushland with the Lower Georges River catchment. Most urban bushland areas border on the fringes of the river and inlets, however, there are some inland bushland areas also.

Urban stormwater runoff is identified in most urban bushland study reports as a major problem contributing to the degradation of bushland areas.

Site specific assessment of the impacts of urban runoff in urban bushland areas has been undertaken as part of the numerous urban bushland surveys in each Council LGA. The three major factors of urban runoff which impact urban bushland areas are summarised below.

There are three major factors linked with urban runoff:

- *an increase in soil moisture occurs*, which assists in the germination and proliferation of exotic plant material, while at the same time inhibiting the survival of indigenous flora;
- *soil nutrients increase and attract the regeneration of weed species*; and
- *runoff is a carrier of exotic plant material* in the form of seed or cuttings. (Source: SSC Urban Bushland Plan of Management, 1990).

Sutherland LGA

Most of the urban bushland within the Sutherland LGA and within the study area (excluding the Towra Point Nature Reserve and Captian Cook's Landing place) is located on the banks of waterways including Oyster Creek, Gwawley Creek and the Georges River.

The four major plant communities found in the Shire are:

- Smooth Barked Apple - *angophora costata* association;
- Scibbly Gum - *Eucalyptus haemastoma* association;
- Coastal Heath/Sclerophyll Woodland; and
- Mangroves.

The National Parks and Wildlife Service manages the wetland sanctuary at Towra Point in Botany Bay and Captain Cook's Landing place Historic Site at Kurnell. (Source: SSC Urban Bushland Plan of Management, 1990).

Hurstville LGA

The majority of bushland within the study area and within Hurstville LGA is on the foreshores and inlets of the Georges River. There is a diversity of vegetation types due to the variety of environments. There are a number of rare and threatened species.

Vegetation communities include the following:
Bushland communities:-

- *Eucalyptus paniculata* (Grey Ironbark)-*Angophora floribunda* (Rough barked Apple)- located north of Henry Lawson Drive;
- Sydney Red Gum - *Angophora costat* / various Eucalypt co-dominants (Sydney Peppermint, Red Bloodwood, Grey Gum) - located on the immediate foreshores of the Georges River;
- *Eucalyptus pilularis* (Blackbutt)/ *Angophora costata* (Sydney Red) - located in Lugarno,k Oatley Heights and Miles Dunphy Reserve; a stand of Blackbutt dominates the sheltered area in Yarran road Reserve, Oatley;
- *Eucalyptus pilularis* (Blackbutt) / *Syncarpia glomulifera* (Turpentine) - located in Lugarno, the Hurstville Golf Club and Miles Dunphy Reserve;
- *Eucalyptus teteticornis* (Forest Red Gum) - small stand in Evatt Park at the end of Allwood Crescent;
- Closed Forest communities located in the small deep gullies sloping down to the river including species such as Cheese Trees (*Glochidion ferdinandi*), Lilly pilly (*Acmena smithii*) and the vines *Sarcopetalum harveyanum* and *Stephania japonica.* Such gullies are seen in Boggywell Creek Bushland (West Side), Murdoch Crescent, Luguarno and Mile Dunphy Reserve.

(Source: National Trust, NSW - Hurstville Council Survey of Bushland Areas, 1995)

Kogarah LGA

Kogarah is located principally on Hawkesbury Sandstone, which has given rise to typical sandstone vegetation. The Wianamatta Shale that extends across and down from the railway line between Allawah and Mortdale once supported the Turpentine – Ironbark Forest is now completely gone, apart from one small stand that remains in Quarry Reserve.

Most of the natural vegetation in Kogarah was cleared during the first half of this century, including most foreshore vegetation. As a result, approximately 2.8% of the sandstone vegetation and 0.1% of the Turpentine – Ironbark Forest remain.

In 1998 the Gosford Wattle (*Acacia prominens*) was classified as an Endangered Ecological Community under the Threatened Species Conservation Act 1995. This species is found at Moore Reserve, Poulton Park and Letitia Street Reserve.

There is approximately 58 hectares of remnant vegetation, or bushland, in Kogarah, generally contained within reserves located along the Georges River. The bushland offers a precious refuge for animals as well as people, and is a valuable asset. (Source: pers. comm. Kogarah Municipal Council, 1999)

Rockdale LGA
There is one small area of bushland in the Rockdale LGA of the Lower Georges River catchment. This is the Hawthorn Street Reserve, also known as Leo Smith Reserve.

The Hawthorn Street Reserve comprises of Bangalay and Red Gum. Recently, the Scientific Committee (established under the Threatened Species Act) has made a preliminary listing of the Kurnell Dune Forest as an Endangered Ecological Community. An isolated remnant of this is found in the Hawthorn Street Reserve. The Kurnell Dune Forest is the original forest vegetation that occurred on the sand dunes throughout the Kurnell Dune Peninsula. In 1997 a grant of $55,000 was obtained by the Scarborough Park South Volunteers Park Committee to prepare a Plan of Management and undertake Rehabilitation works at this Reserve.

3.9 Current Council Stormwater Management Policies

The following is a list of Council's existing documented policies which relate to stormwater management and associated activities.

Rockdale City Council
- Stormwater Pollution Control Code - sets out source control techniques for a range of business descriptions. The code is produced by the Sydney Coastal Councils and modified for use by Rockdale City Council.
- Drainage Stormwater Pollution Control - Section 94 Contribution Scheme for all developments which provide on-site detention of stormwater. Contributions are worked out on the additional impervious area created on a site and a drainage levy according to where the development is located.
- Stormwater Design Code - in particular On-site Stormwater Retention, On-Site Stormwater Detention, and Erosion and Sediment Control.
- DCP No. 28 Objective 4 - Requirements for Access, effective 30 January, 1997. The objective is to provide convenient access to all public open space including parks, reserves, other recreation facilities, malls, plaza's and squares. This policy is indirectly related to stormwater management given it relates to access which is one of the values for waterways throughout the catchment.

- Soil and Water Management Guidelines - regional initiative to implement and enforce uniform control standards and guidelines for the building industry across the Southern region. The guidelines outline measures that builders need to put in place to prevent soil or other building materials entering the waterways, via streets and gutters.

Sutherland Shire Council

- Stormwater Management Policy and Guidelines (Policy) - Water Quality Control Measures include source controls, control devices within a drainage corridor, construction site controls.
- On-site Stormwater Detention Policy and Technical Specification (Policy) - OSD policy and technical information mainly targeted at stormwater quantity control rather than quality control. Water quality is covered briefly under Environmental Considerations.
- Other policies and standards adopted by Sutherland Shire Council relating to the coastal zone area and water quality include (taken from Environmental Strategic Plan - Task Force Reports, 1993):
  Policies:
  - NSW Coast Government Policy
  - REP Plan No.17 Kurnell Peninsula
  - DCP Cronulla Centre
  - LEP Sutherland
  - The Injured Coastline report HOBRSCERA
  - Coastal Protection Act 1979
  - Coastline Management Manual 1991
  - Sydney Regional Coastal Management Strategy

  Standards:
  - Regulation 8 - Clean Waters Act
  - EPA draft water quality criteria
  - State Health Department Water Quality Standards
  - Australian Guidelines for Recreational Water
  - ANZECC
  - Draft National Water Quality Guidelines
- Urban Drainage Design Manual (SSC).
- Other policies adopted by SSC include:
  - Urban Erosional and Sediment Control Field Guide (CALM)
  - Australian Rainfall and Runoff (IEAUST)
  - Management Urban Stormwater (Dept. of Housing)

Kogarah Municipal Council

- Erosion and Sediment Control Guidelines (Policy)
- Allawah DCP - Kogarah Council used the “leading by example” approach to promote ecologically sustainable development and water sensitive urban design for the new Allawah apartments that were proposed to be developed on Council owned land. One of the main objectives of the DCP was to ensure the sustainability of water as a

renewable resource, promoting its conservation, reuse and source control of stormwater pollutants.

- Kogarah Town Centre DCP - the draft DCP that guides the redevelopment of Kogarah Town Centre is on exhibition now. The DCP ensures that environmental protection measures are in place so that redevelopment is sustainable and will not have negative impacts on our environment. The DCP includes a stormwater section that regulates new residential and commercial develo9pment in the Kogarah CBD requiring on-site treatment for stormwater runoff to a tertiary standard as defined in the EPA's *Managing Urban Stormwater - Treatment Techniques 1997*.
- Draft Residential DCP - "Good Design Guide" - this DCP that is at its final stages of being ready for exhibition, sets out planning controls for future residential developments in Kogarah Council. It also looks at appropriate design elements more sustainable with the local natural and built environment. The DCP includes a stormwater section that regulates new residential and commercial development in the Kogarah CBD requiring on-site treatment of stormwater to a tertiary standard as defined in the EPA's *Managing Urban Stormwater - Treatment Techniques 1997*.
- Stormwater Design and Management DCP - this DCP, which is currently being completed, sets out objectiv3s and design controls for the different types of developments in the Municipality within the context of integrated sto9rmwater management. It includes details and examples on how to meet these objectives, design standards and controls to mitigate the impact of new development on the local natural and built environment.

Hurstville Council

- Soil And Water Management (Policy) - Policy statement to prevent erosion, sedimentation and water pollution from building sites
- On-site detention conditions for stormwater (Policy)
- Community Land Plans of Management (Policy)

3.10 Current Stormwater Management Practices

The following is a list of stormwater management practices which are currently implemented in each of the council's. These may include the implementation of policies, education programs, audits and studies related to stormwater pollution control.

Rockdale City Council

- Audit of Industry in Rockdale (Audit) - commenced in August 1997 and is now complete. This involved assessing current practise of approximately 40 - 50 industrial premises located around Production Avenue and Phillips Road. A report on the result of the audit is yet to be produced by Council.
- Environmental Directory for Industry (Education) - this was issued to industries throughout Rockdale in conjunction with the 1997 audit

mentioned above. The directory provides industry with a one page list of contacts for pollution incidents (Rockdale Council); general environmental advice and the Pollution Information Line (EPA); trade waste information (Sydney Water); Workcover; and hazardous materials containment and spillage clean-up (HAZMAT, NSW Fire Brigade).

- Environmental Information for Industry (Education) - a series of leaflets were issued to industries throughout Rockdale, commencing in 1997 with the above activities. They included:
  - No. 1 Stormwater Pollution - advice on washing activities, storage areas, accidental spills and general house keeping;
  - No. 2 Storage of Liquids - mainly advice on the use of bunding around liquid storage areas and isolating the area away from stormwater drains;
  - No. 3 Spill Clean-up Procedures - addresses the use of a material safety data sheet (MSDS), the general procedure for spill clean-ups (ie. stop spill, contain then clean-up), adoption of spill clean-up plans for each industry, and the use of dry cleaning.
  - No. 4 Environmental Legislation - "What you should know":
    - Clean Waters Act, 1970;
    - Environmental Offences and Penalties Act, 1989;
    - Environmentally Hazardous Act, 1985;
    - Clean Air Act, 1961; and
    - Noise Control Act, 1975.
- Solutions to Pollution (Education) - leaflet issued in 1997 to motor vehicle repairers, panel beaters and spray painters. Includes basic "how to" prevent pollution tips and a checklist with contacts of who to call with any queries.
- Scarborough Park North Weed Management Study (Study) - designed to eradicate declared noxious weeds and especially invasive environmental weeds in the short-term with specific requirements towards the overall rehabilitation of remnant bushland areas in the park in the long-term. Implementation strategies include a review of relevant legislation, overview of health and safety issues, and addressing the use of herbicides near water. Recommendations for site rehabilitation including revegatation, hydroseeding, brush matting, direct seeding and erosion control have also been included.
- "A Manual for Sustainable Management" Rockdale Creeks and Gullies (draft), Clouston 19/8/98 (Study) - includes current practices, issues, objectives, management strategies and operational guidelines.
- Georges River Riverkeeper Program - Council is an active member of the Georges River Combined Councils Committee (GRCCC) which includes promoting the Riverkeepers Program. The program consists of a training course in river science and environmental management and the coordination of the work of volunteers who carry out surveillance and educational functions.
- Production and distribution to households in 1997 of the pamphlet "Don't Rubbish Your Waterways" to educate residents on how they can reduce stormwater pollution through household practices.

- Commencement of a water quality benchmark study in December 1998 of 13 sites for an 8 month period. Eleven parameters are being tested each month, with additional heavy metals for some of the 13 sites.
- Introduction of free motor oil drop off locations at 4 service stations for residents in January. Oil is taken in plastic containers and deposited in bright green bins where it is collected and the oil reprocessed into useable oil again.
- Other practices include;
  - installation of 150 litterguards in gully pits to trap litter in street run off;
  - creek cleaning as required to remove accumulated sediments and rubbish; and
  - environmental restoration projects in creeks and wetlands to improve habitats and provide in-stream assimilation of nutrients and suspended sediments.

Sutherland Shire Council

- Strategic Water Monitoring Program (Study) - initiated by the Environmental Science Unit in December 1994. Thirteen parameters are tested at between 40 - 45 locations around Sutherland over a 10 week monitoring period each year.
- "Stormwater - Everyone's Concern" (Education) - awareness campaign including a brochure distributed in the Council area which addressed things such as:
  - where you wash your car
  - composting grass cuttings and other garden refuse
  - reducing fertiliser, pesticide and herbicide use
  - disposing of engine oil, turps, paint, bottles, cans and papers at recycling outlets
- Environmental Strategic Plan (Study) - a series of task group reports were last prepared in 1993. The task groups included the following;
  - Waterways, Water Quality and Catchment Management;
  - Natural Environment;
  - Air Quality, Noise and Environmental Health;
  - Population, Housing, Community Facilities and Recreation;
  - Economic Environment including employment, retailing/commerce and tourism;
  - Energy Management, Transportation and Utilities;
  - Waste Management, Hazards and Contaminated Land; and
  - Built Environment.
- Our Shire - Our Future - SSC's guide for shaping the future to 2030;
- State of the Environment Reporting
- SSROC Soil and Water Management Package.

Kogarah Municipal Council

- Audit of Industry in Kogarah and Carlton - commenced in August 1997 and is continuing. The audits involve a thorough site inspection of the premises and a detailed checklist of the process undertaken on site.

Hurstville Council

- Street Sweeping.
- Street and Park Litter Bins.
- Drains Cleaning.
- Litter Traps - Council has been trialing gully pit litter baskets and is about to install several (mini) GPTs.
- Pollutec CDS GPT installed at William Rd, Riverwood.
- Completion of works upstream of Clarke Street North, Peakhurst to improve stream flow and open stream adjacent to Creek stabilised to eliminate the need for concrete pipes/channels.
- Stabilisation of existing open stormwater channel which leads to a large wetlands area in Edith Bay, Lugarno.

Contents

4. Catchment Values

4.1 Development of Waterway Values

Waterway values, for the purpose of this SMP, have been defined to mean:

> *"The conditions we desire for our catchment waterways and the uses we want our waterways to be suitable for."*

These uses can be:

- Ecological
- Social
- Economic

A preliminary set of values were developed for the waterways within the catchment from documented information and from discussions with the Lower Georges River SMP Steering Committee. These preliminary values were refined using input from the community at a series of Community Consultation Workshops held within each of the Council areas. Sinclair Knight Merz facilitated three workshops in Rockdale, Hurstville and Sutherland Council's and Kogarah Council facilitated three workshops in Kogarah area.

The aim of the workshops was to identify the values that the community and place on their waterways and to prioritise these values. Minutes of each of the workshops and leaflets distributed at the workshops are contained in **Appendix A**.

Values that were identified for the waterways within the study area are described below.

4.1.1 Ecological Values

- Aquatic Ecosystems
  Aquatic species that depend on the waterways for food and other habitat requirements eg. fish and frogs.
- Aquatic Vegetation
  Vegetation within or along the embankments of the waterways which provide habitat, feeding and breeding grounds for all various aquatic species and bird species eg mangroves, seagrasses.
- Water Associated Wildlife
  Wildlife that depends on the waterways for drinking water, food or other habitat requirements (excluding fish and humans) eg. wading birds.

One catchment ecological value was also identified:

- Urban Bushland
  This was defined as land on which there is native vegetation, including remnant and planted, in stands substantial enough to warrant environmental

protection from potential impacts of urban stormwater runoff. (eg. Bushland park reserves, native tree plantations, not including street trees etc.).

4.1.2 Social Values

- Visual Amenity
  What the waterway looks like ie. is it natural looking and pleasant to the eye, is there litter etc.
- Primary Contact Recreation
  Types of recreation in which the body is immersed in water eg. swimming, diving, water skiing.
- Secondary Contact Recreation
  Types of recreation where the body is not immersed in water but some contact with water may occur eg. boating, canoeing, wading, fishing.
- Science and Education
  Use of the waterways and its vegetation and aquatic life for the education of students or for scientific research.
- Human Consumers of Seafood
  People who eat seafood from the waterways.
- Access
  Ability for people to view and be near the waterways and at designated locations enter the waterways.

4.1.3 Economic Values

- Off-Stream Water Use
  Extraction of water from the waterways for the purpose of irrigation and industrial use.

4.2 Values for the Lower Georges River Catchment

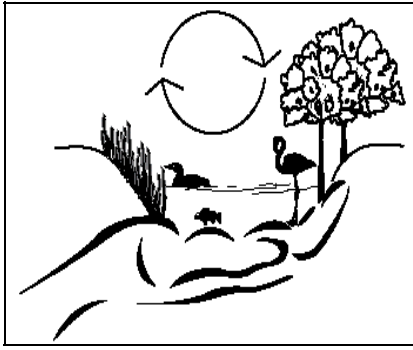
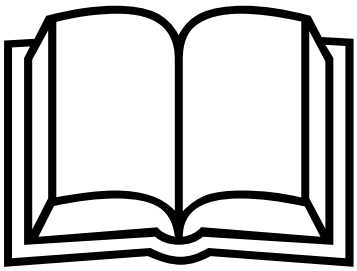
4.2.1 Overall Catchment Values

The following overall catchment values arose from the detailed sub-catchment value sets developed as described in the following section.

From the specific values and priorities already assigned for the waterways, foreshore and catchment areas in each of the sub-catchments A - J, overall values (or “goals”) for the whole of the Lower Georges River catchment can be derived. Such goals provide a context for the overall direction of stormwater management in the Lower Georges River catchment.

The goals are categorised into Primary, Seconday and Tertiary goals according to how important the Community, Stakeholders and Committee perceived them from what priorities were assigned to each of the specific values mentioned earlier.

Primary Goals for the Lower Georges River Catchment
These goals represent the values visual amenity, aquatic vegetation, aquatic ecosystems, water associated wildlife and education which have generally been assigned high priorities across the whole Lower Georges River catchment.

	Healthy Aquatic Ecosystems "…to encourage the existence and health of aquatic ecosystems as a whole within the catchment waterways and surrounding areas." *
	Increase and Maintain Visual Amenity "…to make the waterways, foreshore and catchment areas look more natural and pleasant to the eye, minimsing the presence of human derived waste, especially litter."
	Increase Awareness and Education "…use the waterways, foreshore and catchment areas and its associated aquatic life for the education of students of schools and scientific institutions as well as increasing the awareness of the stormwater issue amongst the community."

* the aquatic ecosystem includes aquatic animals such as fish and frogs, aquatic and riparian vegetation such as reeds and water lilies, and water associated wildlife such as wading birds - all of which are part of a habitat critical to the survival of individuals and the ecosystem as a whole.

Secondary and tertiary goals for the catchment have also been defined and are described on the following page.

Secondary Goals for the LGR Catchment

These goals represent the values primary contact recreation, human consumption of seafood, bushland and access which are not desired at every location around the catchment, but where they are, they have generally been received a medium or high priority. In general, they can be though of as the "Human Interaction" goals for the catchment.

	Safe Swimming "…to have clean and safe beaches and waterways for swimming and other primary contact recreation activities all year round without the concerns of health hazards in the water following major rain events."
Δ	Eat the Seafood Caught in the lower Georges River "…to be able to eat fish, oysters and other fresh water and marine seafood caught in the lower Georges River and associated freshwater tributaries without health concerns derived from poor water quality."
≅	Bushland "…encourage new and preserve and protect existing urban bushland areas and realise their value as an inherent component of a healthy catchment ecosystem towards the achievement of the primary goals."
;	Access "…to have human access to the waterways, foreshore and catchment areas to increase enjoyment, awareness and education as a result of interaction with the natural environment."

(Note: it will be important to restrict access in some sensitive areas to ensure access does not become detrimental)

Tertiary Goal for the LGR Catchment

This goal represents the value secondary contact recreation which is only desired in navigable water areas and received a medium or low priority wherever assigned.

δ	Enjoy the Waterways for Recreation "…use the navigable waterways for the boating and other secondary contact recreation activities with the proviso that impact to the health of the Lower Georges River catchment, particularly the river, estuary and wetland systems are not adversely impacted as a result."

4.2.2 Sub-catchment Values

In Rockdale, Hustville and Sutherland council areas "value sets" were assigned for at least each sub-catchment within that area and/or specific areas the community wished to highlight, such as the foreshore, wetlands, creeks and drains. Values in each set have an individual priority assigned according to the relative importance of the value. In addition, each value set has an overall priority assigned to it according to the importance of each area.

Value sets for Rockdale, Hurstville and Sutherland council areas are shown in **Figures 4.1**, **4.2** and **4.3** respectively.

In Kogarah, values and priorities are for specific areas indicated by the community. Individuals assigned values to areas they considered the highest priority. The collation of these values and their priorities are shown in **Figure 4.4**. These priorities reflect the number of people who held a value to a location. Where there was insufficient data, values are ranked as medium. The overall number of values placed in a location gave prioritisation to areas within a sub-catchment. General priorities for values in each sub-catchment are results from a vote held at the conclusion of the workshop. Details of workshop results are presented in **Appendix B**.

Kogarah Council's prioritising method identifies values the community held in comparison to others for a locality. The value sets are a result of 74 residents and is by no means an extensive consultation program. Another matter to consider is community values may differ from scientific views.

A resident survey of over 1000 homes in the Kogarah municipality was held in May 1997. The survey sought to determine values, behaviour, priorities, needs and issues relating to the Kogarah local government area. Key results were as follows:

- The most important issue relating to the natural environment was improving the water quality in creeks and rivers (this had the highest individual mean score of all responses)
- Taking better care of the natural environment ranked as the second most important issue overall

Values and priorities for the Kogarah area including Kogarah Bay, Kyle Bay and Oatley Bay sub-catchments are presented graphically in **Figure 4.4**.

A list of values and priorities for each sub-catchment area (A - J) is provided in **Tables 4.1** - **4.9** respectively. Values were divided into sub-catchment areas according to the outcome of each Community Workshop, discussions with the SMP Committee and site visits to each area.

Priority symbols used are as follows:
VH - Very High
H - High
M - Medium
L - Low
NA - Not Appropriate

Discussion of how these priorities translate into short and long term stormwater management objectives is given in **Section 5**.

Table 4.1: Kurnell Peninsula Sub-catchment (A) Values & Priorities

Value		Priority
		Kurnell Peninsula incl. Towra Point Nature Reserve
Ecological Values		
A.01 - Aquatic Ecosystems	ξ	H
A.02 - Aquatic Vegetation	|	H
A.03 - Aquatic Wildlife	□	H
Social Values		
A.04 - Visual Amenity	3	H
A.05 - Primary Contact Recreation	δ	NA
A.06 - Secondary Contact Recreation	δ	NA
A.07 - Education	)	M
A.08 - Human Consumption of Seafood	Δ	L

A.09 - Access	;	M
Economic Values		
A.10 - Off-stream Water Use	λ	NA
Catchment Values		
A.11 - Urban Bushland*	≅	H
Overall Area Value		**VH**

* This value was not identified during the community workshop. It was agreed as a result of site visits to the catchment area and discussions with the steering committee that urban bushland is an important consideration for stormwater management, hence the high value.

The overall very high priority assigned to the Kurnell Peninsula sub-catchment reflects the importance of Towra Point Nature Reserve, the natural feature which dominates the Kurnell Peninsula, to the health of the Lower Georges River system.

Urban Bushland, namely the Towra Point Nature Reserve and sand dunes surrounding the developed areas on the peninsula, was not considered at the Sutherland Community Workshop but is considered to have an important value for the catchment and receiving waterways. Urban Bushland is more appropriately addressed under council open space management plans and priorities are assigned to reflect this.

Table 4.2: Gwawley Bay Sub-catchment (B) Values & Priorities

Value		Priority			
		Gwawley Bay & Foreshore	Gwawley Creek	Wetllands upstream of Gwawley Bay	Covered Drains upstream of Wetlands
Ecological Values					
B.01 - Aquatic Ecosystems	ξ	H	H	H	H
B.02 - Aquatic Vegetation	|	H	H	H	H
B.03 - Aquatic Wildlife	□	H	H	H	H
Social Values					
B.04 - Visual Amenity	3	M	M	M	NA
B.05 - Primary Contact Recreation	δ	H	NA	NA	NA
B.06 - Secondary Contact Recreation	δ	H	NA	NA	NA
B.07 - Education	)	M	H	H	L
B.08 - Human Consumption of Seafood	Δ	M	NA	NA	NA

B.09 - Access ;	M	M	M	NA
Economic Values				
B.10 - Off-stream Water Use λ	NA	NA	NA	NA
Catchment Values				
B.11 - Urban Bushland* ≅	L	L	L	NA
Overall Area Value	**H**	**H**	**H**	**L**

* This value was not identified during the community workshop. It was agreed as a result of site visits to the catchment area and discussions with the steering committee that urban bushland needed to be considered for stormwater management, hence the low values.

The overall desire of the community in the Gwawley Bay sub-catchment is to see the aquatic ecosystem, including marine species, riparian vegetation, and wildlife, either preserved or reinstated. This is reflected in the constructed covered drains which discharge into the wetlands upstream of the Sylvannia Waters area although an overall low priority was given to them.

The most important areas identified were those currently in a natural state such as the creeks, wetlands and foreshore areas.

Table 4.3: Oyster Bay Sub-catchment (C) Values & Priorities

Value		Priority	
		Oyster Bay & Foreshore incl. Coronation, Scylla & Carina Bays	Oyster Creek
Ecological Values			
C.01 - Aquatic Ecosystems	ξ	H	H
C.02 - Aquatic Vegetation	|	H	H
C.03 - Aquatic Wildlife	□	H	H
Social Values			
C.04 - Visual Amenity	3	M	M
C.05 - Primary Contact Recreation	δ	H	NA
C.06 - Secondary Contact Recreation	δ	H	NA
C.07 - Education	)	M	H
C.08 - Human Consumption of Seafood	Δ	M	NA
C.09 - Access	;	M	M
Economic Values			
C.10 - Off-stream Water Use	λ	NA	NA
Catchment Values			
C.11 - Urban Bushland*	≅	L	L
Overall Area Value		**H**	**H**

* This value was not identified during the community workshop. It was agreed as a result of site visits to the catchment area and discussions with the steering committee that urban bushland should be considered for stormwater management, hence the low values.

Oyster Bay sub-catchment was not covered in the Sutherland Community Workshop. However, it was decided by the SMP Committee and as a result of a site visit to the area that due to the similarity of the two sub-catchments, that values and priorities would be applied in Oyster Creek with similar aspects from Gwawley Creek. As a result, the value sets for Gwawley Creek and the foreshore area were assigned to Oyster Creek and corresponding foreshore area respectively.

Table 4.4: Lime Kiln Bay Sub-catchment (D) Values & Priorities

Value	Priority			
	Foreshore	Lime Kiln Bay	Boggywell Creek	Industrial Area
Ecological Values				
D.01 - Aquatic Ecosystems ξ	H	H	H	H
D.02 - Aquatic Vegetation |	H	H	H	H
D.03 - Aquatic Wildlife □	H	H	H	H
Social Values				
D.04 - Visual Amenity ʒ	H	H	M	H
D.05 - Primary Contact Recreation δ	H	L	NA	NA
D.06 - Secondary Contact Recreation δ	H	L	NA	NA
D.07 - Education)	H	H	M	H
D.08 - Human Consumption of Seafood Δ	H	H	H	NA
D.09 - Access ;	H	H	M	H
Economic Values				
D.10 - Off-stream Water Use λ	NA	NA	NA	H
Catchment Values				
D.11 - Urban Bushland ≅	H	H	H	NA
Overall Area Value**	**NA**	**NA**	**NA**	**NA**

** This value was replaced at the community workshop for an general priority to attack the problem from the source first and then move downstream (ie. source control).

The general priority that arose out of the Hurstville Community Workshop was to solve the problem of stormwater pollution at the source and then move downstream. Overall Area Value Priorities were therefore not assigned in lieu of this general priority.

Urban Bushland was represented strongly at the Hurstville Community Workshop. As noted above, the priority assigned by the community at the workshop for urban bushland was high, however, as a result of discussions with the SMP Committee it was agreed that a medium priority be assigned for the purpose of this management plan and that the issue of preserving and maintaining urban bushland be more appropriately addressed under council's open space management plans.

The value of Access was cautiously assigned for this sub-catchment as the community is aware of the inherent

problems that human access brings to preserving and maintaining natural areas including the catchment and waterways. Therefore, it was agreed that Access be assigned subject to it being controlled (eg. using signage, and exercising restrictions etc.).

The value of Off-stream Water Use was assigned for the industrial catchment area north of the Hurstville Golf Course. Re-use of stormwater runoff in this area was seen to be of high importance to the management of stormwater in the Lime Kiln Bay sub-catchment.

Table 4.5: Gungah Bay Sub-catchment (E) Values & Priorities

Value		Priority	
		Foreshore incl. Gungah, Neverfail & Jew Fish Bays	Gungah Bay Wetlands
Ecological Values			
E.01 - Aquatic Ecosystems	ξ	H	H
E.02 - Aquatic Vegetation	|	H	H
E.03 - Aquatic Wildlife	□	H	H
Social Values			
E.04 - Visual Amenity	3	H	H
E.05 - Primary Contact Recreation	δ	H	NA
E.06 - Secondary Contact Recreation	δ	H	NA
E.07 - Education	)	H	H
E.08 - Human Consumption of Seafood	Δ	H	H
E.09 - Access	;	H	M
Economic Values			
E.10 - Off-stream Water Use	λ	NA	NA
Catchment Values			
E.11 - Urban Bushland	≅	H	H
Overall Area Value**		**NA**	**NA**

** This value was replaced at the community workshop for a general priority to attack the problem from the source first and then move downstream (ie. source control).

The general priority that arose out of the Hurstville Community Workshop was to solve the problem of stormwater pollution at the source and then move downstream. Overall Area Value Priorities were therefore not assigned in lieu of this general priority.

Urban Bushland was represented strongly at the Hurstville Community Workshop. As noted above, the priority assigned by the community at the workshop for urban bushland was high, however, as a result of discussions with the SMP Committee it was agreed that a medium priority be assigned for the purpose of this management plan and that the issue of preserving and maintaining urban bushland be more appropriately addressed under council's open space management plans.

The value of Access was cautiously assigned for this sub-catchment as the community is aware of the inherent problems that human access brings to preserving and maintaining natural areas including the catchment and waterways. Therefore, it was agreed that Access be assigned subject to it being controlled (eg. using signage, and exercising restrictions etc.).

Table 4.6: Oatley Bay Sub-catchment (F) Values & Priorities*

Value	Priority				
	Neverfail Bay	Oatley Bay	Moore Reserve	Poulton Park	General Vote
Ecological Values					
F.01 - Aquatic Ecosystems ξ	NA	L	L	L	H
F.02 - Aquatic Vegetation |	H	M	M	H	H
F.03 - Aquatic Wildlife □	H	L	L	L	L
Social Values					
F.04 - Visual Amenity 3	H	M	M	NA	M
F.05 - Primary Contact Recreation δ	L	H	NA	NA	L
F.06 - Secondary Contact Recreation δ	NA	L	NA	NA	L
F.07 - Education)	L	L	NA	M	L
F.08 - Human Consumption of Seafood Δ	NA	L	NA	NA	L
F.09 - Access ;	L	L	H	M	L
Economic Values					
F.10 - Off-stream Water Use λ	NA	NA	H	NA	L
Catchment Values					
F.11 - Urban Bushland ≅	M	M	H	H	M

* The original array of values from the Oatley Bay Workshop facilitated by Kogarah Council is shown in Figure 4.4. Refer to Appendix B for the original vote numbers for each value in each subcatchment.

Priority of the areas in Oatley Bay reflects the high use of these locations by the community. These are areas at the bottom of the catchment near natural

waterways. The community's overall values for the catchment also indicate the natural environment as valuable. The most important values indicated are aquatic ecosystems, aquatic vegetation and urban bushland.

The value set for each area suggests the type of use the community has for the location. In Oatley Bay higher values are given to the aquatic environment and water associated activities than the terrestrial areas. The foreshore areas indicate concerns for aquatic vegetation where it is prevalent.

Associated aquatic environmental values are high in the upper Moore Reserve area. This may reflect the existing reed beds and the proposed constructed wetland. The Moore Reserve wetland proposal is well known amongst local residents compared to the wetland that exists on the university campus that received little attention.

The aquatic areas seem to be less important in the results for Poulton Park, however the community rated the area to be high for education. This may indicate that the community value natural features highly enough to use them for educational purposes.

Urban bushland was valued highly in Moore Reserve and Poulton Park areas. This again reflects the community's interest in preserving natural features within their catchment. Additionally, the community valued off stream water use throughout Moore Reserve for irrigation purposes.

Neverfail Bay was valued for its natural and scenic features, however the community noted that it requires much improvement. The bay itself is also valued high within the Oatley Bay vicinity.

Table 4.7: Kyle Bay Sub-catchment (G) Values & Priorities*

Value	Priority				
	Kyle Bay	Connells Bay	Ship-wrights Bay	Georges River Waterway	**Overall Vote**
Ecological Values					
G.01 - Aquatic Ecosystems	M	M	M	H	M
G.02 - Aquatic Vegetation	H	M	NA	M	L
G.03 - Aquatic Wildlife	M	H	NA	M	L
Social Values					

G.04 - Visual Amenity 3	M	H	NA	M	H
G.05 - Primary Contact Recreation δ	H	M	NA	M	M
G.06 - Secondary Contact Recreation δ	L	M	NA	H	M
G.07 - Education)	H	NA	M	L	L
G.08 - Human Consumption of Seafood Δ	NA	M	NA	H	L
G.09 - Access ;	H	M	M	NA	L
Economic Values					
G.10 - Off-stream Water Use λ	H	L	NA	NA	L
Catchment Values					
G.11 - Urban Bushland** ≅	H	M	M	M	L

* The original array of values from the Connells Bay Workshop facilitated by Kogarah Council is shown in Figure 4.4. Refer to Appendix B for the original vote numbers for each value in each subcatchment.

The community expressed that visual appearance throughout the catchment as the most important value. Aquatic ecosystems and water based activities were also highly valuable to the community in the Kyle Bay Catchment area. This is reflected by the high values of popular recreational and natural locations in the Catchment.

Most foreshore and natural areas in the catchment featured access as a value. It is important for the community to freely visit these areas for passive and active recreation. Water based activities were highly valued for both Connell's and Kyle Bay where access is easy.

The natural aquatic environment is highly regarded for foreshore and water bodies by the community. This important feature attracts people to the waterways for recreation. It is essential to improve the water quality entering the bays to maintain community values.

Table 4.8: Kogarah Bay Sub-catchment (H) Values & Priorities*

Value	Priority			
	Kogarah Bay	Carss Park	Beverly Park	Overall Vote
Ecological Values				
H.01 - Aquatic Ecosystems ξ	L	M	NA	M
H.02 - Aquatic Vegetation |	L	M	M	L
H.03 - Aquatic Wildlife □	H	H	NA	L

Social Values				
H.04 - Visual Amenity 3	M	H	M	H
H.05 - Primary Contact Recreation δ	L	H	NA	M
H.06 - Secondary Contact Recreation δ	H	L	L	L
H.07 - Education)	M	M	L	H
H.08 - Human Consumption of Seafood Δ	H	L	L	L
H.09 - Access ;	NA	H	M	L
Economic Values				
H.10 - Off-stream Water Use λ	NA	M	H	M
Catchment Values				
H.11 - Urban Bushland ≅	L	H	L	L

* The original array of values from the Kogarah Bay Workshop facilitated by Kogarah Council is shown in Figure 4.4. Refer to Appendix B for the original vote numbers for each value in each subcatchment.

Carss Park attracted most values from the community because it is popular for land and water activities. The preservation and restoration of the natural ecosystem is an important component for the values in Carss Park. Kogarah Bay waterway was also important to the residents. Visual amenity throughout the catchment was the highest voted value that featured strongly along the foreshore areas. Other outstanding overall values included aquatic ecosystems and primary contact recreation.

Education was seen to be important in the Kogarah Bay Catchment. This included using natural areas for education and educating the community about best management practices. The community expressed educating businesses in the industrial estate to be an important issue for improvement of the catchment.

Because secondary contact recreation is a strong value for the Kogarah Bay waterway, sedimentation is a big issue that was raised by the community. There was also much concern with litter and toxic pollutants entering the Bay.

As with Moore Reserve in the Oatley Bay area off-stream water use for irrigation purposes was rated high in Beverley Park golf course.

Table 4.9: Scarborough Ponds/Sans Souci Sub-catchment (J) Values & Priorities

Value	Priority					
	Botany Bay Fore-shore (Nth of Dolls Pt.)	Kogarah Bay to Dolls Point Foreshore	Scarb-orough Ponds	Sans Souci Drain No.1	Sans Souci Drain No.2	Sans Souci Drain No.3
Ecological Values						
J.01 - Aquatic Ecosystems ξ	H	H	H	H	H	H
J.02 - Aquatic Vegetation |	H	H	H	H	H	H
J.03 - Aquatic Wildlife □	H	H	H	H	H	H
Social Values						
J.04 - Visual Amenity ʒ	H	H	H	H	H	H
J.05 - Primary Contact Recreation δ	H	H	NA	NA	NA	NA
J.06 - Secondary Contact Recreation δ	H	H	L	L	M	L
J.07 - Education)	H	H	H	L	M	NA
J.08 - Human Consumption of Seafood Δ	H	H	NA	NA	NA	NA
J.09 - Access ;	H	H	H	H	H	H
Economic Values						
J.10 - Off-stream Water Use λ	NA	NA	NA	NA	NA	NA
Catchment Values						
J.11 - Urban Bushland* ≅	NA	NA	M	L	L	L
Overall Area Value	**H**	**H**	**VH**	**M**	**H**	**L**

* This value was not identified during the community workshop. It was agreed as a result of site visits to the catchment area and discussions with the steering committee that urban bushland is an important consideration for stormwater management, hence the medium and low values.

Common values for all areas within Sub-catchment J identified above are Visual Amenity, Aquatic Ecosystems, Aquatic Vegetation, Aquatic Wildlife and Access, all of which have a high priority assigned to them. Off-stream Water Use from the catchment waterways was unanimously not desired for all areas within the sub-catchment.

Urban Bushland was not considered at the Rockdale Community Workshop but is considered to have an important value for the catchment waterways, including Scarborough Ponds and Sans Souci Drain No.s 1, 2 and 3. Urban Bushland is more appropriately addressed under

council open space management plans and priorities are assigned to reflect this.

Contents

5. Stormwater Management Objectives

Stormwater management objectives have been developed to protect the desired waterway values, as described in **Section 4**. These objectives need to incorporate both long term and short term (within 3 years) actions. The long term objectives are commitments in principle to a 'vision' for the catchment.

The actions that form part of this plan form the basis for achieving the short term objectives. Specific areas/hot-spots which have been identified which relate to the management objectives are provided in **Section 6**. For example, one stormwater management objective is to address areas of bank erosion. Specific areas where bank erosion are identified as a problem are identified throughout the issues and causes tables listed for each Council LGA in **Section 6**.

Stormwater management objectives, for the purpose of this SMP, have been defined to mean:

> *" what we seek to achieve in our management of stormwater to protect and/or achieve the identified waterway values."*

5.1 Ecologically Sustainable Development

It is important the stormwater management objectives be based on the principles of ecologically sustainable development (ESD). This requires the integration of environmental and economic considerations in decision making.

The key principles of achieving ESD as outlined in the Draft Managing Urban Stormwater Council Handbook (NSW EPA 1997a), include the following:

- *The Precautionary Principle* - if there are 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;
- *Inter-generational Equity* - the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- *Conservation of Biological Diversity and Ecological Integrity*; and
- *Improved Valuation and Pricing of Environmental Resources*.

5.2 Stormwater Treatment Objectives

In setting stormwater management objectives, it is important to quantify the stormwater treatment measures required to achieve these objectives. **Table 5.1** lists the short and long term water quality goals for a range of parameters and the level of treatment required to achieve these goals under the headings of post-construction and construction phases as well as existing and new development.

Criteria used to set the goals are taken from ANZECC water quality guidelines, the DOH Managing Urban Stormwater, Soils and Construction Manual (Aug 1998) and from experience of generally accepted criteria.

Post-construction treatment objectives for existing and new development areas are based on the following criteria:

- *Existing developed areas* mainly including houses of less than 50% imperviousness, treatment measures are generally those of Council, which are identified in **Section 7**. The treatment objectives in **Table 5.1** represent an estimation of the effectiveness of these measures on a catchment basis. This was based on broad scale catchment modelling for Kogarah' sub-catchments; and
- *New or proposed redevelopment areas*, which also include any type of development with imperviousness greater than 50%, treatment objectives were based on requiring a tertiary level treatment on site. The estimated efficiency of this standard is also shown in **Table 5.1**.

Construction phase stormwater treatment objectives are in accordance with guidelines set by the EPA for the treatment of stormwater during construction.

5.2.1 Stormwater Treatment Objectives for Existing and Proposed Development

The stormwater treatment objectives shown in **Table 5.1** are categorised into those objectives which apply to *existing* as opposed to *proposed* development.

The EPA regards it as important to distinguish between existing as opposed to proposed areas of development in order to facilitate the uptake of innovative and cost-effective stormwater management opportunities which can be integrated into new development, but are frequently unable to be retrofitted to existing urban areas.

For example, stormwater wetlands are often not applicable to existing areas of urban development due to a lack of space, whereas, new (proposed) development is able to set aside dedicated space to incorporate such stormwater quality control mechanisms.

The EPA intends to clarify the distinction between existing as opposed to proposed areas of urban development in the final *Council Handbook* to be published later this year (1999). (Source: EPA, 4/5/99)

5.3 Short and Long Term Stormwater Management Objectives

Stormwater management objectives are linked to the stormwater treatment objectives, thus providing management guidelines for both existing and new development.

Short term objectives (up to 3 years) have been set for waterway values which were given a high priority. This has been done to ensure that resources are initially allocated to high priority waterway values.

Objectives for each of the waterway values are described in **Table 5.1**. Long term objectives have been set for each waterway value.

Receiving Waterways
The main Georges River and associated estuary bays and backwaters make up the receiving waterways as referred to in **Table 5.1**.

Catchment Waterways
Catchment waterways referred to in **Table 5.1** can be described as the creeks, drains and waterways that collect runoff from the catchment upstream of the receiving waterways.

Urban Bushland
It was agreed as a result of the community workshops, site visits, and discussions with the steering committee that urban bushland is an important consideration for stormwater management in the Lower Georges River. It was agreed that short-term objectives as part of this SMP need to focus on the treatment of stormwater rather than bushland regeneration. The issue of preserving and maintaining urban bushland is appropriately addressed in more detail under Council's Open Space Management Plans.

Table 5.1: Stormwater Treatment Objectives

Pollutant	Goal (Long-term)	Treatment Objective (Short-term)
POST CONSTRUCTION PHASE		
(a) Existing Development		
Suspended solids (SS)	Suspended solids load to achieve natural dry and wet weather concentrations for the catchment	70% retention of the SS average annual load
Total Phosphorus (TP)	The load of phosphorus from the catchment meets ANZECC guidelines for aquatic ecosystems	20% retention of the TP average annual load
Total Nitrogen (TN)	The load of nitrogen from the catchment meets ANZECC guidelines for aquatic ecosystems	35% retention of the TN average annual load
Faecal coliforms	The load of faecal coliforms in catchment waterways meets with ANZECC guidelines for consumption of seafood	90% retention of the Faecal coliform average annual load
Litter	No anthropogenic litter in waterways. Organic litter occurring at natural levels of the catchment	Retention of litter greater than 50mm is to the maximum extent possible for storm events of up to 1 in 3 month ARI
Oil and Grease	No visible oils and grease in waterways	Retention of oil and grease are to the maximum extent possible for storm events of up to 1 in 3 month ARI
Toxicants	No toxicants entering waterways	Limit the application, generation and migration of toxic substances to the maximum extent possible
(b) New Development (or Redevelopment)		
Suspended solids (SS)	Suspended solids load to achieve natural dry and wet weather concentrations for the catchment	Areas with more than 50% imperviousness, an 80% retention of the SS average annual load
Total Phosphorus (TP)	The load of phosphorus from the catchment meets ANZECC guidelines for aquatic ecosystems	Areas with more than 50% imperviousness, a 40% retention of the TP average annual load
Total Nitrogen (TN)	The load of nitrogen from the catchment meets ANZECC guidelines for aquatic ecosystems	Areas with more than 50% imperviousness, a 40% retention of the TN average annual load
Faecal coliforms	The load of faecal coliforms in catchment waterways meets with ANZECC guidelines for consumption of seafood	Areas with more than 50% imperviousness, a 99% retention of the faecal coliform average annual load
Litter	No anthropogenic litter in waterways. Organic litter occurring at natural levels of the catchment	Total retention of litter greater than 50mm for storm events of up to 1 in 3 month ARI
Oil and Grease	No visible oils and grease in waterways	Total retention of oil and grease for storm events of up to 1 in 3 month ARI
CONSTRUCTION PHASE		
Suspended solids (SS)	Suspended solids load from site does not exceed natural levels	70% retention of the SS average annual load leaving site. Refer to **Table 5.1a** below for more details for sizing of sediment retention basins.
Coarse Sediment	No coarse sediment leaves the site in addition to natural loads	Retention of sediment larger than 0.125 mm for storm events of up to 1 in 3 month ARI at the site
Oil and Grease	No visible oils and grease enter waterways from site	Total retention of oil and grease for storm events of up to 1 in 3 month ARI
Toxicants	No export of toxicants from site	Limit the application, generation and migration of toxic substances to the maximum extent possible

Table 5.1a: Sediment Basin Design Criteria

This table is included for reference for the treatment of suspended solids during the construction phase. For further information refer to the EPA's document "The EPA's approach to managing stormwater quality from construction sites".

Type C (coarse grained soils)	
Treatment process	Rapid settling
Design principle	Settling of a design particle in the peak flow expected from a design storm.
Recommended design criterion	Settling a 0.02 mm particle in 25% of the peak flow from the 1 year ARI, time of concentration storm event.
Type F (fine grained soils)	
Treatment process	Slow settling
Design principle	Containment of all runoff expected from a 5-day rainfall event with specified probability of exceedance.
Recommended design criterion	Containment of all runoff from the 75th percentile, 5-day rainfall event
Type D (fine grained, dispersible soils)	
Treatment process	Flocculation Slow settling
Design principle	Containment of all runoff expected from a 5-day rainfall event with specified probability of exceedance.
Recommended design criterion	Containment of all runoff from the 75th percentile, 5-day rainfall event

Table 5.2(a): Stormwater Management Objectives

Sub-catchment A - Kurnell Peninsula

Note: the overall area value assigned to Kurnell Peninsula is Very High, therefore a particularly high priority should be given to stormwater management in this area.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
A.01 - Maintenance and restoration of aquatic ecosystems in Kurnell Peninsula Catchment Waterways as well as Receiving Waterways including Woolooware, Quibray and Weeney Bays and in particluar the Towra Point Nature Reserve. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Improve water quality in Kurnell Peninsula Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible, particularly in Towra Park Nature Reserve. ☐ Planning and policy controls endorse healthy catchments and waterways
A.02 - Protection and restoration of aquatic vegetation in both Kurnell Peninsula Catchment Waterways as well as Receiving Waterways including Woolooware, Quibray and Weeney Bays and in particluar the Towra Point Nature Reserve. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Kurnell Peninsula Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Kurnell Peninsula Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** and in accordance with the objectives of JAMBA, CAMBA and RAMSAR. ☐ Restoration of aquatic vegetation where feasible, particularly in Towra Point Nature Reserve. ☐ Rehabilitation and protection of aquatic vegetation in Kurnell Peninsula Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

A.03 - Protection and encouragement of aquatic wildlife in the Receiving Waterways, in particular the Towra Point Nature Reserve. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Kurnell Peninsula Catchment addressed ☐ Riparian vegetation within Kurnell Peninsula Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Kurnell Peninsula particularly Towra Point Nature Reserve ☐ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(a): Stormwater Management Objectives (cont'd)
Sub-catchment A - Kurnell Peninsula

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
A.04 - Improved visual amenity of all waterways - to look natural in the absence of man-made structures/litter Priority: High	☐ As above for A.01 - A.03 plus: ☐ No visible litter for flows up to a 1 in 3 month storm event ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ As above for A.01 -A.03 plus: ☐ Visual amenity is restored in Kurnell Peninsula Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
A.07 - Education - learn from the waterways for scientific and continuous improvement purposes. Priority: Medium		☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Kurnell Peninsula Catchment
A.08 - Human Consumption of Seafood - be able to consume seafood including fish, crustaceans etc. caught from the waterways Priority: Low		☐ Water quality for human consumption of seafood from waterways of the Kurnell Peninsula Catchment meets with ANZECC guidelines.
A.09 - Access - maintain & improve controlled access to Kurnell Peninsula Waterways in particular Towra Point Nature Reserve Priority: Medium		☐ Kurnell Peninsula Catchment natural areas are accessible
Catchment Values		

A.11 - Urban Bushland - preserve and maintain bushland areas, particularly Towra Nature Reserve and remnant stands of sand-dune bushland. Priority: Medium		☐ Bushland areas within Kurnell Peninsula Catchment are not adversely affected by stormwater, particularly Towra Point Nature Reserve. ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(b): Stormwater Management Objectives

Sub-catchment B - Gwawley Bay

Note: High overall area values were assigned to Gwawley Bay and the Foreshore, Gwawley Creek and the Wetlands upstream of Gwawley Bay therefore a high priority should be given to stormwater management in these areas. The covered drains upstream of the Gwawley Bay Wetlands have a low overall area value and therefore only long term stormwater management objectives for the drains.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
B.01 - Maintenance and restoration of aquatic ecosystems in all Catchment Waterways as well as Receiving Waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Improve water quality in Gwawley Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible.. ☐ Planning and policy controls endorse healthy catchments and waterways
B.02 - Protection and restoration of aquatic vegetation in all Catchment Waterways as well as Receiving Waterways. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Gwawley Bay Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Gwawley Bay Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of aquatic vegetation where feasible ☐ Rehabilitation and protection of aquatic vegetation in Gwawley Bay Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

B.03 - Protection and encouragement of aquatic wildlife in the Catchment and Receiving Waterways. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Gwawley Bay Catchment addressed ☐ Riparian vegetation within Gwawley Bay Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Gwawley Bay Catchment ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(b): Stormwater Management Objectives (cont'd)
Sub-catchment B - Gwawley Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
B04 - Improved visual amenity of all waterways - to look natural in the absence of man-made structures/litter Priority: Medium (NA for existing covered drains)		☐ As above for B.01 -B.03 plus: ☐ Visual amenity is restored in Gwawley Bay Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
B.05 - Primary Contact Recreation - create a safe, healthy waterway for swimming along the Georges River and in Gwawley Bay. Priority: HIgh	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Gwawley Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Gwawley Bay Catchment to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Water quality meets ANZECC guidelines for primary recreation in the Gwawley Bay.
B.06 - Secondary Contact Recreation - create a safe, healthy waterway for boating, canoeing, sailing etc. along the Georges River and in Gwawley Bay Priority: High	☐ Faecal coliforms entering Gwawley Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Gwawley Bay Catchment to the maximum extent practicable	☐ Waterways are safe and accessible for secondary contact recreation
B.07 - Education - learn from the waterways for scientific and continuous improvement purposes in all areas. Priority: High (Gwawley Ck & Wetlands), Medieum (Gwawley Bay & Foreshore) and Low (Covered Drains)	☐ Effective local water quality monitoring programs operating ☐ Regional water quality monitoring programs are supported ☐ Involvement of schools, universities or other research organisations in stormwater monitoring programs ☐ Community have an increased awareness of stormwater issues ☐ Community members actively involved in stormwater management including monitoring ☐ Residents and commercial operators in Gwawley Bay Catchment use Best Management Practices.	☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Gwawley Bay Catchment

B.08 - Human Consumption of Seafood - be able to consume seafood including fish, crustaceans etc. caught from the waterways Priority: Medium (only Gwawley Bay & Foreshore)		☐ Water quality for human consumption of seafood from waterways of the Gwawley Bay Catchment meets with ANZECC guidelines.

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(b): Stormwater Management Objectives (cont'd)
Sub-catchment B - Gwawley Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
B.09 - Access - maintain & improve controlled access to natural Catchment and Receiving Waterways Priority: Medium (for all areas except covered drains which are NA)		☐ Gwawley Bay Catchment natural areas are accessible
Catchment Values		
B.10 - Urban Bushland - preserve and maintain bushland areas Priority: Low (for all areas except covered drains which are NA)		☐ Bushland areas within Gwawley Bay Catchment are not adversely affected by stormwater ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(c): Stormwater Management Objectives

Sub-catchment C - Oyster Bay

Note: The overall area value assigned to the Oyster Bay subcatchment was High therefore a high priority needs to be given to stormwater management in this area.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
C.01 - Maintenance and restoration of aquatic ecosystems in all Catchment Waterways as well as Receiving Waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Improve water quality in Oyster Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible. ☐ Planning and policy controls endorse healthy catchments and waterways
C.02 - Protection and restoration of aquatic vegetation in all Catchment Waterways as well as Receiving Waterways. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Oyster Bay Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Oyster Bay Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.** ☐ Restoration of aquatic vegetation where feasible. ☐ Rehabilitation and protection of aquatic vegetation in Oyster Bay Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

C.03 - Protection and encouragement of aquatic wildlife in the Catchment and Receiving Waterways. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Oyster Bay Catchment addressed ☐ Riparian vegetation within Oyster Bay Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Oyster Bay ☐ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(c): Stormwater Management Objectives (cont'd)
Sub-catchment C - Oyster Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
C04 - Improved visual amenity of all waterways - to look natural in the absence of man-made structures/litter Priority: Medium		☐ As above for C.01 -C.03 plus: ☐ Visual amenity is restored in Oyster Bay Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
C.05 - Primary Contact Recreation Priority: HIgh	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Oyster Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Oyster Bay Catchment to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Water quality meets ANZECC guidelines for primary recreation in the Oyster Bay.
C.06 - Secondary Contact Recreation Priority: High	☐ Faecal coliforms entering Oyster Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Oyster Bay Catchment to the maximum extent practicable	☐ Waterways are safe and accessible for secondary contact recreation
C.07 - Education Priority: High (Gwawley Ck & Wetlands), Medieum (Gwawley Bay & Foreshore) and Low (Covered Drains)	☐ Effective local water quality monitoring programs operating ☐ Regional water quality monitoring programs are supported ☐ Involvement of schools, universities or other research organisations in stormwater monitoring programs ☐ Community have an increased awareness of stormwater issues ☐ Community members actively involved in stormwater management including monitoring ☐ Residents and commercial operators in Oyster Bay Catchment use Best Management Practices.	☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Oyster Bay Catchment
C.08 - Human Consumption of Seafood Priority: Medium (only Georges River & Bays)		☐ Water quality for human consumption of seafood from waterways of the Oyster Bay Catchment meets with ANZECC guidelines.
C.09 - Access Priority: Medium		☐ Oyster Bay Catchment natural areas are accessible

Catchment Values		
C.11 - Urban Bushland Priority: Low		☐ Bushland areas within Oyster Bay Catchment are not adversely affected by stormwater ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(d): Stormwater Management Objectives

Sub-catchment D - Lime Kiln Bay

Note: Overall area values were not assigned for the Lime Kiln Bay subcatchment as they have been for other areas. Rather, the community specified that a "top-down" prioritisation be assigned such that the pollution source is addressed first followed by downstream issues. This needs to be considered in stormwater management for this area.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
D.01 - Maintenance and restoration of aquatic ecosystems in all Catchment Waterways as well as Receiving Waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Improve water quality in Lime Kiln Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible.. ☐ Planning and policy controls endorse healthy catchments and waterways
D.02 - Protection and restoration of aquatic vegetation in all Catchment Waterways as well as Receiving Waterways. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Lime Kiln Bay Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Lime Kiln Bay Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of aquatic vegetation where feasible ☐ Rehabilitation and protection of aquatic vegetation in Lime Kiln Bay Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

D.03 - Protection and encouragement of aquatic wildlife in the Catchment and Receiving Waterways. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Lime Kiln Bay Catchment addressed ☐ Riparian vegetation within Lime Kiln Bay Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Lime Kiln Bay Catchment ☐ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(d): Stormwater Management Objectives (cont'd)
Sub-catchment D - Lime Kiln Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
D.04 - Improved visual amenity of all waterways Priority: High (for Foreshore, Lime Kiln Bay & Industrial Area) and Medium (Boggywell Ck)	☐ As above for D.01 - D.03 plus: ☐ No visible litter for flows up to a 1 in 3 month storm event ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ As above for D.01 -D.03 plus: ☐ Visual amenity is restored in Lime Kiln Bay Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
D.05 - - Primary Contact Recreation - create a safe, healthy waterway for swimming along the Georges River. Priority: High (Low for Lime Kiln Bay)	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Lime Kiln Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Lime Kiln Bay Catchment to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Water quality meets ANZECC guidelines for primary recreation in the Lime Kiln Bay.
D.06 - - Secondary Contact Recreation Priority: High (Low for Lime Kiln Bay)	☐ Faecal coliforms entering Lime Kiln Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Lime Kiln Bay Catchment to the maximum extent practicable	☐ Waterways are safe and accessible for secondary contact recreation
D.07 - Education - learn from the waterways for scientific and continuous improvement purposes in all areas. Priority: High (Foreshore, Lime Kiln Bay & Industrial Area), Medieum (Boggywell Ck)	☐ Effective local water quality monitoring programs operating ☐ Regional water quality monitoring programs are supported ☐ Involvement of schools, universities or other research organisations in stormwater monitoring programs ☐ Community have an increased awareness of stormwater issues ☐ Community members actively involved in stormwater management including monitoring ☐ Residents and commercial operators in Lime Kiln Bay Catchment use Best Management Practices.	☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Lime Kiln Bay Catchment

D.08 - Human Consumption of Seafood - be able to consume seafood including fish, crustaceans etc. caught from the waterways Priority: High (except for Industrial Area which is NA)	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Faecal coliforms entering Lime Kiln Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Lime Kiln Bay Catchment to the maximum extent practicable	☐ Water quality for human consumption of seafood from waterways of the Lime Kiln Bay Catchment meets with ANZECC guidelines.
D.09 - Access Priority: High (Medium for Boggywell Ck)	☐ Access restricted in sensitive areas ☐ A plan to link a network of popular natural areas is established	☐ Lime Kiln Bay Catchment natural areas are accessible

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(d): Stormwater Management Objectives (cont'd)
Sub-catchment D - Lime Kiln Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Economic Values		
D.10 - Off-stream Water Use (re-use in the industrial area) Priority: High	☐ Feasible stormwater re-use options are identified for Lime Kiln Bay Catchment ☐ Environmental flows are given careful consideration, for potential use and re-use of stormwater	☐ Stormwater is used or reused without affecting natural flow regimes
Catchment Values		
D.11 - Urban Bushland Priority: Medium		☐ Bushland areas within Lime Kiln Bay Catchment are not adversely affected by stormwater ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(e): Stormwater Management Objectives

Sub-catchment E - Gungah Bay

Note: Overall area values were not assigned for the Gungah Bay subcatchment as they have been for other areas. Rather, the community specified that a "top-down" prioritisation be assigned such that the pollution source is addressed first followed by downstream issues. This needs to be considered in stormwater management for this area.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
E.01 - Maintenance and restoration of aquatic ecosystems in all Catchment Waterways as well as Receiving Waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Improve water quality in Gungah Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible. ☐ Planning and policy controls endorse healthy catchments and waterways
E.02 - Protection and restoration of aquatic vegetation in all Catchment Waterways as well as Receiving Waterways. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Gungah Bay Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Gungah Bay Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.** ☐ Restoration of aquatic vegetation where feasible. ☐ Rehabilitation and protection of aquatic vegetation in Gungah Bay Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

E.03 - Protection and encouragement of aquatic wildlife in the Catchment and Receiving Waterways. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Gungah Bay Catchment addressed ☐ Riparian vegetation within Gungah Bay Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Gungah Bay ☐ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(e): Stormwater Management Objectives (cont'd)
Sub-catchment E - Gungah Bay

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
E.04 - Improved visual amenity of all waterways - to look natural in the absence of man-made structures/litter Priority: High	☐ As above for E.01 - E.03 plus: ☐ No visible litter for flows up to a 1 in 3 month storm event ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ As above for E.01 -E.03 plus: ☐ Visual amenity is restored in Gungah Bay Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
E.05 - - Primary Contact Recreation Priority: High (NA for Gungah Bay Wetlands)	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Gungah Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Gungah Bay Catchment to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Water quality meets ANZECC guidelines for primary recreation in the Gungah Bay.
E.06 - - Secondary Contact Recreation Priority: High (NA for Gungah Bay Wetlands)	☐ Faecal coliforms entering Gungah Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Gungah Bay Catchment to the maximum extent practicable	☐ Waterways are safe and accessible for secondary contact recreation
E.07 - Education - learn from the waterways for scientific and continuous improvement purposes in all areas. Priority: High	☐ Effective local water quality monitoring programs operating ☐ Regional water quality monitoring programs are supported ☐ Involvement of schools, universities or other research organisations in stormwater monitoring programs ☐ Community have an increased awareness of stormwater issues ☐ Community members actively involved in stormwater management including monitoring ☐ Residents and commercial operators in Gungah Bay Catchment use Best Management Practices.	☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Gungah Bay Catchment
E.08 - Human Consumption of Seafood - be able to consume seafood including fish, crustaceans etc. caught from the waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Faecal coliforms entering Gungah Bay are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Gungah Bay Catchment to the maximum extent practicable	☐ Water quality for human consumption of seafood from waterways of the Gungah Bay Catchment meets with ANZECC guidelines.
E.09 - Access Priority: High (Medium for Gungah Bay Wetlands)	☐ Access restricted in sensitive areas ☐ A plan to link a network of popular natural areas is established	☐ Gungah Bay Catchment natural areas are accessible

Catchment Values		
E.11 - Urban Bushland - preserve and maintain bushland areas Priority: Medium		☐ Bushland areas within Gungah Bay Catchment are not adversely affected by stormwater ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(f): Stormwater Management Objectives

Sub-catchment F - Oatley Bay

A full set of values and priorities across the whole area is illustrated in **Figure 4.4** and summarised for this subcatchment in **Table 4.6**. Details of Oatley Bay Workshop results and area groupings can be sited in **Appendix B.** The summarised values in **Table 4.6** form the basis for the following stormwater management objectives.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
Ecological Values		
F.01 - Maintenance and restoration of aquatic ecosystems in all catchment waterways as well as receiving waterways	❑ Retention of 80% of sediment average annual export rates. ❑ Retention of 60% of nitrogen and 20% of phosphorus average annual export rates. ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Limit the application, generation and migration of toxic substances to the maximum extent practicable ❑ Potential restoration sites assessed and restored where feasible ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Improve water quality in Oatley Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ❑ Restoration of natural waterways where feasible, particularly in Moore Reserve and Oatley Pleasure Grounds. ❑ Planning and policy controls endorse healthy catchments and waterways
F.02 - Protection and restoration of aquatic vegetation in all catchment waterways as well as receiving waterways	❑ Potential restoration sites assessed and restored where feasible ❑ Bank erosion along streams within Oatley Bay Catchment addressed ❑ Aquatic vegetation and physical habitat requirements within Oatley Bay Catchment are rehabilitated ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of aquatic vegetation where feasible, particularly in Moore Reserve and Oatley Pleasure Grounds. ❑ Rehabilitation and protection of aquatic vegetation in Oatley Bay Catchment to enhance aquatic biodiversity ❑ Planning and policy controls endorse healthy catchments and waterways

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
F.03 - Protection and encouragement of aquatic wildlife in the catchment and receiving waterways	❑ Bank erosion along streams within Oatley Bay Catchment addressed ❑ Riparian vegetation within Oatley Bay Catchment is restored and rehabilitated ❑ An increased range of animals make use of the waterways and riparian zone ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of indigenous riparian vegetation of Oatley Bay, Moore Reserve, Oatley Pleasure Grounds and Poulton Park ❑ Planning and policy controls endorse healthy catchments and waterways
Social Values		
F.04 - Improvement of the visual amenity of all waterways – to look natural in the absence of man-made structures/litter	❑ No visible litter for flows up to a 1 in 3 month storm event ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Visual amenity is restored in Oatley Bay Catchment waterways and bays ❑ Planning and policy controls endorse healthy catchments and waterways
F.05 - Primary contact recreation – create a safe, healthy waterway for swimming along the Georges River and bays	❑ Faecal coliforms entering Oatley Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Oatley Bay Catchment to the maximum extent practicable	❑ Water quality meets ANZECC guidelines for primary recreation in the Oatley Bay

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
F.06 - Secondary contact recreation – create a safe, healthy waterway for boating, canoeing, sailing etc along the Georges River and bays.	❑ Retention of 80% of sediment average annual export rates. ❑ Faecal coliforms entering Oatley Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Oatley Bay Catchment to the maximum extent practicable	❑ Waterways are safe and accessible for secondary contact recreation
F.07 - Education – learn from the waterways for scientific and continuous improvement purposes in all areas.	❑ Effective local water quality monitoring programs operating ❑ Regional water quality monitoring programs are supported ❑ Involvement of schools, universities or other research organisations in stormwater monitoring programs ❑ Community have an increased awareness of stormwater issues ❑ Community members actively involved in stormwater management including monitoring ❑ Residents and commercial operators in Oatley Bay Catchment use Best Management Practices.	❑ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ❑ Local community understand stormwater issues and impacts of poor practices within Oatley Bay Catchment
F.08 - Human consumption of seafood – be able to consume seafood including fish crustaceans etc caught from the waterway	❑ Faecal coliforms entering Oatley Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Oatley Bay Catchment to the maximum extent practicable	❑ Water quality for human consumption of seafood from Oatley Bay and Neverfail Bay meets with ANZECC guidelines.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
F.09 - Access-maintain & improve controlled access to natural catchment and receiving waterways	❑ Access restricted in sensitive areas ❑ A plan to link a network of popular natural areas is established	❑ Oatley Bay Catchment natural areas are accessible
Economical Values		
F.10 - Off-stream water use (re-use of stormwater)	❑ Feasible stormwater re-use options are identified for Oatley Bay Catchment ❑ Environmental flows are given careful consideration, for potential use and re-use of stormwater	❑ Stormwater is used or reused without affecting natural flow regimes
Catchment Values		
F.11 - Urban bushland – preserve and maintain bushland areas	❑ Stormwater is not causing erosion within bushland ❑ Retention of 60% of nitrogen and 20% of Phosphorus average annual export rates to bushland. ❑ Weed dispersion from outlets reduced ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Bushland areas within Oatley Bay Catchment are not adversely affected by stormwater, particularly Moore Reserve and Poulton Park. ❑ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(g): Stormwater Management Objectives

Sub-catchment G - Kyle Bay

A full set of values and priorities across the whole area is illustrated in **Figure 4.4** and summarised for this subcatchment in **Table 4.6**. Details of Kyle Bay Workshop results and area groupings can be sited in **Appendix B.** The summarised values in **Table 4.6** form the basis for the following stormwater management objectives.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
Ecological Values		
G.01 - Maintenance and restoration of aquatic ecosystems in all catchment waterways as well as receiving waterways	❑ Retention of 80% of sediment average annual export rates. ❑ Retention of 60% of nitrogen and 20% of phosphorus average annual export rates. ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Limit the application, generation and migration of toxic substances to the maximum extent practicable ❑ Potential restoration sites assessed and restored where feasible ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Improve water quality in Kyle Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ❑ Restoration of natural waterways where feasible, particularly in Connells Point Reserve and Shipwrights Bay Reserve. ❑ Planning and policy controls endorse healthy catchments and waterways
G.02 - Protection and restoration of aquatic vegetation in all catchment waterways as well as receiving waterways	❑ Potential restoration sites assessed and restored where feasible ❑ Bank erosion along streams within Kyle Bay Catchment addressed ❑ Aquatic vegetation and physical habitat requirements within Kyle Bay Catchment are rehabilitated ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of natural waterways where feasible, particularly in Connells Point Reserve and Shipwrights Bay Reserve. ❑ Rehabilitation and protection of waterway habitats in Kyle Bay Catchment to enhance aquatic biodiversity ❑ Planning and policy controls endorse healthy catchments and waterways

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
G.03 - Protection and encouragement of aquatic wildlife in the catchment and receiving waterways	❑ Bank erosion along streams within Kyle Bay Catchment addressed ❑ Riparian vegetation within Kyle Bay Catchment is restored and rehabilitated ❑ An increased range of animals make use of the waterways and riparian zone ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of indigenous riparian vegetation of the bays, Connells Point Reserve and Shipwrights Bay Reserve ❑ Planning and policy controls endorse healthy catchments and waterways
Social Values		
G.04 - Improvement of the visual amenity of all waterways – to look natural in the absence of man-made structures/litter	❑ No visible litter for flows up to a 1 in 3 month storm event ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Visual amenity is restored in Kyle Bay Catchment waterways and bays ❑ Planning and policy controls endorse healthy catchments and waterways
G.05 - Primary contact recreation – create a safe, healthy waterway for swimming along the Georges River and bays	❑ Faecal coliforms entering Connells Bay and Kyle Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kyle Bay Catchment to the maximum extent practicable	❑ Water quality meets ANZECC guidelines for primary contact recreation in Connells Bay and Kyle Bay

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
G.06 - Secondary contact recreation – create a safe, healthy waterway for boating, canoeing, sailing etc along the Georges River and bays.	❑ Retention of 80% of sediment average annual export rates. ❑ Faecal coliforms entering Connells Bay and Kyle Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kyle Bay Catchment to the maximum extent practicable	❑ Water quality meets ANZECC guidelines for secondary contact recreation in Connells Bay and Kyle Bay
G.07 - Education – learn from the waterways for scientific and continuous improvement purposes in all areas.	❑ Effective local water quality monitoring programs operating ❑ Regional water quality monitoring programs are supported ❑ Involvement of schools, universities or other research organisations in stormwater monitoring programs ❑ Community have an increased awareness of stormwater issues ❑ Community members actively involved in stormwater management including monitoring ❑ Residents and commercial operators in Kyle Bay Catchment use Best Management Practices.	❑ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ❑ Local community understand stormwater issues and impacts of poor practices within Kyle Bay Catchment
G.08 - Human consumption of seafood – be able to consume seafood including fish crustaceans etc caught from the waterway	❑ Faecal coliforms in water leaving Kyle Bay Catchment are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kyle Bay Catchment to the maximum extent practicable	❑ Water quality for human consumption of seafood from Kyle Bay Catchment estuarine areas meets with ANZECC guidelines.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
G.09 - Access-maintain & improve controlled access to natural catchment and receiving waterways	❑ Access restricted in sensitive areas ❑ A plan to link a network of popular natural areas is established	❑ Kyle Bay Catchment natural areas are accessible
Economical Values		
G.10 - Off-stream water use (re-use of stormwater)	❑ Feasible stormwater re-use options are identified for Kyle Bay Catchment ❑ Environmental flows are given careful consideration, for potential use and re-use of stormwater	❑ Stormwater is used or reused without affecting natural flow regimes
Catchment Values		
G.11 - Urban bushland – preserve and maintain bushland areas	❑ Stormwater is not causing erosion within bushland ❑ Retention of 60% of nitrogen and 20% of Phosphorus average annual export rates to bushland. ❑ Weed dispersion from outlets reduced ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Bushland areas within Kyle Bay Catchment are not adversely affected by stormwater, particularly Kyle Williams Reserve ❑ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(h): Stormwater Management Objectives

Sub-catchment H - Kogarah Bay

A full set of values and priorities across the whole area is illustrated in **Figure 4.4** and summarised for this subcatchment in **Table 4.6**. Details of Kogarah Bay Workshop results and area groupings can be sited in **Appendix B.** The summarised values in **Table 4.6** form the basis for the following stormwater management objectives.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
Ecological Values		
H.01 - Maintenance and restoration of aquatic ecosystems in all catchment waterways as well as receiving waterways	❑ Retention of 80% of sediment average annual export rates. ❑ Retention of 60% of nitrogen and 20% of phosphorus average annual export rates. ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Limit the application, generation and migration of toxic substances to the maximum extent practicable ❑ Potential restoration sites assessed and restored where feasible ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Improve water quality in Kogarah Bay Catchment waterways to meet requirements for protection of aquatic ecosystems ❑ Restoration of natural waterways where feasible, particularly in Carss Park and Beverley Park. ❑ Planning and policy controls endorse healthy catchments and waterways
H.02 - Protection and restoration of aquatic vegetation in all catchment waterways as well as receiving waterways	❑ Potential restoration sites assessed and restored where feasible ❑ Bank erosion along streams within Kogarah Bay Catchment addressed ❑ Aquatic vegetation and physical habitat requirements within Kogarah Bay Catchment are rehabilitated ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of natural waterways where feasible, particularly in Connells Point Reserve and Shipwrights Bay Reserve. ❑ Rehabilitation and protection of waterway habitats in Kogarah Bay Catchment to enhance aquatic biodiversity ❑ Planning and policy controls endorse healthy catchments and waterways

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
H.03 - Protection and encouragement of aquatic wildlife in the catchment and receiving waterways	❑ Bank erosion along streams within Kogarah Bay Catchment addressed ❑ Riparian vegetation within Kogarah Bay Catchment is restored and rehabilitated ❑ An increased range of animals make use of the waterways and riparian zone ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Restoration of indigenous riparian vegetation of Kogarah Bay and Carss Park ❑ Planning and policy controls endorse healthy catchments and waterways
Social Values		
H.04 - Improvement of the visual amenity of all waterways – to look natural in the absence of man-made structures/litter	❑ No visible litter for flows up to a 1 in 3 month storm event ❑ No visible oils and grease for flows up to a 1 in 3 month storm event ❑ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Visual amenity is restored in Kogarah Bay Catchment waterways and bays ❑ Planning and policy controls endorse healthy catchments and waterways
H.05 - Primary contact recreation – create a safe, healthy waterway for swimming along the Georges River and bays	❑ Faecal coliforms entering Kogarah Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kogarah Bay Catchment to the maximum extent practicable	❑ Water quality meets ANZECC guidelines for primary contact recreation in Kogarah Bay

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
H.06 - Secondary contact recreation – create a safe, healthy waterway for boating, canoeing, sailing etc along the Georges River and bays.	❑ Retention of 80% of sediment average annual export rates. ❑ Faecal coliforms entering Kogarah Bay are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kogarah Bay Catchment to the maximum extent practicable	❑ Water quality meets ANZECC guidelines for secondary contact recreation in Kogarah Bay
H.07 - Education – learn from the waterways for scientific and continuous improvement purposes in all areas.	❑ Effective local water quality monitoring programs operating ❑ Regional water quality monitoring programs are supported ❑ Involvement of schools, universities or other research organisations in stormwater monitoring programs ❑ Community have an increased awareness of stormwater issues ❑ Community members actively involved in stormwater management including monitoring ❑ Residents and commercial operators in Kogarah Bay Catchment use Best Management Practices.	❑ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ❑ Local community understand stormwater issues and impacts of poor practices within Kogarah Bay Catchment
H.08 - Human consumption of seafood – be able to consume seafood including fish crustaceans etc caught from the waterway	❑ Faecal coliforms in water leaving Kogarah Bay Catchment are reduced by the maximum extent possible ❑ Limit the application, generation and migration of toxic substances in Kogarah Bay Catchment to the maximum extent practicable	❑ Water quality for human consumption of seafood from Kogarah Bay Catchment estuarine areas meets with ANZECC guidelines.

Waterway Value	Stormwater Management Objectives	
	Short term (< 3 years)	**Long term**
H.09 - Access-maintain & improve controlled access to natural catchment and receiving waterways	❑ Access restricted in sensitive areas ❑ A plan to link a network of popular natural areas is established	❑ Kyle Bay Catchment natural areas are accessible
Economical Values		
H.10 - Off-stream water use (re-use of stormwater)	❑ Feasible stormwater re-use options are identified for Kogarah Bay Catchment ❑ Environmental flows are given careful consideration, for potential use and re-use of stormwater	❑ Stormwater is used or reused without affecting natural flow regimes, particularly for Beverley Park Golf course
Catchment Values		
H.11 - Urban bushland – preserve and maintain bushland areas	❑ Stormwater is not causing erosion within bushland ❑ Retention of 60% of nitrogen and 20% of Phosphorus average annual export rates to bushland. ❑ Weed dispersion from outlets reduced ❑ Integration of the natural into the built environment is to the maximum extent practicable	❑ Bushland areas within Kogarah Bay Catchment are not adversely affected by stormwater, particularly Carss Park ❑ Planning and policy controls endorse healthy catchments and waterways

Table 5.2(i): Stormwater Management Objectives

Sub-catchment J - Scarborough Ponds/Sans Souci

Note: the overall area value assigned to Scarborough Ponds is Very High, while the Georges River and Botany Bay Foreshore have an overall area value of High. This needs to be considered in stormwater management in each of the areas, with particularly high priority given to Scarborough Ponds.

Waterway Value	Stormwater Management Objectives	
	Short Term (<3years)	Long Term
Ecological Values		
J.01 - Maintenance and restoration of aquatic ecosystems in all Catchment Waterways as well as Receiving Waterways Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Limit the application, generation and migration of toxic substances to the maximum extent practicable ☐ Potential restoration sites assessed and restored where feasible ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Improve water quality in Scarborough Ponds/Sans Souci Catchment waterways to meet requirements for protection of aquatic ecosystems ☐ Restoration of natural waterways where feasible.. ☐ Planning and policy controls endorse healthy catchments and waterways
J.02 - Protection and restoration of aquatic vegetation in all Catchment Waterways as well as Receiving Waterways. Priority: High	☐ Short-term treatment objectives to be achieved for all parameters listed in **Table 5.1**. ☐ Potential restoration sites assessed and restored where feasible ☐ Bank erosion along streams within Scarborough Ponds/Sans Souci Catchment addressed ☐ Aquatic vegetation and physical habitat requirements within Scarborough Ponds/Sans Souci Catchment are rehabilitated ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of aquatic vegetation where feasible ☐ Rehabilitation and protection of aquatic vegetation in Scarborough Ponds/Sans Souci Catchment to enhance aquatic biodiversity ☐ Planning and policy controls endorse healthy catchments and waterways

J.03 - Protection and encouragement of aquatic wildlife in the Catchment and Receiving Waterways. Priority: High	☐ Short-term treatment objectives for all parameters listed in **Table 5.1** to be achieved ☐ Bank erosion along streams within Scarborough Ponds/Sans Souci Catchment addressed ☐ Riparian vegetation within Scarborough Ponds/Sans Souci Catchment is restored and rehabilitated ☐ An increased range of animals make use of the waterways and riparian zone ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Restoration of indigenous riparian vegetation of Scarborough Ponds/Sans Souci Catchment ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Table 5.2(i): Stormwater Management Objectives (cont'd)
Sub-catchment J - Scarborough Ponds/Sans Souci

Waterway Value	Stormwater Management Objectives	
	Short Term (<3 years)	Long Term
Social Values		
J.04 - Improved visual amenity of all waterways - to look natural in the absence of man-made structures/litter Priority: High	☐ As above for J.01 - J.03 plus: ☐ No visible litter for flows up to a 1 in 3 month storm event ☐ No visible oils and grease for flows up to a 1 in 3 month storm event ☐ Redevelopments meet standards set that increase imperviousness and improve water quality leaving the site ☐ Integration of the natural into the built environment is to the maximum extent practicable	☐ As above for J.01 -J.03 plus: ☐ Visual amenity is restored in Scarborough Ponds/Sans Souci Catchment waterways and bays ☐ Planning and policy controls endorse healthy catchments and waterways
J.05 - Primary Contact Recreation - create a safe, healthy waterway for swimming along the Georges River and Botanty Bay Foreshores. Priority: High (Foreshores)	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Scarborough Ponds/Sans Souci are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Scarborough Ponds/Sans Souci Catchment to the maximum extent practicable	☐ Long-term treatment objectives to be achieved for all parameters listed in **Table 5.1** ☐ Water quality meets ANZECC guidelines for primary recreation in the Scarborough Ponds/Sans Souci.
J.06 - Secondary Contact Recreation Priority: High (Foreshores),	☐ Faecal coliforms entering Scarborough Ponds/Sans Souci are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Scarborough Ponds/Sans Souci Catchment to the maximum extent practicable	☐ Waterways are safe and accessible for secondary contact recreation
J.07 - Education - learn from the waterways for scientific and continuous improvement purposes in all areas. Priority: High (Foreshores & Scarborough Ponds), Medium (S.S. Drain 2), Low (S.S. Drain 1)	☐ Effective local water quality monitoring programs operating ☐ Regional water quality monitoring programs are supported ☐ Involvement of schools, universities or other research organisations in stormwater monitoring programs ☐ Community have an increased awareness of stormwater issues ☐ Community members actively involved in stormwater management including monitoring ☐ Residents and commercial operators in Scarborough Ponds/Sans Souci Catchment use Best Management Practices.	☐ An effective monitoring and performance system using environmental indicators that assists education and review of the measures taken ☐ Local community understand stormwater issues and impacts of poor practices within Scarborough Ponds/Sans Souci Catchment
J.08 - Human Consumption of Seafood - be able to consume seafood including fish, crustaceans etc. caught from the waterways Priority: High (Foreshores only)	☐ Short-term treatment objectives to be achieved for parameters listed in **Table 5.1** ☐ Faecal coliforms entering Scarborough Ponds/Sans Souci are reduced by the maximum extent possible ☐ Limit the application, generation and migration of toxic substances in Scarborough Ponds/Sans Souci Catchment to the maximum extent practicable	☐ Water quality for human consumption of seafood from waterways of the Scarborough Ponds/Sans Souci Catchment meets with ANZECC guidelines.
J.09 - Access Priority: High	☐ Access restricted in sensitive areas ☐ A plan to link a network of popular natural areas is established	☐ Scarborough Ponds/Sans Souci Catchment natural areas are accessible
Catchment Values		

J.11 - Urban Bushland Priority: Medium (Scarborough Ponds), Low (Sans Souci Drains 1, 2 & 3)		☐ Bushland areas within Scarborough Ponds/Sans Souci Catchment are not adversely affected by stormwater ☐ Planning and policy controls endorse healthy catchments and waterways

Note: shaded areas represent there being no stormwater management objectives due to the priority of the Waterway Value being < High

Contents

6. Stormwater Management Issues

The NSW EPA have defined stormwater management issues to be:

> *" those factors that currently prevent, or may prevent, stormwater management objectives from being satisfied." (NSW EPA,1997a)*

These issues may be:

- Environmental;
- Social; and/or
- Managerial.

Stormwater issues associated with each subcatchment were identified from the Community Workshops, discussions with Council officers, and from existing documentation. In addition, specific "hot spots" within the study area were identified through catchment inspections.

"Hot spots" are known locations within the catchment which affect stormwater quality or are affected by stormwater. It is important to target these specific issues in the SMP as their remediation or prevention will have a direct and noticeable effect on the catchment and stormwater quality.

Stormwater issues and "hot spots" for each waterway are given in the tables on the following pages. Possible causes or "pressures" associated with each are also given. Issues and causes are grouped according to each council LGA area within the study area and were identified by Council staff as well as a brief site visit with Sinclair Knight Merz.

Table numbers are as follows:

- **Table 6.1** - Issues and Causes in Sutherland Shire Council Catchment Areas
- **Table 6.2** - Issues and Causes in Hurstville Council Catchment Areas
- **Table 6.3** - Issues and Causes in Kogarah Municipal Council Catchment Areas
- **Table 6.4** - Issues and Causes in Rockdale City Council Catchment Areas

Managerial

The tables mentioned above, and presented on the following pages, illustrate specific issues/locations which have been identified as hot-spots which are obvious to the eye. Many issues, however, stem from managerial practice in industry, commercial as well as social/residential areas.

Managerial issues, in terms of stormwater “hot-spots”, can be thought of as poor practices and tend to be non-point source and therefore difficult to include on a map. Rather they are more wide-spread and historically and culturally in-grained into the way things are carried out in society. Poor practices will generally require things such as education and enforcement to change them to good practises.

Poor practices that have been identified as part of this study are listed below:

- Cleaners tipping washing waters in the stormwater gutter;
- Painters/residents cleaning brushes into the drainage system;
- Daily hosing out of factories into the stormwater system;
- Illegal disposal of wash-up water from resaurants and fast food outlets;
- Tipping out cooking oil into the drainage system (down the sink included);
- Concrete contractors, both large and small, washing barrows/mixers into the stormwater drainage system;
- Exposed aggregate concrete being blasted free of mortar which falls on the ground to be carried into the stormwater system in the next rain event;
- Service stations degreasing car parts into grated stormwater drains;
- Spray painters washing sanded car bodies off into the stormwater drainage system;
- Construction sites with out adequate erosion and sedimentation devices in place;
- Recyclable rubbish collection days - materials being blown around the streets;
- Dogs and cats - especially people walking dogs and not picking up droppings;
- Carpet cleaning contractors disposing of dirty effluent into the stormwater gutter.

Upstream Sub-catchment SMP’s

One issue which has perhaps the highest impact on water quality in the Lower Georges River are environmental flows from upstream in the Georges River, particularly those influenced by stormwater.

This issue cannot be dealt with in detail in this SMP, however, it is important that each SMP prepared within the Georges River Catchment be assessed upon completion relative to each other. This will facilitate effective long-term stormwater management strategies implemented at the local sub-catchment level which complement neighbouring sub-catchments and fit into an overall Georges River Catchment framework.

It is recommended that the Georges River Catchment Management Committee facilitate the above process as part of the implementation of the stormwater management plan.

Table 6.1: Issues and Causes in Sutherland Shire Council Catchment Areas

Issues and Possible Causes/Pressures	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.1 **Reference Number
EROSION OF WATERCOURSES AND SEDIMENT DEPOSITION	A-J.01, 02 & 09	☐ Horse stables within Towra Point Nature Reserve	☐ Horse hooves disturb catchment land surface and make it susceptible to being eroded during stormwater flows	SS01
		☐ Sand-mining operations - sediment deposition	☐ sedimentation downstream of sand-mining operation caused by particulates suspended in surface runoff	SS07
Possibly caused by: ☐ Removal of riparian vegetation		☐ Calsil Brickworks - sediment depostion	☐ sediment from truck movements in/out of site as well as runoff with suspended particulates from site	SS08
☐ Increased flood flows and stormwater velocity as a result of development.		☐ General industries which involve Materials Handling Depots and Plants such as Concrete Batching Plants, Council Depots, Construction Sites etc.	☐ insufficient bunding of materials storage areas and no protection from stormwater runoff from sites entering the stormwater system	SS12
☐ Construction sites and material depots upstream which are not protected.		☐ Concrete lined drain downstream of North Caringbah Residential area - sedimentation	☐ upstream erosion within the residential area, possibly contributed to by residential development sites, creating sedimention issue in downstream stormwater drain	SS13
☐ Un-controlled access in sensitive areas		☐ directly upstream and downstream of Port Hacking Rd in Gwawley Ck.	☐ bank exposed causing continuing erosion preventing riparian vegetation establishing	SS16
		☐ downstream of Gwawley Ck just upstream of Sylvannia Waters - erosion/sedimentation	☐ bank erosion and sedimentation of upstream eroded material	SS18
		☐ Gwawley Wetlands - upstream of Belgrave Esplanade/Goulbourn Peninsula and the end of Box Rd - erosion and sedimentation	☐ local bank erosion and sedimentation of upstream eroded material	SS19

		☐ upstream of Bates Drive in Oyster Ck - erosion and sedimentation	☐ local bank erosion and sedimentation of upstream eroded material - just recently drredged	SS22

#Numbering system refers to **Table 5.2**.

** Reference Numbers refer to locations illustrated on the figure following this set of tables. Note that reference numbers on the figure may contain a suffix “a, b, c or d”. Each suffix may refer to the same hot-spot in a slightly different location or a set of suffix’s may refer to an area over which the hot-spot applies.

Table 6.1: Issues and Causes in Sutherland Shire Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.1 **Reference Number
LITTER IN WATERCOURSE Possibly caused by: ☐ Lack of awareness of residents of impact of littering on environment, where the litter goes and how much litter is generated. ☐ General littering (commercial, roads etc) ☐ Inappropriate rubbish bin use ☐ More frequent cleaning of garbage bins, gully pits required.	A-J.01-04	☐ Concrete lined drain downstream of North Carinbah Residential area - litter and sediment	☐ upstream erosion and litter within the residential area, possibly contributed to by residential development sites, creating litter issue in downstream stormwater drain	SS13
		☐ downstream of Gwawley Ck just upstream of Sylvannia Waters - litter	☐ litter deposited from upstream and also local shops	SS18
POLLUTION DISCHARGES Possibly caused by: ☐ Discharge from industrial areas within the catchment . No inventory of types of pollutants in discharge ☐ Lack of awareness in industry of impacts of discharges on environment	A-J.01-06, 08, 09 & 10	☐ Possible oil discharge from Oil Refinery Jetty in Botany Bay – to be investigated	☐ underwater connection for direct oil transfers from sea to land	SS02
		☐ Aircraft un-spent fuel fall-out.	☐ diffuse source from flight paths	SS03
		☐ Possible discharge of chemicals from Caltex Refinery into downstream stormwater drains	☐ point source - likely to be from surface runoff as well as possibly bulk discharges.	SS05
		☐ Possible discharge of chemicals from AGL plant on Kurnell Peninsula – to be investigated		SS06
		☐ Possible discharge of chemicals from Cronulla STP – to be investigated	☐ likely to be from surface runoff as well as possibly bulk discharges from spills	SS10
		☐ Major Roads throughout Sutherland including Princes Hwy, Taren Point Rd, Port Hacking Rd and Captain Cook Drive - diffuse pollution discharge which ends up in surface runoff.		SS14
		☐ Railways in Sutherland draining to the Lower Georges River Catchment - mainly the Illawarra Line	☐ oil, chemical discharges along the line	SS15

		☐ stormwater drain adjacent Flower Power on Taren Point Rd - stagnant water with dense surface film of algae - possible chemical discharges	☐ chemical/pesticide application and runoff from both stormwater and daily water applications	SS20
		☐ Major Carparks in Shopping Centres, commuter carparks etc.	☐ **Oil and grease**	

#Numbering system refers to **Table 5.2**.

** Reference Numbers refer to locations illustrated on the figure following this set of tables. Note that reference numbers on the figure may contain a suffix “a, b, c or d”. Each suffix may refer to the same hot-spot in a slightly different location or a set of suffix’s may refer to an area over which the hot-spot applies.

Table 6.1: Issues and Causes in Sutherland Shire Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.1 **Reference Number
ELEVATED LEVELS OF FAECAL BACTERIA, PARTICULARLY DURING WET WEATHER EVENTS Possibly caused by: ☐ Sewer overflows ☐ Animal faeces Illegal connections to stormwater network	A-J.01-11	☐ Major sewer overflows		SS17
		☐ Animal faeces from Horse Stables within Towra Point Nature Reserve		SS01
DEGRADED AQUATIC AND RIPARIAN HABITATS Possibly caused by: ☐ Modified streamflow regime ☐ Removal of riparian vegetation and introduction of exotic species ☐ Weed growth ☐ Erosion and sediment deposition ☐ Introduction of exotic fish species (eg. carp)	A-J.01-04, 07, 08, 11	☐ directly upstream and downstream of Port Hacking Rd in Gwawley Ck.	☐ bank exposed causing continuing erosion preventing riparian vegetation establishing	SS16
		☐ Gwawley Wetlands - upstream of Belgrave Esplanade/Goulbourn Peninsula and the end of Box Rd	☐ local back erosion preventing riparian vegetation establishment	SS19
		☐ stormwater drain adjacent Flower Power on Taren Point Rd - stagnant water with dense surface film of algae	☐ fertiliser application and runoff from both stormwater and daily water applications	SS20
ELEVATED NUTRIENT CONCENTRATIONS Possibly caused by: ☐ Discharge from industrial areas ☐ Excess fertiliser use in parks, gardens, golf courses and residential areas ☐ Washing of cars in streets ☐ Sewer overflows	A-J.01-06 & 08	☐ Horse stables within Towra Point Nature Reserve	☐ Fertiliser use in Sefton Golf Course	SS01
		☐ Possible discharge of nutrients from Cronulla STP	☐ likely to be from surface runoff as well as possibly bulk discharges from spills	SS10
		☐ Major sewer overflows		SS17
		☐ stormwater drain adjacent Flower Power on Taren Point Rd - stagnant water with dense surface film of algae	☐ fertiliser application and runoff from both stormwater and daily water applications	SS20

#Numbering system refers to **Table 5.2**.

** Reference Numbers refer to locations illustrated on the figure following this set of tables. Note that reference numbers on the figure may contain a suffix "a, b, c or d". Each suffix may refer to the same hot-spot in a slightly different location or a set of suffix's may refer to an area over which the hot-spot applies.

Table 6.1: Issues and Causes in Sutherland Shire Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.1 **Reference Number
POOR VISUAL QUALITY Possibly due to: ☐ Degraded natural channels ☐ Open concrete lined channels ☐ Gross pollutants visible ☐ Graffiti on concrete channels/culverts	A-J.04	☐ Bulk litter dumped on roads throughout outer Kurnell Peninsula	☐ residential litter dumping	SS04
		☐ Drains downstream of Caltex Refinery - surface films, algae blooms	☐ oil discharge	SS05
		☐ Drains downstream of Calsil Brick Works	☐ concrete/lime discharge	SS08
		☐ Drains downstream of Carbon Black International	☐ carbon particulate discharge which settles in the area and is transported by stormwater flows ☐ also carbon particle fall out during transportation of product	SS09
		☐ General Industrial discharges throughout industrial area		SS12
		☐ Concrete lined drain downstream of North Carinbah Residential area - sedimentation and litter	☐ upstream erosion within the residential area, possibly contributed to by residential development sites, creating unsightly issue in downstream stormwater drain	SS13
		☐ directly upstream and downstream of Port Hacking Rd in Gwawley Ck - erosion and sedimentation	☐ bank exposed causing continuing erosion preventing riparian vegetation establishing - also sedimentation of upstream eroded material within the channel	SS16
		☐ stormwater drain adjacent Flower Power on Taren Point Rd - stagnant water with dense surface film of algae	☐ fertiliser application and runoff from both stormwater and daily water applications	SS20
ACCESS	A-J.01-09 & 11	☐ Little access throughout Towra Point Nature Reserve - to improve this in a controlled manner is desired.		SS21

WEED GROWTH Possibly due to: ☐ Elevated nutrient levels in runoff and soils ☐ Concentrated stormwater runoff through urban bushland areas as a result of urban development	A-J.01-04, 08 & 11	☐ Bitou Bush throughout Kurnell Peninsula, particularly in the sand dunes where is was reportedly planted in the past to stabilise the dunes.		SS11

#Numbering system refers to Table 5.2.
** Reference Numbers refer to locations illustrated on the figure following this set of tables. Note that reference numbers on the figure may contain a suffix "a, b, c or d". Each suffix may refer to the same hot-spot in a slightly different location or a set of suffix's may refer to an area over which the hot-spot applies.

Table 6.2: Issues and Causes in Hurstville Council Catchment Areas

Issues and Possible Causes/Pressures	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.2 **Reference Number
EROSION OF WATERCOURSES AND SEDIMENT DEPOSITION	A-J.01, 02 & 09	☐ General industry which involves materials handling depots and plants including Council Depots, Golf Course Green Keeping, Construction Sites, Concrete Batching Plants etc. - erosion and sedimentation	☐ lack of bunding of materials storage areas and downstream protection to prevent suspended sediment entering the stormwater system in a storm	HC01
		☐ sedimentation transport from residential construction sites and other areas which involve handling of materials	☐ diffuse source	HC06
Possibly caused by: ☐ Removal of riparian vegetation		☐ gross pollutant transport from existing bank stabilisation methods - also bank erosion	☐ loose application of bark chips along banks to provide mulch is easily washed away in a storm event	HC07
☐ Increased flood flows and stormwater velocity as a result of development.		☐ erosion and sedimentation of stream banks	☐ downstream of test gabion structure installed in un-named creek	HC09
☐ Construction sites and material depots upstream which are not protected.		☐ banks of the Georges River - erosion	☐ as a result of water skiing	HC10
☐ Un-controlled access in sensitive areas				

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Table 6.2: Issues and Causes in Hurstville Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.2 **Reference Number
LITTER IN WATERCOURSE Possibly caused by: ☐ Lack of awareness of residents of impact of littering on environment, where the litter goes and how much litter is generated. ☐ General littering (commercial, roads etc) ☐ Inappropriate rubbish bin use ☐ More frequent cleaning of garbage bins, gully pits and litter booms required.	A-J.01-04	☐ litter from commercial areas - specific area inspected was downstream of Mulga Rd in the Gungah Wetlands	☐ particularly shopping bags	HC05
POLLUTION DISCHARGES Possibly caused by: ☐ Discharge from industrial areas within the catchment . No inventory of types of pollutants in discharge ☐ Lack of awareness in industry of impacts of discharges on environment	A-J.01-06, 08, 09 & 10	☐ general industry discharges	☐ mainly small industry but over a large area	HC03
		☐ leachate from landfills - particularly Boggywell Ck and Hurstville G.C.	☐ ingress of leachate into broken stormwater pipes buried up to 7 m beneath the surface	HC04
		☐ gross pollutants from commercial areas - specific area inspected was downstream of Mulga Rd in the Gungah Wetlands	☐ particularly shopping bags	HC05
		☐ gross pollutants (mainly sediment) from residential construction sites and other areas which involve handling of materials	☐ diffuse source	HC06
		☐ bank erosion downstream of the Hurstville G.C. stormwater pipe discharge within the mangroves	☐ erosion of sediment has removed essential habitat for some mangroves which have as a result died	HC08

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Table 6.2: Issues and Causes in Hurstville Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.2 **Reference Number
ELEVATED LEVELS OF FAECAL BACTERIA, PARTICULARLY DURING WET WEATHER EVENTS Possibly caused by: ☐ Sewer overflows ☐ Animal faeces	A-J.01-11	☐ Major sewer overflows - in particular just upstream of the Hurstville G.C. in the main drain downstream of the industrial area.		HC02
DEGRADED AQUATIC AND RIPARIAN HABITATS Possibly caused by: ☐ Modified streamflow regime ☐ Removal of riparian vegetation and introduction of exotic species ☐ Weed growth ☐ Erosion and sediment deposition ☐ Introduction of exotic fish species (eg. carp)	A-J.01-04, 07, 08, 11	☐ upstream of Hurstville G.C. in main drain downstream of the industrial area - degraded aquatic habitat - water running black on inspection during dry weather flow.	☐ pollution from industrial area	HC03
		☐ bank erosion and ineffective bank stabilisation techniques in un-named creek flowing into Lime Kiln Bay	☐ erosion of banks which prevents riparian vegetation establishment ☐ bark chips currently used to mulch/stabilise the banks is easily washed away and degrades aquatic habitat	HC07, HC09
		☐ bank erosion downstream of the Hurstville G.C. stormwater pipe discharge within the mangroves	☐ erosion of sediment has removed essential habitat for some mangroves which have as a result died	HC08
ELEVATED NUTRIENT CONCENTRATIONS Possibly caused by: ☐ Discharge from industrial areas ☐ Excess fertiliser use in parks, gardens, golf courses and residential areas	A-J.01-06 & 08	☐ Major sewer overflows - in particular just upstream of the Hurstville G.C. in the main drain downstream of the industrial area.		HC02
		☐ leachate ingress into stormwater drainage pipes through landfill areas including Boggywell Ck and Hurstville G.C. is likely to result in major nutrient loads into the receiving waters, particularly since the pipes are likely to be broken due to subsidence.	☐ leachate ingress into broken pipes is likely to increase nutrient discharge into receiving waters	HC08
		☐ bark chips washed from stream banks during storm events are likely to add to nutrient load	☐ loose application of stream bank stabilisation measures is ineffective	HC07

☐ Washing of cars in streets ☐ Sewer overflows				

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Table 6.2: Issues and Causes in Hurstville Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.2 **Reference Number
POOR VISUAL QUALITY	A-J.04	☐ industrial discharges downstream of industrial area has resulted in black water and significant reduction in aquatic habitat	☐ poor source pollution control throughout the industrial estate ☐ includes chemical and gross pollutants	HC03
Possibly due to: ☐ Degraded natural channels		☐ litter in receiving waterways - in particular the Gungah Bay Wetlands which are downstream of the Oatley Centre shops.	☐ commercial areas contribute shopping bags and other packaging materials	HC05
☐ Open concrete lined channels ☐ Gross pollutants visible Graffiti on concrete channels/culverts		☐ bank erosion throughout the natural streams in Hurstville		HC09, HC07, HC08
EDUCATION ☐ in the community	All values	☐ there is reportedly a general apathy in the community towards stormwater management - this needs to reversed by effective education/advertising campaigns		-

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Kogarah Municipal Council Catchment Areas

Including sub-catchments F, G and H

Table 6.3: Issues and Causes in Kogarah Municipal Council Catchment Areas

Issues and Possible Causes/Pressures	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.3 **Reference Number
EROSION OF WATERCOURSES AND SEDIMENT DEPOSITION	A-J.01, 02 & 09	☐ Major construction works - in particular Sydney Water works currently taking place at the top of Moore Reserve on a major pipe diversion - erosion and sedimentation	☐ major source of sediment during storm ☐ large areas of exposed fill not protected from erosion during construction ☐ large drain entering the middle of the construction site not diverted around exposed fill material	KC02
		☐ Sydney Water drain discharging to Kogarah Bay at Carss Park - major transporter of sediment from diffuse sources	☐ concentrated sediment in discharge from diffuse upstream sources	KC08
Possibly caused by: ☐ Removal of riparian vegetation		☐ Construction sites throughout the area - diffuse source of sediment pollution	☐ ineffective protection on construction sites to prevent erosion and sediment transport off-site	KC11
☐ Increased flood flows and stormwater velocity as a result of development.		☐ Materials Handling depots and plants including Council Depot, Concrete Batching Plants etc - diffuse source of sediment pollution - in particular there is currently a large fill storage site at the top of Poulton Park which is possible in the creek line without any form of protection against sediment transport downstream (KC04)	☐ ineffective or no protection against sediment transport off-site	KC11, KC04
☐ Construction sites and material depots upstream which are not protected.		☐ Oatley Pleasure Grounds	☐ end of stormwater pipe discharging on, and before, beach causing bank erosion	KC13
☐ Un-controlled access in sensitive areas		☐ Creeks in Moore Reserve with unstable banks and poor vegetative cover		
		☐ Creeks in Poulton Reserve with unstable banks and poor vegetative cover		
		☐ Topsoil from residential housing as well as soil from beneath houses during storm events.		
		☐ Stormwater outlets to bushland.		
		☐ Old and poor conditioned pipes.		

		☐ Outlets located on beach or mudflats.		

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Table 6.3: Issues and Causes in Kogarah Municipal Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.3 **Reference Number
LITTER IN WATERCOURSE Possibly caused by: ☐ Lack of awareness of residents of impact of littering on environment, where the litter goes and how much litter is generated. ☐ Lack of awareness of industry stormwater impacts or relaxed enforcement ☐ General littering (commercial, roads etc) ☐ Inappropriate rubbish bin use ☐ More frequent cleaning of garbage bins, gully pits and litter booms required.	A-J.01-04	☐ Commercial and Industrial areas		KC07
		☐ School yards and routes to and from school.		
POLLUTION DISCHARGES Possibly caused by: ☐ Discharge from industrial areas within the catchment . No inventory of types of pollutants in discharge ☐ Lack of awareness in industry of impacts of discharges on environment	A-J.01-06, 08, 09 & 10	☐ Illawarra Rail Line - in particular the rail works yard - The yards appear to have a good pollution control management system currently in-place but it is a potential source of pollution (eg. oil, cleaning substances, etc.)	☐ on-site spills and deposited substances reaching stormwater system during storm events	KC01
		☐ Moore Reserve, Poulton Park and Beverly Park land-fill - ingress of leachate into major stormwater drains which are likely to be cracked due to subsidence	☐ leachate from land-fill may contain chemical pollutants ☐ these drains flow directly into Oatley Bay	KC03, KC05, KC10
		☐ Princes Highway - petroleum substances deposited on roads go directly into the stormwater system during storm events (King Georges Rd is also a major thoroughfare which would contribute significant pollution)	☐ petroleum substances deposited over time directly enter the stormwater system during storm events ☐ spills may also occur which would impact on stormwater water quality	KC06
		☐ general industrial estate discharges, including petroleum substances as well as fine metal filings and associated chemical pollutants	☐ storage areas are not properly bunded to prevent pollutants entering the stormwater system	KC07
		☐ Sydney Water drain running from industrial estate into Kogarah Bay at Carss Park - transportation of general industry pollution and other sources including roads	☐ transportation of pollution into Kogarah Bay	KC08, KC07

		☐ Beverley Park Golf Course	☐ Herbicide use near natural and constructed drainage lines	
		☐ Corrosion of metal building materials	☐	

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Table 6.3: Issues and Causes in Kogarah Municipal Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.3 **Reference Number
ELEVATED LEVELS OF FAECAL BACTERIA, PARTICULARLY DURING WET WEATHER EVENTS Possibly caused by: ☐ Sewer overflows ☐ Animal faeces	A-J.01-11	☐ Major Sewer Overflows and damaged sewer lines (there is a major pipe at the end of West Crescent which has sewage flowing into it)	☐ Diffuse source of Faecal Coliform pollution throughout the area ☐ land subsidence causing cracking in pipes	KC12
		☐ Open Space areas where dog walking is frequented - there are current measures in place to reduce this source through the use of dog litter bins	☐ diffuse source of Faecal Coliform pollution throughout open space areas. Infiltration would leach into cracked stormwater pipes and subsequently into receiving water bays downstream	KC03, KC05, KC10
		☐ Illegal sewer connections		
DEGRADED AQUATIC AND RIPARIAN HABITATS Possibly caused by: ☐ Modified streamflow regime ☐ Removal of riparian vegetation and introduction of exotic species ☐ Weed growth ☐ Erosion and sediment deposition ☐ Introduction of exotic fish species (eg. carp)	A-J.01-04, 07, 08, 11	☐ Downstream of land fill areas such as Moore Reserve, Poulton Park, Carss Park and Beverly Park - mainly wetland areas with sensitive stands of mangroves	☐ leachate ingress into major upstream stormwater drains discharging into the areas	KC03, KC05, KC10, KC09
		☐ Creeks in Moore Reserve with unstable banks and poor vegetative cover	☐ vegetation kill-off herbicide sprays on banks ☐ insufficient topsoil for vegetation to establish	
		☐ Creeks in Poulton Park with unstable banks and poor vegetative cover	☐ vegetation kill-off herbicide sprays on banks ☐ insufficient topsoil for vegetation to establish	
		☐ Poor river foreshore vegetation	☐ vegetation kill-off herbicide sprays on banks ☐ insufficient topsoil for vegetation to establish	
ELEVATED NUTRIENT CONCENTRATIONS Possibly caused by: ☐ Discharge from industrial areas ☐ Excess fertiliser use in parks, gardens, golf courses and residential areas	A-J.01-06 & 08	☐ Major stormwater drains discharging at the downstream end of land-fill sites such as Moore Reserve, Poulton Park, Carss Park and Beverly Park	☐ cracked drains as a result of subsidence allows ingress of leachate from landfill	KC03, KC05, KC09, KC10
		☐ Sewer overflows	☐	
		☐ Beverley Park Golf Course	☐ Fertilisers	

☐ Washing of cars in streets ☐ Sewer overflows		☐ Park Gardens	☐ Fertilisers ☐ Vegetation cutting waste	

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Table 6.3: Issues and Causes in Kogarah Municipal Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.3 **Reference Number
POOR VISUAL QUALITY	A-J.04	☐ Areas affected by sedimentation due to poor upstream erosion control measures	☐ including: Oatley Bay as a result of sedimentation from Sydney Water activities at the top of Moore Reserve; Oatley Bay as a result of storage of large fill quantities in the creek line at the top of Poulton Park; & Kogarah Bay as a result of major sediment transport into the Bay from diffuse upstream sources	KC02, KC04, KC11, KC07, KC08, KC09, KC10
Possibly due to: ☐ Degraded natural channels		☐ Stormwater outlets located on beach or mudflats	☐ erosion and scouring or beach	
☐ Open concrete lined channels ☐ Gross pollutants visible Graffiti on concrete channels/culverts		☐ Stormwater outlets to bushland	☐ erosion and scouring	
ACCESS	A-J.01-09 & 11			
WEED GROWTH Possibly due to: ☐ Elevated nutrient levels in runoff and soils ☐ Concentrated stormwater runoff through urban bushland areas as a result of urban development	A-J.01-04, 08 & 11	☐ Stormwater outlets to bushland	☐ erosion and scouring	

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Rockdale City Council Catchment Areas

Including sub-catchment J

Table 6.4: Issues and Causes in Rockdale City Council Catchment Areas

Issues and Possible Causes/Pressures	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.4 **Reference Number
EROSION OF WATERCOURSES AND SEDIMENT DEPOSITION	A-J.01, 02 & 09	☐ Along sections of the Sans Souci Drains No.s 1, 2 & 3 which are not concrete-lined there is significant erosion of banks	☐ high velocity flows from concrete-lined channels entering an un-lined section of the channel, often of completely different shape with no transition zone, causes turbulence and subsequent erosion and sediment transportation downstream	RC01, RC02, RC03, RC04, RC05
Possibly caused by: ☐ Removal of riparian vegetation ☐ Increased flood flows and stormwater velocity as a result of development. ☐ Construction sites and material depots upstream which are not protected. ☐ Un-controlled access in sensitive areas		☐ Horse stables/yards adjacent the Sans Souci Drain No.2	☐ horse hooves disturb the ground surface and allow erosion to occur during storm events. Since the yards are on the drain line, sediment enters directly into the stormwater system	RC03, RC04
		☐ Industrial drain downstream of Production Avenue	☐ dumping of construction materials	RC09

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Table 6.4: Issues and Causes in Rockdale City Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.4 **Reference Number
LITTER IN WATERCOURSE Possibly caused by: ☐ Lack of awareness of residents of impact of littering on environment, where the litter goes and how much litter is generated. ☐ General littering (commercial, roads etc) ☐ Inappropriate rubbish bin use ☐ More frequent cleaning of garbage bins, gully pits and litter booms required.	A-J.01-04	☐ Open lined drain in little reserve (Sans Souci Drain No.1) - often polluted with litter	☐ upstream commercial areas - particularly along Rocky Point Road where there are numerous fast food outlets	RC03
		☐ Sans Souci Drain No.2 - downstream of Ramsgate Shopping area		RC06, RC07
POLLUTION DISCHARGES Possibly caused by: ☐ Discharge from industrial areas within the catchment . No inventory of types of pollutants in discharge ☐ Lack of awareness in industry of impacts of discharges on environment	A-J.01-06, 08, 09 & 10	☐ Industrial area drain which runs into Scarborough Ponds from Production Avenue	☐ chemical pollution entering the stormwater system from spills or deposition of chemicals on the ground which are picked up in storm events	RC09, RC10, RC11
		☐ Market Gdns off Marshall St - discharges into Scarbourough Ponds north of Barton St.	☐ potential source of pesticides and other related chemical which may be used in the market garden	RC14
		☐ Landfill sites - leachate entering stormwater drains - particularly near Production Avenue	☐ leachate may include chemical pollutants	RC15
		☐ Major Roads - including President Ave & Rocky Point Road	☐ diffuse source of petroleum substances throughout the area entering the stormwater system which drains directly to Lady Robinsons Beach, Scarborough Ponds and Sans Souci Drain No.1.	RC13, RC16, RC12

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Table 6.4: Issues and Causes in Rockdale City Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.4 **Reference Number
ELEVATED LEVELS OF FAECAL BACTERIA, PARTICULARLY DURING WET WEATHER EVENTS Possibly caused by: ☐ Sewer overflows ☐ Animal faeces	A-J.01-11	☐ Sans Souci Drain No.2 - as a result of horse yards adjacent the drain	☐ horse manure	RC06, RC04, RC03, RC02
DEGRADED AQUATIC AND RIPARIAN HABITATS Possibly caused by: ☐ Modified streamflow regime ☐ Removal of riparian vegetation and introduction of exotic species ☐ Weed growth ☐ Erosion and sediment deposition ☐ Introduction of exotic fish species (eg. carp)	A-J.01-04, 07, 08, 11	☐ Sans Souci Drains No.s 1, 2 & 3 - particularly the discharge point of No.2 into the Georges River	☐ as a result of high levels of nutrients and sediment deposition	RC01 - 06
		☐ Industrial drains discharging into Scarborough Ponds - decrease aquatic habitat quality	☐ as a result of high levels of pollutants and nutrients including landfill leachate	RC09 - 11
		☐ Drains from major roads entering Scarborough Ponds, Lady Robinsons Beach and Sans Souci Drain No.1 - decrease aquatic habitat quality in receiving waters	☐ as a result of high levels of pollutants, namely petroleum substances	RC13, RC16
ELEVATED NUTRIENT CONCENTRATIONS Possibly caused by: ☐ Discharge from industrial areas ☐ Excess fertiliser use in parks, gardens, golf courses and residential areas ☐ Washing of cars in streets ☐ Sewer overflows	A-J.01-06 & 08	☐ Industrial drain discharging into Scarborough Ponds downstream of Production Ave - leachate from old land-fill site	☐ nutrients from land-fill leachate	RC15, RC09
		☐ Market Gdns stormwater runoff	☐ fertilisers	RC14
		☐ All Sans Souci Drains No. 1-3 appear to have elevated levels of nutrients based on appearance, colour and odour - in particular Drain No. 2 due to the presence of horse yards along its banks	☐ horse yards ☐ stagnation of low lying stretches of the drains	RC01 - 06
		☐ Major Sewer Overflows		RC17

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Table 6.4: Issues and Causes in Rockdale City Council Catchment Areas (cont'd)

Issues and Possible Causes	Corresponding Values and Objectives#	"Hot Spots"	Possible Additional Causes Specific to the "Hot Spots"	Figure 6.4 **Reference Number
POOR VISUAL QUALITY	A-J.04	☐ All Sans Souci Drains No.s 1-3	☐ erosion ☐ stagnant pools of water ☐ sedimentation ☐ also high odours as a result of high nutrients, stagnation and algae blooms ☐ nutrients from horses	RC01 - 06
Possibly due to: ☐ Degraded natural channels ☐ Open concrete lined channels Gross pollutants visible Graffiti on concrete channels/culverts		☐ Litter in open drains - Sans Souci Drain No.s 1-3 - and on the Lady Robinsons Beach	☐ litter from commercial areas, particularly fast food outlets	RC01 - 08
ACCESS	A-J.01-09 & 11	☐ Access along open drains needs to be controlled to reduce littering ☐ Access to Scarborough Ponds for Secondary Contact Recreation not desired	☐ adolescents with fast food wrappers frequent these areas ☐ motorised boats may harm aquatic life in the system	RC01 - 06 RC10

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Contents

7. Potential Stormwater Management Options

Stormwater management options are of two general types, structural and non-structural, and are described in more detail below.

7.1 Non-structural Options

Non-structural options include:

- educational measures (eg. advertising, school curriculum etc);
- planning controls (eg. Council policies and strategies etc);
- studies and assessments; and
- others.

7.1.1 Educational Measures

Education and participation are critical to long term stormwater management throughout the catchment. The full range of target audiences needs to be identified and provided with appropriate information. This audience includes residents, businesses, developers, community groups, environmental groups, schools, youth groups and media. The most effective long term method is to modify behaviour by educating people at an early age (CDM, 1993). This can be undertaken through the inclusion of stormwater issues as part of the school curriculum, beginning at primary school. Tours of the local waterways, inspection of litter collected in gross pollutant traps and participation in revegetation works associated with the waterways can be included as an interactive part of the curriculum.

An education plan should be based on the following objectives:

- Promote a clear identification and understanding of the problem and the solutions. Part of this understanding involves increasing public awareness of how their behaviour affects the health of the whole catchment;
- Identify responsibilities and efforts to date;
- Promote community ownership of the problems and the solutions; and
- Integrate public feedback into the education program.

(CDM, 1993)

Educational programs covering a variety of environmental issues have been tested and implemented throughout NSW by agencies such as NSW Environment Protection Authority, Local Councils, Department of Land and Water Conservation and Catchment Management Trusts and Committees. These programs could be adapted and used to target stormwater within the Lower Georges River catchment.

Where possible, council education programs should be integrated with any existing agency programs (e.g. schools streamwatch, stencils, SIA etc) which cover the same area to avoid unnecessary duplication and potential confusion within the community.

A proportion of people within the Lower Georges River catchment are from culturally and linguistically diverse backgrounds. It is important to target these people in any education plan developed for the catchment. The NSW EPA is targeting different cultural backgrounds in their 'Solutions to Pollution' campaign and the Stormwater Trust's Education Campaign (e.g. multi-lingual signs, pamphlets in individual languages of ethnic grps etc). Councils in their local education programs can use materials prepared by these campaigns.

7.1.2 Land Use Planning

Land use planning is important for ensuring a long term approach to the minimisation of pollutants in stormwater runoff. Council policies and guidelines can be used to ensure that land use practices do not result in increased pollution of receiving waters, by integrating water quality concerns into the development and redevelopment process. This can be through land zonings, which influence the type of land use activity in an area. It can also be through Development Control Plans and Development Application and Building Application consent requirements, which can be used to regulate design and incorporate water quality improvements through treatment measures and improved construction standards.

Refer to **Section 3** for a description of Council's existing policies and practices in relation to stormwater management.

7.2 Structural Options

Structural options, amongst other things such as targeted educational programs etc. are beneficial for targeting known "hot-spot" locations within the catchment. These solutions typically address the immediate, and often visible, issue as opposed to addressing the source of the problem. For example, there may be a location within the creek at which there is regularly significant amounts of litter. A structural measure such as a gross pollutant trap (GPT) can be installed to collect the litter before it enters the waterway. This has an immediate effect on removing litter from the creek however, the source of the problem is the people who are not disposing the litter

in the proper manner. The GPT does not target the source of the problem

Many structural options are available for addressing the various stormwater issues. A list of different types of structural options is given in the EPA "Draft Managing Urban Stormwater: Treatment Techniques", 1997. They include:

- litter traps - eg. litter baskets, litter booms, gross pollutant traps;
- sediment traps;
- constructed stormwater wetlands;
- bank stabilisation - eg. vegetation planting, grass lining, rock walls, reno mattresses, concrete;
- vegetation planting;
- sand filters; and
- others.

7.3 Potential Stormwater Management Options

A list of overall potential stormwater management options was developed in conjunction with Council and stakeholders based on numerous sources including the draft EPA Managing Urban Stormwater: Council Handbook (1997), CDM (1993) California Storm Water Best Management Practice Handbooks, Sustainable Water Best Practices prepared by Hornsby Shire Council (1997) and other miscellaneous publications such as Riverwise leaflets published by DLWC. These options are presented in **Table 7.1** and categorised according to general issues as identified by the EPA in the Managing Urban Stormwater handbook.

Table 7.1: List of General Potential Stormwater Management Options

Issue	Ref	Category*	Management Tool
Water Quality	1.01	NS	Education Material
	1.02	NS	Planning controls – Land capability assessment – Levy's – New and redevelopment DCPs – Incentives to implement structural and management SMO's – Dept. of Housing "Blue Book" to be adopted throughout the catchment in each of the 4 Council's planning policies – push for Source Control options Ref: Georges River REP Gazetted on 5 February
	1.03	NS	Maximum % of impervious surfaces - reduction of existing impervious areas and incentives to reduce existing impervious areas
	1.04	NS	Water-sensitive urban design

Issue	Ref	Category*	Management Tool
	1.05	NS/S	Retaining Existing Open Watercourses
	1.06	S	Control sewer overflows
	1.07	S	Label stormwater pits
	1.08	S	Erect signs along creeks, lakes, estuaries, etc.
	1.09	S	Provide facilities for disposal of oils and harmful chemicals
	1.10	NS	Conduct regular catchment audits, concentrating on commercial/industrial areas
	1.11	S	Undertake regular maintenance of stormwater treatment measures
	1.12	NS	Eliminate illegal sewer connections to stormwater systems
	1.13	NS	Assessment of the water quality impacts of new urban developments at the land us planning stage (eg preparation of local environmental plans)
	1.14	NS/S	Acid Sulphate soil management - particularly in construction sites
	1.15	S	Erosion and sediment control - construction activities and industrial sites – stream bank stabilisation and rehabilitation – source controls at construction site (eg. silt fences, etc.)
	1.16	S	Litter baskets
	1.17	S	Litter racks
	1.18	S	Litter booms
	1.19	S	Sediment traps
	1.20	S	Gross pollutant traps
	1.21	S	Flocculation
	1.22	S	Catch Basins
	1.23	S	Water Quality inlets
	1.24	S	Buffer strips
	1.25	S	Grass swales
	1.26	S	Parking Lot Storage
	1.27	S	Porous Pavements
	1.28	S	Extended detention basins - refer to SPCC 1977 Report re: risks
	1.29	S	Constructed wetlands
	1.30	S	Triple Interceptors
	1.31	S	Coalescing plate interceptors
	1.32	S	Infiltration basins
	1.33	S	Infiltration trenches (eg incorporating ATLANTIS cells or other design)
	1.34	S	Sand filters – zeolite – compost
	1.3	S	Modular Paving

Issue	Ref	Category*	Management Tool
	5		
	1.36	S	Treatment of Runoff entering Bushland
	1.37	S	Rainwater Tanks
	1.38	S	Proprietary products
Water)	2.01	NS	Planning controls (delineate floodplains)
Quantity	2.02	NS	Purchase flood prone properties
(Stream-flow	2.03	S	Rainwater tanks
	2.04	S	Infiltration basins
	2.05	S	Infiltrate roof runoff
	2.06	S	Porous pavements
	2.07	S	Grass swales
	2.08	S	Retarding basins - wet detention basins
	2.09	S	Extended detention basins - dry detention basins
	2.10	NS/S	Retain urban watercourses (flow attenuation)
	2.11	S	On-site Stormwater Detention Systems
Water Re-	3.01	S	Irrigation Design Agriculture
use/ Saving	3.02	NS/S	Plant Selection
	3.03	S	Planting Technique
	3.04	S	Irrigation Design Open Space
	3.05	S	Irrigation Design Gardens
	3.06	S	Water Saving Devices
	3.07	S	Water Harvesting On Sites
	3.08	S	Rain Water Tanks
	3.09	S	Roof Gardens - turf so that nutrient uptake can be harvested when cut.
	3.10	S	Grey Water Re-use
	3.11	S	Effluent Re-use in Buildings
	3.12	S	Effluent Re-use for Irrigation
	3.13	S	Effluent Re-use for Industrial Applications
	3.14	S	ECOMAX Effluent Treatment System
	3.15	S	Dual Water Supply System
	3.16	S	On-site Infiltration Systems (eg incorporation of ATLANTIS cells)
	3.17	S	On-site Stormwater Detention Systems
Aquatic	4.01	NS/S	Preserve existing habitats
Habitats	4.02	NS	Planning controls (delineate riparian buffers)

Issue	Ref	Category*	Management Tool
	4.03	S	Reconstruct habitats
	4.04	S	Replanting
Riparian Vegetation	5.01	NS	Preserve existing vegetation
	5.02	NS	Planning controls (delineate riparian buffers)
	5.03	S	Replanting
Channel Erosion	6.01	S	Streamflow management
	6.02	S	Bank stabilisation and protection
	6.03	S	Riparian vegetation planting
Weed growth in bushland	7.01	S	Stormwater Quality management
	7.02	S	Plant indigenous vegetation
Other	8.01	NS	Safer Alternative Products
	8.02	NS	Vehicle use reduction
	8.03	NS	Vehicle leak and spill control
	8.04	NS/S	Illegal dumping control
	8.05	S	Stormwater Drain Flushing
	8.06	NS/S	Roadway/Bridge Maintenance
	8.07	NS/S	Water Qualtiy Monitoring
	8.08	NS	On-site management for industrial and commercial sites
	8.09	NS	Investigation into the type of chemicals produced and discharged by specific industries
	8.10	NS	Investigate sewer lines of private properties at conveyance stage
	8.11	NS	Common Water Quality Monitoring Programme Database - information sharing between Councils within the one catchment.

* NS - Non-structural; S - Structural; NS/S - both Structural and Non-structural elements

Stormwater management options for each Council subcatchment and the Lower Georges River catchment as a whole were subsequently selected from the list of general potential options. These were then further refined to address the specific issues, hot-spots, objectives and values of each area.

7.4 Overall Lower Georges River Stormwater Management Options

Many of the specific stormwater management options identified were common to all four Councils as well as other stormwater managers such as Sydney Water, RTA and RAC. These overall stormwater management options are presented in **Table 7.2** below.

Table 7.2 includes the following information:

- a description of the stormwater management action;
- the responsible parties for carrying out the action; and
- the target issue addressed by the action.

Table 7.2: Overall Lower Georges River Stormwater Management Options

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source - policies - enforcement	Sediments	All Councils, RTA, RAC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	All	All Councils, RTA, RAC	All
OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	All	All Councils, RTA, RAC	All
OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	Litter	All Councils, RTA, RAC	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	All	All Councils, RTA, RAC, EPA	All
OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	Heavy Metals	RTA	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16
OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	Bacteria	All Councils	SS01, SS17, HC02, HC03, KC12, KC03, KC05, KC10, RC02, RC03, RC04, RC06
OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	All	All Councils	All
OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning	Sediments	All Councils	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
	policies, DCPs catchment wide.			
OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	All	All Councils	All
OA11	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	Sediments	All Councils	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	Sediments	All Councils, RTA, RAC & Sydney Water	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	Sediments	All Councils, RTA	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	All	All Councils	All
OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Appropriate authority or industry body to provide facilities for disposal of oils and harmful chemicals and make known to industrial/ commercial managers and residents. Ref. Waste Services Authority - Incorporate into Hazardous Response Plan	Toxicants	All Councils	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16
OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	Oil & Grease	All Councils	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16
OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	Organic (Oxygen Demanding Substances)	All Councils	SS01, SS10, SS17, SS20, HC02, HC08, HC07, KC03, KC05, KC09, KC10, RC01-RC06, RC09, RC14, RC15, RC17
OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	Oil & Grease	RTA, All Councils	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16
OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans;	Toxicants	RTA, RAC, All Councils, EPA	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
	development of service agmnts for spill containment) - Incorporate into Hazardous Response Plan			
OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & report monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	Bacteria	Sydney Water, All Councils, EPA	SS01, SS17, HC02, HC03, KC12, KC03, KC05, KC10, RC02, RC03, RC04, RC06
OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	Bacteria	Sydney Water, All Councils	SS01, SS17, HC02, HC03, KC12, KC03, KC05, KC10, RC02, RC03, RC04, RC06
OA22	Investigate the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	Bacteria	Sydney Water	SS01, SS17, HC02, HC03, KC12, KC03, KC05, KC10, RC02, RC03, RC04, RC06
OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	All	All Councils	All
OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	All	All Councils	All
OA25	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	Nutrients	All Councils	SS01, SS10, SS17, SS20, HC02, HC08, HC07, KC03, KC05, KC09, KC10, RC01-RC06, RC09, RC14, RC15, RC17
OA26	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	All	All Councils	All
OA27	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	All	All Councils	All
OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river. Exercise regulations under the Clean Waters Act to require sewage holding tanks on pleasure craft boats to prevent direct sewage discharge into the LGR	Bacteria	All Councils	SS01, SS17, HC02, HC03, KC12, KC03, KC05, KC10, RC02, RC03, RC04, RC06

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	Nutrients	All Councils	SS01, SS10, SS17, SS20, HC02, HC08, HC07, KC03, KC05, KC09, KC10, RC01-RC06, RC09, RC14, RC15, RC17
OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	All	All Councils	All
OA31	Maintain bush walking tracks	Sediments	All Councils	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA32	LEFT BLANK INTENTIONALLY			
OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	All	All Councils	All
OA34	Raise awareness of penalties for a range of poor practices related to stormwater	All	All Councils	All
OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction etc.	All	All Councils	All
OA36	LEFT INTENTIONALLY BLANK			
OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	Organic (Leaf Litter etc)	All Councils	SS01, SS10, SS17, SS20, HC02, HC08, HC07, KC03, KC05, KC09, KC10, RC01-RC06, RC09, RC14, RC15, RC17
OA38	LEFT INTENTIONALLY BLANK	-	-	
OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	Sediments	All Councils	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	All	All Councils	All
OA41	Liaise with the RAC to develop stormwater management options specific to railways & facilities for construction, operation & maintenance activities, in particular RAC needs to develop its own SMP.	All	RAC, All Councils	All
OA42	Liaise with the RTA to develop stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	All	RTA, All Councils	All
OA43	LEFT INTENTIONALLY BLANK	-	-	
OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	All	All Councils	All
OA45	Waste Minimisation & Education Campaign at Rail Stations &	Litter	State Rail	SS13, SS18, HC05, KC07, RC03, RC06, RC07

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
	Corridor			
OA46	Encourage rainwater tanks and on-site detention for new and existing developments	Sediments	All Councils	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22, HC01, HC60, HC07, HC09, HC10, KC02, KC08, KC11, KC04, KC13, RC01-RC05, RC09
OA47	LEFT INTENTIONALLY BLANK	-	-	
OA48	Place passive signage in parks for litter.	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA49	Identify and educate pamphlet and local paper deliverers	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA50	Encourage cleanup days at schools and combine with education program	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA52	Provide "No junk mail" stickers	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA53	LEFT BLANK INTENTIONALLY			
OA54	Compile inventory of riparian and aquatic habitats and their state	All	All Councils	All
OA55	Develop a mangrove regeneration program	All	All Councils	All
OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	All	All Councils	All
OA57	Provide onsite updateable signage showing progress of bush regeneration	All	All Councils	All
OA58	Develop and implement maintenance programs for treatment devices	All	All Councils	All
OA59	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	All	All Councils	All
OA60	Produce a simplified stormwater management plan with educational components (make accessible)	All	All Councils	All
OA61	Develop methods to encourage wide community participation with stormwater management.	All	All Councils	All
OA62	Identify stormwater system gaps in drainage map and update.	All	All Councils	All
OA63	Measure and report effectiveness of options for all issues	All	All Councils	All
OA64	Develop litter management programs for recreational/park areas	Litter	All Councils	SS13, SS18, HC05, KC07, RC03, RC06, RC07
OA65	Provide updateable signage at various treatment devices showing statistics of what has been captured.	All	All Councils	All
OA66	Install GPTs for runoff from railway land	Oils & Grease	RAC	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility **	Targeted Hotspots***
OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	Toxicants	All Councils	SS18, SS03, SS05, SS06, SS10, SS14, SS15, SS20, HC03-HC06, HC08, KC01, KC03, KC05-KC07, KC10, RC09-RC16

* Target Issue assigned "All" means: litter, organic (both leaf litter and oxygen demanding substances), nutrients, sediments, bacteria, oil & grease, heavy metals and toxicants.
** RTA - Roads and Traffic Authority; RAC - Rail Access Corporation
*** refer to Tables 6.1 – 6.4 for locations of hot-spots.

7.5 Council LGA Specific Stormwater Management Options

The specific stormwater management options for Sutherland, Hurstville, Kogarah and Rockdale LGA's are presented below in **Table 7.3** to **Table 7.6** respectively.

Information included in the tables includes the following:

- a description of the stormwater management action;
- the responsible parties for carrying out the action; and
- the target issue addressed by the action.

Table 7.3: Sutherland LGA Specific Stormwater Management Options

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
SC01	GWAWLEY CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC02	GWAWLEY WETLANDS STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC03	OYSTER CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC04	Investigate the expected improvement in sedimentation reduction in waterways by installing a sediment trap(s) or GPT(s) downstream of the permanent industrial zones such as Taren Point and Kurnell.	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC05	Install sediment trap (& litter) GPT in drain feeding into Sylvania Waters at Box Road. Currently being designed.	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC06	Install trash rack or litter boom for Gwawley Ck upstream of Sylvania Waters. Also investigate origin of litter and look at point source controls.	Litter	SSC	SS13, SS18,
SC07	Install trash rack or litter boom in un-named creek/drain downstream of Caringbah Residential area (drains into Woolooware Bay). Also investigate origin of litter and look at point source controls.	Litter	SSC	SS13, SS18,
SC08	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits to be installed around the Miranda Shopping precinct as well as additional bins.	Litter	SSC	SS13, SS18,
SC09	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits could be installed around the fast food and shopping outlets along Kingsway/Princes Highway.	Litter	SSC	SS13, SS18,
SC10	INVESTIGATE AIRCRAFT FUEL/OIL FALL-OUT - Ascertain if it is a pollution source and move towards ways of mitigating if it is found to be.	Toxicants	SSC, FAC?	SS03
SC11	INVESTIGATE POLLUTION in stormwater run-off from industrial sites including the Cronulla STP, Caltex Oil Refinery, AGL, Abbotts, etc to ascertain if these sites are polluting SW and develop mitigation strategies on basis of results of investigation	Toxicants	SSC	SS02, SS03, SS05, SS06, SS10, SS14, SS15, SS20
SC12	Investigate the need for installing Constructed Wetlands (or other treatment) on Oyster Creek, Gwawley	All	SSC, Sydney Water	All

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
	Creek and other miscellaneous creeks where land availability permits to treat elevated bacteria and oxygen demanding organic matter in SW			
SC13	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. Ref. Overall LGR SMO "OA23"	All	SSC	All
SC14	Removal of weed species, particularly Bitou Bush upstream of the Towra Nature Reserve in Kurnell.	Organic (Oxygen Demanding Substances)	SSC	SS11
SC15	WORK WITH PRIVATE FERTILISER USERS - golf courses, nurseries (Flower Power in particular) - to identify ways in which nutrients could be reaching the waterways and how to prevent it and/or treat it.	Nutrients	SSC	SS01, SS10, SS17, SS20
SC16	INTRODUCE BUFFER STRIPS BETWEEN NUTRIENT SOURCES & WATERWAYS - nurseries, Horse Stables on Captain Cook Drive, Cronulla STP, and major sewer overflow locations (where possible).	Nutrients	SSC, /Sydney Water, RTA	SS01, SS10, SS17, SS20
SC17	PREVENT STREET RUBBISH DUMPING - particularly in Kurnell. Clean-up when ever possible.	All	SSC	All
SC18	MAINTENANCE OF GPT on Gwawley Ck, Box Road, Miranda	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC19	MAINTENANCE OF GPT located in Cronulla Golf Course, Hume Road, Cronulla	Litter	SSC	SS13, SS18,
SC20	MAINTENANCE OF GPT located in Cronulla Golf Course, Sturt Road, Cronulla	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC21	MAINTENANCE GPT IN RESOLUTION DRIVE at the intersection of Edeavour Rd (sth), Woolooware	Sediments	SSC, RTA	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC22	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC23	INSTALL TRASH RACK at Seymour Shaw Park, The Boulevarde, Miranda	Litter	SSC	SS13, SS18,
SC24	MAINTAIN SIR JOSEPH BANKS DRIVE, KURNELL - GPT	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC25	MAINTAIN ENDEAVOUR ROAD, CARINGBAH - GPT	Sediments	SSC, RTA	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22
SC26	MAINTAIN SCYLLA BAY - GPT	Sediments	SSC	SS01, SS07, SS08, SS12, SS13, SS16, SS18, SS19, SS22

* Target Issue assigned “All” means: litter, organic (both leaf litter and oxygen demanding substances), nutrients, sediments, bacteria, oil & grease, heavy metals and toxicants.
** RTA - Roads and Traffic Authority; RAC - Rail Access Corporation; SSC - Sutherland Shire Council
*** refer to Tables 6.1 – 6.4 for locations of hot-spots.

Table 7.4: Hurstville LGA Specific Stormwater Management Options

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
HC01	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek upstream of Lime Kiln Bay	Sediment	HC	HC07, HC09, HC10
HC02	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek downstream of Penshurst Industrial Area	Sediment	HC	HC07, HC09, HC10
HC03	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in the gully creek downstream of Brewer Place which flows into Boggywell Ck	Sediment	HC	HC07, HC09, HC10
HC04	Increase and implement an approvied street and stormwater pit cleaning program	Sediment	HC	HC01, HC06, HC07, HC09, HC10
HC05	INVESTIGATE THE INSTALLATION OF TRASH RACK OR GPT in un-named creek downstream of the Oatley Shopping area prior to the Gunga Bay wetlands to remove litter. Possible location is beneath Mulga Rd where the pipe(s) discharge into the wetlands.	Litter	HC/KMC/RAC	HC05
HC06	INSTALL BARAMY TRASH RACK (currently being considered by Council) in un-named creek as part of Lime Kiln Bay wetland development.	Litter	HC	HC05
HC07	Investigate the feasibility of installing Constructed Wetlands downstream of the major landfill areas (Boggywell Ck, Hurstville G.C.) to treat elevated bacteria and oxygen demanding organic matter in stormwater as well as sewer overflows.	All	HC	All
HC08	Install Constructed Wetlands upstream of Lime Kiln Bay in un-named creek - this will act as a back-up to Sydney Waters SOLP operation for reducing faecal, bacteria and nutrient load to the LGR.	All	HC	All
HC09	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. After Overall LGR SMO "OA23"	All	HC	All
HC10	CONDUCT FEASIBILITY STUDY FOR RE-ESTABLISHING HEALTHY RIPARIAN & AQUATIC HABITATS in Boggywell Ck drain, Hurstville G.C drain and the un-named creek upstream of Lime Kiln Bay where appropriate.	All	HC	All
HC11	Investigate the use of safer alternative products for bank stabilisation, particularly in the un-named creek upstream of Lime Kiln Bay where bark chips are currently being used.	Organics (Oxygen Demanding Substances)	HC	HC02, HC08, HC07
HC12	Investigate sources north of McRaes Res from Hurstville LGA	All	Hurstville Council	All

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
	and Railway land and provide appropiate treatment		/ RAC	
HC13	Investigate and provide treatment measures in the upper catchment north of Empress Res	All	KMC / Hurstville / RAC	All
HC14	Install litter control devices in Gannons Park (Boggywell Creek). With the trash rack poposed in the drain upstream of Lime Kiln Bay the litter load in this bay will be reduced significantly.	LItter	HC	HC05

* Target Issue assigned "All" means: litter, organic (both leaf litter and oxygen demanding substances), nutrients, sediments, bacteria, oil & grease, heavy metals and toxicants.
** RTA - Roads and Traffic Authority; RAC - Rail Access Corporation; HC - Hurstville Council; KMC - Kogarah Municipal Council
*** refer to Tables 6.1 – 6.4 for locations of hot-spots.

Table 7.5: Kogarah LGA Specific Stormwater Management Options

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
KC01	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from McRaes Res to open space area in northern end of Moore Reserve Catchment.	All	KMC	All
KC02	Investigate pipe source North West of Renown Park	All	KMC	All
KC03	Stencile drains in commercial areas and erect a catchment sign in McRaes Reserve, Arrowsmith and Grove Parks.	All	KMC	All
KC04	Investigate the possibility of recycling stormwater for the use of irrigation in Moore Reserve.	All	KMC	All
KC05	Assess the health of the existing wetland on the university grounds and monitor the runoff for potential pollutants	All	KMC	All
KC06	Maintain dog faeces disposal bins, including supply of bags for disposal.	Bacteria	KMC	KC12, KC03, KC05, KC10
KC07	Install GPTs with sediment bays for Moore Res catchment in Oatley Bay	Litter	KMC	KC07
KC08	Use Moore Reserve wetland as an educational opportunity on stormwater pollution	All	KMC	All
KC09	Place sediment basins at outlets to bushland for Oatley Bay catchment.	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC10	LEFT BLANK INTENTIONALLY			
KC11	Strategically Install litter baskets at pits within Oatley Bay catchment	Litter	KMC	KC07
KC12	Expand and improve sediment bay below Ada St*	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC13	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from Renown Park to McRaes Res.	All	KMC	All
KC14	Rehabilitate creeks in Moore Reserve	All	KMC	All
KC15	Introduce a constructed "natural creek" to replace the use of the western stormwater pipeline in Moore Reserve	All	KMC	All

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
KC16	Collect and treat leachate at the southern end of Moore Reserve	Toxicants	KMC	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC17	Construct a wetland in the northern part of Moore Reserve with upstream GPT.	All	KMC	All
KC18	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	All	Hurstville Council / RAC	All
KC19	Construct a wetland in the quarry site with upstream GPT to cater for litter, sediment and oil	All	KMC / RTA	All
KC20	Install GPTs/sediment bay for Poulton Park catchment	Litter	KMC / RTA	KC07
KC21	Place erosion controls that affect Poulton park catchment current landfill site	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC22	Investigate potential leachate in Poulton Park catchment	Toxicants	KMC	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC23	Introduce a constructed "natural creek" north of quarry site in passive area	All	KMC	All
KC24	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Bell Park, Eastern side of Hurstville Rd.	All	KMC / RTA	All
KC25	Construct a 'natural creek to replace foreshore pipe in Oatley Pleasure Grounds	All	KMC	All
KC26	Install GPTs/Sediment Bays outside Moore Reserve and Poulton Park catchments for Neverfail/Oatley Bay	Litter	KMC	KC07
KC27	Strategically install litter baskets at pits within the foreshore catchments	Litter	KMC	KC07
KC28	Install 'end of line' GPTs for Kogarah Bay Foreshore	Litter	KMC	KC07
KC29	Stencil drains in medium density residential, commercial and industrial areas, and erect a catchment sign in Jubilee Oval, Empress Reserve and Meade Park.	All	KMC	All
KC30	Install offline wetland with upstream GPT to treat sediment/oil/litter on western side of Beverley Park Golf Course. Investigate the possibility of diverting stormwater from Moore Park to place wetland further upstream.	All	KMC	All
KC31	Install trash rack with sediment trap in Moore Park	Litter	KMC	KC07
KC32	Install GPTs to collect oil/sediment/litter along the Princes Highway at the intersections of Battie Ave, Jubilee Ave and Harslett Cres.	Oils & Grease	KMC / RTA	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC33	Install GPTs affecting Beverley Park catchment	Litter	KMC	KC07
KC34	Investigate the use of a GPT that will not be affected by the tide in the South East side of Beverley Park	Litter	KMC	KC07
KC35	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in south east side of Beverley Park	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC36	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows	Sediments	KMC	KC02, KC08, KC11, KC04, KC13

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
	such as infiltration basins in Jubilee Oval			
KC37	Investigate the possibility of recycling stormwater for the use of irrigation on Beverley Park Golf Club	All	KMC	All
KC38	Install wetland in the south part of Carss Park with upstream GPT that treats oil/sediments/litter	All	KMC	All
KC39	Install wetland in the south part of Harold Frazer Reserve with upstream GPT that treats oil/sediments/litter	All	KMC / Sydney Water	All
KC40	Install 'end of line' GPT for outlets to the southern end of Sydney Water channel	Litter	KMC	KC07
KC41	Install GPTs for stormwater affecting Carss Park catchment	Litter	KMC	KC07
KC42	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Stuart Park, Meade Park and Empress Reserve	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC43	Investigate and provide treatment measures in the upper catchment north of Empress Res	All	KMC / Hurstville / RAC	All
KC44	Install an inline GPT for oil/sediment/litter in Grosvenor St Reserve	Oils & Grease	KMC / RTA	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC45	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from Harold Frazer Reserve to northern end of Wonora Rd School	All	KMC	All
KC46	Install GPT for oil/sediment/litter at the intersection of King Georges Rd and Blakesley Road	Oils & Grease	KMC / RTA	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC47	Install GPT/infiltration system in Augusta Street	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC48	Install GPT for oil/sediment in Todd Park	Oils & Grease	KMC / RTA	KC01, KC03, KC05, KC10, KC06, KC07, KC08
KC49	Strategically install litter baskets at pits within the Kyle Bay catchments	Litter	KMC	KC07
KC50	Install GPTs for stormwater affecting Connells Bay waterways	Litter	KMC	KC07
KC51	Investigate the potential for constructing a 'natural creek' in Connells Point Reserve.	All	KMC	All
KC52	Investigate the possibility of using a wet pond/infiltration facility for stormwater treatment of low flows such as infiltration basins in Merriman Reserve	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC53	Install GPTs and repair pipes for pipes discharging to Kyle Bay.	Litter	KMC	KC07
KC54	Install sediment basin for outlet in Kyle Williams Reserve	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
KC55	Install GPTs for stormwater that affects Shipwrights Bay	Litter	KMC	KC07
KC56	Rehabilitate creeks in Shipwrights Bay catchments, providing water way crossings where unsealed vehicle access crosses natural drainage lines	All	KMC	All
KC57	Divert small stormwater flow at northern end of Woodlands Ave to a sediment bay leading to the natural creek for prevention of erosion on the unsealed road and improvement of environmental flows.	Sediments	KMC	KC02, KC08, KC11, KC04, KC13

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
KC58	Introduce a constructed "natural creek" to replace the use of the stormwater pipeline behind tennis courts in Shipwrights Bay Reserve, install a GPT upstream.	All	KMC	All
KC59	Introduce a wet sediment basin in Shipwrights Bay Reserve	All	KMC	All
KC60	Educational program for medium density flats	Litter	KMC	KC07
KC61	Install GPT in Empress Reserve	Litter	KMC	KC07
KC62	Place sediment bays at outlets to bushland	Sediments	KMC	KC02, KC08, KC11, KC04, KC13
[KC63]	Install litter boom in Carss Park Sydney Water Channel	Litter	KMC, Sydney Water	KC07

* Target Issue assigned “All” means: litter, organic (both leaf litter and oxygen demanding substances), nutrients, sediments, bacteria, oil & grease, heavy metals and toxicants.
** RTA - Roads and Traffic Authority; RAC - Rail Access Corporation; HC - Hurstville Council; KMC - Kogarah Municipal Council
*** refer to Tables 6.1 – 6.4 for locations of hot-spots.

Table 7.6: Rockdale LGA Specific Stormwater Management Options

Ref. No.	Stormwater Management Action	Target Issue*	Responsibility	Targeted Hotspots***
RC01	STREAMFLOW MGT & ENHANCE AQUATIC & RIPARIAN HABITATS IN SANS SOUCI DRAIN NO.S 1-3 to minimise scouring in earth channels	Sediments	RCC	RC01-RC05, RC09
RC02	Create buffer strips between stormwater lines and horse stables such that sediment in water flowing from the stables is intercepted before reaching the waterways.	Nutrients	RCC	RC01-RC06, RC09, RC14, RC15, RC17
RC03	Install litter collection devices on all drains feeding into Scarborough Ponds	Litter	RCC	RC03, RC06, RC07
RC04	Point source collection of litter from major contributing areas such as the Ramgate Shopping area and fast food and shopping outlets along Rocky Point Road. (litter baskets)	Litter	RCC	RC03, RC06, RC07
RC05	Install trash rack or GPT in Sans Souci Drain No. 2 downstream of the Ramsgate Shopping area to remove litter.	Litter	RCC	RC03, RC06, RC07
RC06	Install trash rack or GPT in Sans Souci Drain No. 1 at Little Reserve downstream of the fast food/commercial areas on Rocky Point Road.	Litter	RCC	RC03, RC06, RC07
RC07	Install trash rack or GPT in Sans Souci Drain No. 3	Litter	RCC	RC03, RC06, RC07
RC08	Install Constructed Wetlands on Sans Souci Drain No.s 1-3 and upstream of Scarborough Ponds to treat elevated bacteria and oxygen demanding organic matter in stormwater. Note: concept plans have already been drawn up for Stan Moses Res in SS Drain No.2	All	RCC	All
RC09	Install litter and sediment collection traps, preferrably as close to the source as possible, to intercept litter and sediment prior to it reaching Lady Robinsons Beach.	Litter	RCC	RC03, RC06, RC07
RC10	Improve access along open drains to enhance safety	Litter	RCC	RC03, RC06, RC07
RC11	Enable secondary contact recreation access in Scarborough Ponds by ensuring safe points which are clearly identifiable and accessible. This will increase enjoyment and education benefited from the ponds.	Litter	RCC	RC03, RC06, RC07
RC12	BENCHMARK WATER QUALITY PROGRAM - Continue WQ monitoring program commenced in Dec 98 to establish benchmark WQ at 13 sites in Rockdale	All	RCC	All

* Target Issue assigned "All" means: litter, organic (both leaf litter and oxygen demanding substances), nutrients, sediments, bacteria, oil & grease, heavy metals and toxicants.
** RTA - Roads and Traffic Authority; RAC - Rail Access Corporation; RCC - Rockdale City Council
*** refer to Tables 6.1 – 6.4 for locations of hot-spots.

Contents

8. Evaluation and Analysis of Identified Stormwater Management Options

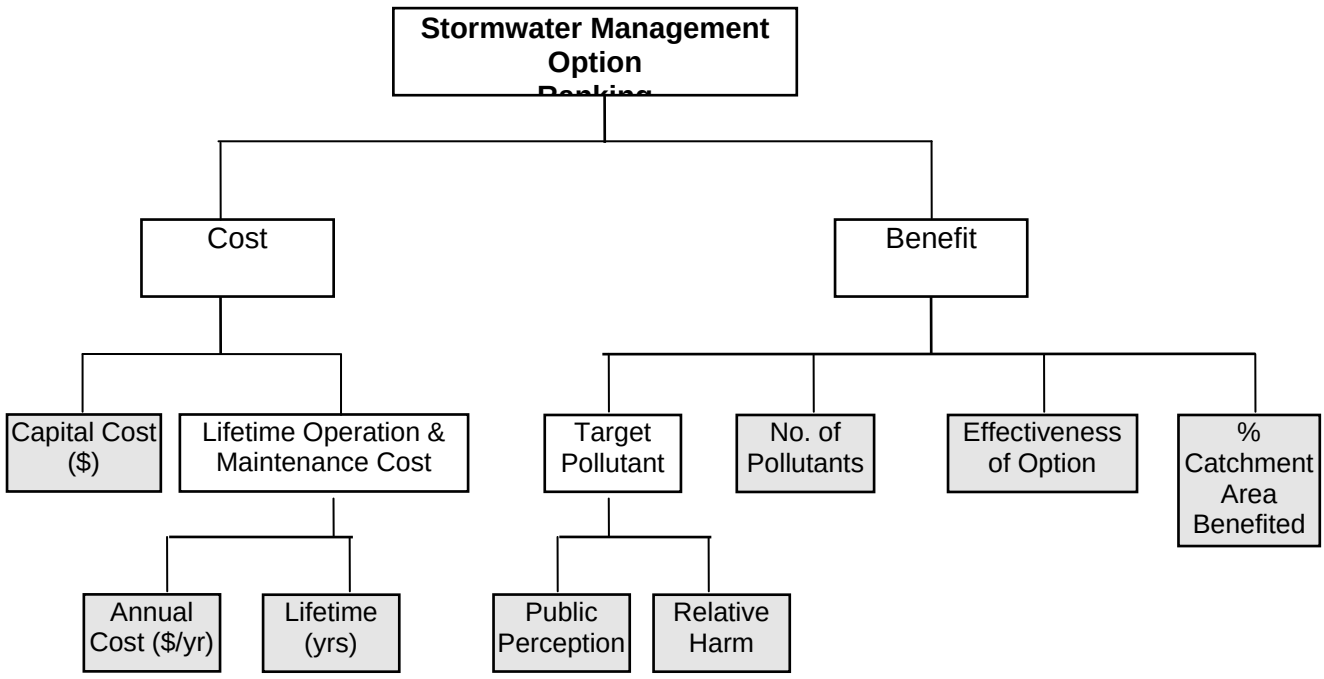
A large number of stormwater management options are identified in **Section 7**. It is difficult to directly compare these options given that the options provide different environmental and social benefits, have a large range of costs to be allocated over different time frames and vary between non-structural and structural solutions. However, it is important to prioritise the options to ensure that resources are allocated effectively.

The ranking methodology detailed below has been used to evaluate and rank the stormwater management options. This ranking methodology has been developed in coordination with Council and catchment stakeholders.

8.1 Ranking Methodology Overview

Each of the stormwater management options has been ranked by taking into consideration the costs and benefits associated with each option over a short term (3 year) time frame. **Figure 8.1** shows graphically the ranking factors considered in the analysis.

Figure 8.1: Overview of Criteria Used to Rank Stormwater Options



Note: shaded boxes represent factors for which values were assigned for the purposes of evaluation.

This methodology was based on the criteria given in the NSW EPA "Draft Stormwater Management Council Handbook", 1997, but has been modified

to improve the process for ranking the options within the Lower Georges River catchment, in coordination with Councils and relevant stakeholders. A description of each factor is provided in the following sections.

8.2 Costs

The estimated cost for each option is divided into two components: capital cost; and lifetime operation/maintenance cost. A score from 1 to 10 is assigned to each cost category. The greater the cost, the greater the score (linear relationship). Where costs fall within the lowest bracket of <$100,000 the score assigned is the actual cost as a fraction of $100,000. For example, if an option costs $55,000 the score would be 0.55, rather than 1.

The lifetime operation/maintenance cost score is designed to reflect in the ranking the lifetime liability to Council that a particular option may have. This is useful when considering two options, one with a longer life than the other. To score this cost, the annual cost is simply multiplied by the lifetime of the option. In the case of structural options the lifetime is generally assumed to be approximately 20 years. Other options, such as non-structural education programs, may have shorter lifetimes, in which case the lifetime maintenance cost can be expected to be much less.

The Cost Index (CI) for each option is calculated by taking the average of all the individual cost scores for each option.

Table 8.1 shows the ranking of costs. This ranking was developed with Councils and catchment stakeholders.

Table 8.1: Ranking of Costs

Capital Cost		Lifetime Operation/Maintenance Cost	
Estimated Cost ($)	**Score**	**Estimated Cost ($)**	**Score**
<100,000	expressed as a fraction of $100,000	<100,000	expressed as a fraction of $100,000
100,000 - 200,000	2	100,000 - 200,000	2
200,001 - 300,000	3	200,001 - 300,000	3
300,001 - 400,000	4	300,001 - 400,000	4
400,001 - 500,000	5	400,001 - 500,000	5
500,001 - 600,000	6	500,001 - 600,000	6
600,001 - 700,000	7	600,001 - 700,000	7
700,001 - 800,000	8	700,001 - 800,000	8
800,001 - 900,000	9	800,001 - 900,000	9
>900,001	10	>900,001	10

Where options require a Council officer's time, costs are estimated at $1,500 per week per officer.

8.3 Benefits

The Benefit Index (BI) for each option is calculated by taking the average of all the individual cost scores for each option.

The scores assigned to each benefit category used in the evaluation process are defined below:

- **Target Pollutant:** Scoring associated with the target pollutant removed by a stormwater option is regarded in two parts:
  - ***Public Perception*** - a score is assigned between 1 and 8, reflecting the extent to which the pollutant is perceived by the community to be a problem within the catchment. The pollutant considered to be the biggest problem is assigned the highest score. If all pollutants are removed by the option, it is given a score of 9.
  - ***Relative Harm*** - a score is assigned between 1 and 8, reflecting the relative harm the pollutant has in urban stormwater from a scientific perspective. Relative harm differs from public perception in that it represents "actual" harm rather than "perceived" harm of a particular pollutant. An option that removes all pollutants is assigned a score of 9, representing the maximum benefit.

  A number of target pollutants were identified in coordination with Councils and relevant stakeholders. These include:
  - Toxicants
  - Heavy Metals
  - Oil & Grease
  - Bacteria
  - Visual
  - Litter
  - Nutrients
  - Organic Matter - both leaf litter type and oxygen demanding substances
  - Sediments
  - All
- **No. of Pollutants:** The greater the number of pollutants targeted, the greater the score (linear relationship).
- **Relative Effectiveness of Option:** Scores differ between non-structural and structural options as follows:
  - ***Non-Structural*** - where the option is a non-structural solution, the effectiveness has been given as a qualitative value (ie High to Low). For instance, a non-structural option such as an education program in schools may be regarded to have a low-medium effectiveness. In this case, the score assigned would be 3. Should it be regarded to have a medium-high effectiveness, the score would be 8.
  - ***Structural*** - where the option is a structural solution, the effectiveness of the option is the efficiency with which the option is able to capture/remove the target pollutant. The greater the effectiveness of the option, the higher the score (linear relationship).
- **% Catchment Area Benefited:** A score from 1 to 10 is assigned to the percentage catchment area benefited by the option, *including both upstream and downstream* of where the option is installed. For

example, take a GPT installed in a shopping centre carpark with an area approximately 5% of the total catchment area. There is 5km of waterway downstream of the GPT and the total length of waterways in the catchment is 10km. It is known that the majority of litter originates from the shopping centre carpark targeted. Therefore, the % catchment area benefited score would not be merely 0.05, rather it would be more like 5 - 7 to reflect the fact that 50% of the waterway length would be benefited and most of the litter problem would be removed in addition to the 0.05% of the actual catchment area from which litter is collected. The greater the % catchment area, the higher the score (linear relationship).

Table 8.2 shows the ranking of the benefits. These were developed in coordination with Councils and stakeholders.

Table 8.2: Ranking of Benefits

Target Pollutant	Public Perception Score	Relative Harm* Score	No. Pollutants	Score	Effectiveness of Option (%)		Score	Catchment Area (%)	Score
					Structural	Non-Structural			
Litter	7	3	1	1	<10%	L	1	<10	1
Organic (Leaf Litter etc)	4	4	2	2	11-20		2	11-20	2
Organic (Oxygen Demanding Substances)	4	7	3	3	21-30	L-M	3	21-30	3
Nutrients	4	4	4	4	31-40		4	31-40	4
Sediments	7	5	5	5	41-50	M	5	41-50	5
Bacteria	6	5	6	6	51-60		6	51-60	6
Oil & Grease	6	6	7	7	61-70		7	61-70	7
Heavy Metals	4	7	8	8	71-80	M-H	8	71-80	8
Toxicants	6	8	9 (All)	9	81-90		9	81-90	9
All	9	9			91-100	H	10	91-100	10

A table was prepared for each of the overall stormwater management options and individual Council options to summarise the ranking data available for each of the factors as outlined above.

The cost and benefit data for the overall Lower Georges River catchment stormwater management options ranking is presented in **Table 8.3**.

The cost and benefit data for each of Sutherland, Hurstville, Kogarah and Rockdale LGA's stormwater management options ranking is presented in **Table 8.4 - Table 8.7** respectively.

Table 8.3: Overall Lower Georges River Catchment SMO Ranking Data

Ref. No.	Responsibility	Stormwater Management Action	Capital ($)	Annual Maint. Cost ($)	Lifetime yrs	Lifetime Maint. Cost ($)	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
OA01	All Councils, RTA, RAC	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	10,000	6,000	5	30,000	Sediments	3	M-H	90%
OA02	All Councils, RTA, RAC	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	20,000	3,000	5	15,000	All	9	M	80%
OA03	All Councils, RTA, RAC	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	20,000	6,000	5	30,000	All	9	M	80%
OA04	All Councils, RTA, RAC	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	5,000	3,000	5	15,000	Litter	1	M	50%
OA05	All Councils, RTA, RAC, EPA	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	20,000	12,000	5	60,000	All	9	M-H	40%
OA06	RTA	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	-	20,000	10	200,000	Heavy Metals	3	M	70%
OA07	All Councils	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	10,000	12,000	10	120,000	Bacteria	3	L-M	40%
OA08	All Councils	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	5,000	3,000	5	15,000	All	9	M	60%
OA09	All Councils	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	6,000	1,500	10	15,000	Sediments	2	M	60%
OA10	All Councils	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	12,000	3,000	10	30,000	All	9	M-H	30%
[OA11]	All Councils	REDUCTION OF % IMPERVIOUS AREA - investigate the expected	24,000	1,500	5	7,500	Sediments	2	M	50%

Ref. No.	Responsibility	Stormwater Management Action	Capital ($)	Annual Maint. Cost ($)	Lifetime yrs	Lifetime Maint. Cost ($)	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
		improvement in erosion reduction and sedimentation of waterways.								
OA12	All Councils, RTA, RAC & Sydney Water	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	12,000	20,000	5	100,000	Sediments	2	M	50%
OA13	All Councils, RTA	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	1,000,000	200,000	10	2,000,000	Sediments	4	H	70%
OA14	All Councils	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	12,000	1,500	5	7,500	All	9	M	30%
OA15	All Councils	HARMFUL SUBSTANCES DISPOSAL DEPOT - Appropriate authority or industry body to provide facilities for disposal of oils and harmful chemicals and make known to industrial/ commercial managers and residents. Ref. Waste Services Authority	12,000	10,000	10	100,000	Toxicants	5	M-H	40%
OA16	All Councils	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	6,000	3,000	3	9,000	Oil & Grease	5	M-H	40%
OA17	All Councils	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	400,000	40,000	5	200,000	Organic (Oxygen Demanding Substances)	6	H	60%
OA18	RTA, All Councils	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	300,000	30,000	10	300,000	Oil & Grease	6	H	70%
OA19	RTA, RAC, All Councils, EPA	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	5,000	1,500	5	7,500	Toxicants	3	M	40%
OA20	Sydney Water, All Councils, EPA	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	40,000	6,000	5	30,000	Bacteria	5	M-H	85%
OA21	Sydney Water,	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO	20,000	3,000	5	15,000	Bacteria	5	M-H	85%

Ref. No.	Responsibility	Stormwater Management Action	Capital ($)	Annual Maint. Cost ($)	Lifetime yrs	Lifetime Maint. Cost ($)	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
	All Councils	STORMWATER in coordination with Council								
OA22	Sydney Water	Investigate the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	50,000	10,000	2	20,000	Bacteria	5	M-H	85%
OA23	All Councils	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	40,000	4,000	2	8,000	All	9	L-M	15%
OA24	All Councils	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	10,000	3,000	5	15,000	All	9	L-M	15%
OA25	All Councils	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	12,000	2,500	5	12,500	Nutrients	1	M	70%
[OA26]	All Councils	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	10,000	3,000	3	9,000	All	9	M	50%
[OA27]	All Councils	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	80,000	10,000	3	30,000	All	9	H	90%
OA28	All Councils	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	10,000	1,500	5	7,500	Bacteria	2	H	60%
OA29	All Councils	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	10,000	2,000	10	20,000	Nutrients	5	M-H	5%
OA30	All Councils	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	6,000	1,500	10	15,000	All	9	H	60%
OA31	All Councils	Maintain bush walking tracks	30,000	2,000	20	40,000	Sediments	1	70%	10%
OA32	LEFT BLANK INTENTIONALLY									
OA33	All Councils	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	3,000	0	5	0	All	9	M-H	10%
OA34	All Councils	Raise awareness of penalties for a range of poor practices related to stormwater	3,000	0	1	0	All	9	M	50%
OA35	All Councils	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction	60,000	12,000	20	240,000	All	9	M-H	60%

Ref. No.	Responsibility	Stormwater Management Action	Capital ($)	Annual Maint. Cost ($)	Lifetime yrs	Lifetime Maint. Cost ($)	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
		and ...								
OA36	LEFT BLANK INTENTIONALLY									
OA37	All Councils	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	15,000	2,000	20	40,000	Organic (Leaf Litter etc)	3	M	40%
OA38	LEFT BLANK INTENTIONALLY		-	-	-	-	-	-	-	-
OA39	All Councils	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	15,000	15,000	20	300,000	Sediments	2	M	40%
OA40	All Councils	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	30,000	15,000	20	300,000	All	9	M	80%
[OA41]	RAC, All Councils	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	10,000	1,000	5	5,000	All	9	M	20%
[OA42]	RTA, All Councils	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	10,000	1,000	5	5,000	All	9	M	10%
OA43	LEFT BLANK INTENTIONALLY		-	-	-	-	-	-	-	-
OA44	All Councils	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	5,000	5,000	20	100,000	All	9	M	100%
OA45	State Rail	Waste Minimisation & Education Campaign at Rail Stations & Corridor	20,000	2,000	5	10,000	Litter	3	M	20%
OA46	All Councils	Encourage rainwater tanks and on-site detention for new and existing developments	5,000	1,000	20	20,000	Sediments	4	L-M	10%
OA47	LEFT BLANK INTENTIONALLY		-	-	-	-	-	-	-	-
OA48	All Councils	Place passive signage in parks for litter.	15,000	3,000	20	60,000	Litter	1	L-M	20%
OA49	All Councils	Identify and educate pamphlet and local paper deliverers	3,000	1,000	20	20,000	Litter	1	M	20%
OA50	All Councils	Encourage cleanup days at schools and combine with education program	3,000	1,000	20	20,000	Litter	1	M	10%
OA51	All Councils	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	5,000	1,000	20	20,000	Litter	1	M	10%
OA52	All Councils	Promote "No junk mail" stickers	5,000	1,000	5	5,000	Litter	1	L-M	20%
OA53	LEFT BLANK INTENTIONALLY									
OA54	All Councils	Compile inventory of riparian and aquatic habitats and their state	15,000	5,000	20	100,000	All	9	M	20%
OA55	All Councils	Develop a mangrove regeneration program	15,000	5,000	20	100,000	All	9	M	20%
OA56	All Councils	Develop a network of access routes with a map showing points of interest for	10,000	2,000	20	40,000	All	9	M	10%

Ref. No.	Responsibility	Stormwater Management Action	Capital ($)	Annual Maint. Cost ($)	Lifetime yrs	Lifetime Maint. Cost ($)	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
		community and providing educational and interpretational signage								
OA57	All Councils	Promote local bushcare groups and their progress	10,000	2,000	20	40,000	All	9	M	10%
OA58	All Councils	Develop and implement maintenance programs for treatment devices	15,000	5,000	20	100,000	All	9	M	30%
[OA59]	All Councils	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	10,000	5,000	20	100,000	All	9	M	10%
OA60	All Councils	Produce a simplified stormwater management plan with educational components (make accessible)	5,000	500	20	10,000	All	9	L-M	100%
OA61	All Councils	Develop methods to encourage wide community participation with stormwater management.	15,000	5,000	20	100,000	All	9	M	100%
OA62	All Councils	Identify stormwater system gaps in drainage map and update.	1,000	500	20	10,000	All	9	L-M	20%
OA63	All Councils	Measure and report effectiveness of options for all issues	5,000	500	20	10,000	All	9	M	100%
OA64	All Councils	Develop litter management programs for recreational/park areas	5,000	500	20	10,000	Litter	1	M-H	20%
OA65	All Councils	Provide updates of treatment device performance through various forms of media.	15,000	500	20	10,000	All	9	M	40%

OA66	RAC	Install GPTs for runoff from railway land	20,000	5,000	20	100,000	Oils & Grease	5	80%	20%
OA67	All Councils	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	10,000	3,000	3	9,000	Toxicants	3	M	75%

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

Table 8.4: Sutherland LGA SMO Ranking Data

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life time yrs	Lifetim e Maint. Cost	Target Pollutant	No. Pollutants	Effect ivene ss	% Catchm ent Benefit ed
SC01	SSC	GWAWLEY CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	100,000	1,000	20	20,000	Sedim ents	2	H	8%
SC02	SSC	GWAWLEY WETLANDS STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	50,000	5,000	5	25,000	Sedim ents	2	H	2%
SC03	SSC	OYSTER CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	100,000	10,00 0	5	50,000	Sedim ents	2	H	10%
[SC04]	SSC	Investigate the expected improvement in sedimentation reduction in waterways by installing a sediment trap(s) or GPT(s) downstream of the permanent industrial zones such as Taren Point and Kurnell.	60,000	5,000	2	10,000	Sedim ents	2	H	10%
SC05	SSC	Install sediment trap (& litter) GPT in drain feeding into Sylvania Waters at Box Road. Currently being designed.	100,000	7,000	20	140,00 0	Sedim ents	4	H	5%
SC06	SSC	Install trash rack or litter boom for Gwawley Ck upstream of Sylvania Waters. Also investigate origin of litter and look at point source controls.	20,000	2,000	10	20,000	Litter	4	H	5%
SC07	SSC	Install trash rack or litter boom in un-named creek/drain downstream of Caringbah Residential area (drains into Woolooware Bay). Also investigate origin of litter and look at point source controls.	20,000	2,000	15	30,000	Litter	4	H	8%
SC08	SSC	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits to be installed around the Miranda Shopping precinct as well as additional bins.	10,000	2,000	10	20,000	Litter	4	H	15%
SC09	SSC	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits could be installed around the fast food and shopping outlets along Kingsway/Princes Highway.	20,000	4,000	10	40,000	Litter	4	H	15%
[SC10]	SSC, FAC?	INVESTIGATE AIRCRAFT FUEL/OIL FALL-OUT - Ascertain if it is a pollution source and move towards ways of mitigating if it is found to be.	25,000	2,000	2	4,000	Toxica nts	2	M	20%
SC11	SSC	INVESTIGATE POLLUTION in stormwater run-off from industrial sites including the Cronulla STP, Caltex Oil Refinery, AGL, Abbotts, etc to ascertain if these sites are polluting SW and develop mitigation strategies on basis of	30,000	3,000	5	15,000	Toxica nts	3	M	10%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life time yrs	Lifetim e Maint. Cost	Target Pollutant	No. Pollutants	Effect ivene ss	% Catchm ent Benefit ed
		results of investigation								
[SC12]	SSC, Sydney Water	Investigate the need for installing Constructed Wetlands (or other treatment) on Oyster Creek, Gwawley Creek and other miscellaneous creeks where land availability permits to treat elevated bacteria and oxygen demanding organic matter in SW	40,000	4,000	2	8,000	All	9	H	20%
SC13	SSC	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. Ref. Overall LGR SMO "OA23"	10,000	1,500	5	7,500	All	9	M	20%
SC14	SSC	Removal of weed species, particularly Bitou Bush upstream of the Towra Nature Reserve in Kurnell.	40,000	3,000	3	9,000	Organic (Oxygen Demanding Substances)	3	L	10%
SC15	SSC	WORK WITH PRIVATE FERTILISER USERS - golf courses, nurseries (Flower Power in particular) - to identify ways in which nutrients could be reaching the waterways and how to prevent it and/or treat it.	15,000	6,000	3	18,000	Nutrients	4	M-H	10%
SC16	SSC, /Sydney Water, RTA	INTRODUCE BUFFER STRIPS BETWEEN NUTRIENT SOURCES & WATERWAYS - nurseries, Horse Stables on Captain Cook Drive, Cronulla STP, and major sewer overflow locations (where possible).	30,000	3,000	2	6,000	Nutrients	4	M	10%
SC17	SSC	PREVENT STREET RUBBISH DUMPING - particularly in Kurnell. Clean-up when ever possible.	30,000	3,000	5	15,000	All	9	L	5%
SC18	SSC	MAINTENANCE OF GPT on Gwawley Ck, Box Road, Miranda	-	8,000	20	160,000	Sediments	4	M-H	5%
SC19	SSC	MAINTENANCE OF GPT located in Cronulla Golf Course, Hume Road, Cronulla	-	6,000	20	120,000	Litter	5	M-H	3%
SC20	SSC	MAINTENANCE OF GPT located in Cronulla Golf Course, Sturt Road, Cronulla	-	5,000	20	100,000	Sediments	4	M-H	2%
SC21	SSC, RTA	MAINTENANCE GPT IN RESOLUTION DRIVE at the intersection of Edeavour Rd (sth), Woolooware	250,000	8,000	20	160,000	Sediments	4	M-H	3%
SC22	SSC	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	-	7,000	20	140,000	Sediments	4	M-H	2%
SC23	SSC	INSTALL TRASH RACK at Seymour Shaw Park, The Boulevarde, Miranda	70,000	3,000	20	60,000	Litter	2	M-H	2%
SC24	SSC	SIR JOSEPH BANKS DRIVE, KURNELL - GPT	42,000	7,000	20	140,000	Sediments	4	M	2%
SC25	SSC, RTA	ENDEAVOUR ROAD, CARINGBAH - GPT	63,000	8,000	20	160,000	Sediments	4	M	3%
SC26	SSC	SCYLLA BAY - GPT	116,000	7,000	20	140,000	Sediments	4	M	2%

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

Table 8.5: Hurstville LGA SMO Ranking Data

Ref. No.	Responsibility	Stormwater Management Action	Capital $	Annual Maint. Cost $	Lifetime yrs	Lifetime Maint. Cost $	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
HC01	HC	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek upstream of Lime Kiln Bay	150,000	15,000	3	45,000	Sediment	2	H	5%
HC02	HC	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek downstream of Penshurst Industrial Area	150,000	15,000	3	45,000	Sediment	2	H	5%
HC03	HC	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in the gully creek downstream of Brewer Place which flows into Boggywell Ck	50,000	5,000	3	15,000	Sediment	2	H	2%
HC04	HC	Increase and implement an approved street and stormwater pit cleaning program	-	370,000	10	3,700,000	Sediment	4	H	70%
[HC05]	HC/KMC/RAC	INVESTIGATE THE INSTALLATION OF TRASH RACK OR GPT in un-named creek downstream of the Oatley Shopping area prior to the Gunga Bay wetlands to remove litter. Possible location is beneath Mulga Rd where the pipe(s) discharge into the wetlands.	10,000	-	1	-	Litter	5	H	5%
HC06	HC	INSTALL BARAMY TRASH RACK (currently being considered by Council) in un-named creek as part of Lime Kiln Bay wetland development.	130,000	10,000	10	100,000	Litter	5	H	5%
[HC07]	HC	Investigate the feasibility of installing Constructed Wetlands downstream of the major landfill areas (Boggywell Ck, Hurstville G.C.) to treat elevated bacteria and oxygen demanding organic matter in stormwater as well as sewer overflows.	40,000	4,000	2	8,000	All	9	H	8%
HC08	HC	Install Constructed Wetlands upstream of Lime Kiln Bay in un-named creek - this will act as a back-up to Sydney Waters SOLP operation for reducing faecal, bacteria and nutrient load to the LGR.	1,070,000	30,000	10	300,000	All	9	H	8%
HC09	HC	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. After Overall LGR SMO "OA23"	10,000	1,500	5	7,500	All	9	M	5%
[HC10]	HC	CONDUCT FEASIBILITY STUDY FOR RE-ESTABLISHING HEALTHY RIPARIAN & AQUATIC HABITATS in Boggywell Ck drain, Hurstville G.C drain and the un-named creek upstream of Lime Kiln Bay where appropriate.	40,000	3,000	2	6,000	All	9	M	10%
[HC11]	HC	Investigate the use of safer alternative products for bank stabilisation, particularly in the un-named creek upstream of Lime Kiln Bay where bark chips are currently being used.	5,000	1,000	2	2,000	Organics (Oxygen Demanding Substances)	2	L	10%
HC12	Hurstvill	Investigate sources north of McRaes	20,000	5,000	20	100,00	All	9	70%	5%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annual Maint. Cost $	Lif e tim e yrs	Lifetim e Maint. Cost $	Target Pollutan t	No. Pollut ants	Effe ctive ness	% Catch ment Benefi ted
	e Council / RAC	Res from Hurstville LGA and Railway land and provide appropiate treatment				0				

HC13	KMC / Hurstville / RAC	Investigate and provide treatment measures in the upper catchment north of Empress Res	40,000	10,000	20	200,000	All	9	70%	10%
HC14	HC	Install litter control devices in Gannons Park (Boggywell Ck).	180,000	10,000	20	200,000	Litter	3	M	5%

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

Table 8.6: Kogarah LGA SMO Ranking Data

Ref. No.	Responsibility	Stormwater Management Action	Capital $	Annual Maint. Cost $	Lifetime yrs	Lifetime Maint. Cost $	Target Pollutant	No. Pollutants	Effectiveness	% Catchment Benefited
[KC01]	KMC	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from McRaes Res to open space area in northern end of Moore Reserve Catchment.	10,000	0	1	0	All	9	M	30%
KC02	KMC	Investigate pipe source North West of Renown Park	250	0	1	0	All	9	M	10%
KC03	KMC	Stencile drains in commercial areas and erect a catchment sign in McRaes Reserve, Arrowsmith and Grove Parks.	12,000	1,000	10	10,000	All	9	M	30%
[KC04]	KMC	Investigate the possibility of recycling stormwater for the use of irrigation in Moore Reserve.	10,000	5,000	1	5,000	All	9	50%	40%
[KC05]	KMC	Assess the health of the existing wetland on the university grounds and monitor the runoff for potential pollutants	3,000	1,000	5	5,000	All	9	H	10%
KC06	KMC	Maintain dog faeces disposal bins, including supply of bags for disposal.	0	2,000	10	20,000	Bacteria	3	M-H	5%
KC07	KMC	Install GPTs with sediment bays for Moore Res catchment in Oatley Bay	60,000	5,000	20	100,000	Litter	2	70%	5%
KC08	KMC	Use Moore Reserve wetland as an educational opportunity on stormwater pollution	10,000	2,000	20	40,000	All	9	M	50%
KC09	KMC	Place sediment basins at outlets to bushland for Oatley Bay catchment.	6,000	1,000	20	20,000	Sediments	1	70%	5%
KC10	LEFT INTENTIONALLY BLANK		-	-	-	-	-	-	-	-
KC11	KMC	Strategically Install litter baskets at pits within Oatley Bay catchment	10,800	10,000	20	200,000	Litter	2	60%	30%
KC12	KMC	Expand and improve sediment bay below Ada St*	3,000	3,000	20	60,000	Sediments	1	70%	5%
KC13	KMC	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from Renown Park to McRaes Res.	100,000	5,000	20	100000	All	9	M	20%
KC14	KMC	Rehabilitate creeks in Moore Reserve	300,000	17,500	20	350,000	All	9	10%	5%
KC15	KMC	Introduce a constructed "natural creek" to replace the use of the western stormwater pipeline in Moore Reserve	250,000	10,000	20	200,000	All	9	10%	20%
KC16	KMC	Collect and treat leachate at the southern end of Moore Reserve	500,000	25,000	20	500,000	Toxicants	7	100%	80%
KC17	KMC	Construct a wetland in the northern part of Moore Reserve with upstream GPT.	600,000	20,000	20	400,000	All	9	30%	50%
KC18	Hurstville Council / RAC	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	20,000	5,000	20	100,000	All	9	70%	5%
KC19	KMC / RTA	Construct a wetland in the quarry site with upstream GPT to cater for litter, sediment and oil	450,000	20,000	20	400,000	All	9	50%	30%
KC20	KMC / RTA	Install GPTs/sediment bay for Poulton Park catchment	55,000	5,000	20	100,000	Litter	3	70%	10%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life tim e yrs	Lifetime Maint. Cost $	Target Pollut ant	No. Pollut ants	Effec tiven ess	% Catch ment Benefit ed
KC21	KMC	Place erosion controls that affect Poulton park catchment current landfill site	7,500	1,000	5	5,000	Sedim ents	2	80%	5%
KC22	KMC	Investigate potential leachate in Poulton Park catchment	400,000	20,00 0	20	400,000	Toxica nts	7	100 %	30%
KC23	KMC	Introduce a constructed "natural creek" north of quarry site in passive area	150,000	7,500	20	150,000	All	9	10%	10%
[KC24]	KMC / RTA	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Bell Park, Eastern side of Hurstville Rd.	100,000	5,000	20	100,000	All	9	60%	10%
KC25	KMC	Construct a 'natural creek to replace foreshore pipe in Oatley Pleasure Grounds	75,000	4,000	20	80,000	All	9	10%	10%
KC26	KMC	Install GPTs/Sediment Bays outside Moore Reserve and Poulton Park catchments for Neverfail/Oatley Bay	80,000	12,00 0	20	240,000	Litter	3	70%	10%
KC27	KMC	Strategically install litter baskets at pits within the foreshore catchments	5,880	2,500	20	50,000	Litter	2	60%	20%
KC28	KMC	Install 'end of line' GPTs for Kogarah Bay Foreshore	48,000	10,00 0	20	200,000	Litter	2	60%	10%
KC29	KMC	Stencil drains in medium density residential, commercial and industrial areas, and erect a catchment sign in Jubilee Oval, Empress Reserve and Meade Park.	10,000	1,000	10	10,000	All	9	M	20%
KC30	KMC	Install offline wetland with upstream GPT to treat sediment/oil/litter on western side of Beverley Park Golf Course. Investigate the possibility of diverting stormwater from Moore Park to place wetland further upstream.	600,000	20,00 0	20	400,000	All	9	30%	40%
KC31	KMC	Install trash rack with sediment trap in Moore Park	5,000	3,000	20	60,000	Litter	3	40%	30%
KC32	KMC / RTA	Install GPTs to collect oil/sediment/litter along the Princes Highway at the intersections of Battie Ave, Jubilee Ave and Harslett Cres.	90,000	7,500	20	150,000	Oils & Greas e	6	70%	20%
KC33	KMC	Install GPTs affecting Beverley Park catchment	15,000	2,000	20	40,000	Litter	3	70%	20%
KC34	KMC	Investigate the use of a GPT that will not be affected by the tide in the South East side of Beverley Park	100,000	10,00 0	20	200,000	Litter	3	60%	30%
KC35	KMC	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in south east side of Beverley Park	100,000	10,00 0	20	200,000	Sedim ents	4	40%	20%
KC36	KMC	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Jubilee Oval	50,000	7,500	20	150,000	Sedim ents	4	40%	10%
[KC37]	KMC	Investigate the possibility of recycling stormwater for the use of irrigation on Beverley Park Golf Club	50,000	15,00 0	20	300,000	All	9	60%	20%
KC38	KMC	Install wetland in the south part of Carss Park with upstream GPT that treats	500,000	20,00 0	20	400,000	All	9	40%	50%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life tim e yrs	Lifetime Maint. Cost $	Target Pollut ant	No. Pollut ants	Effec tiven ess	% Catch ment Benefit ed
		oil/sediments/litter								
KC39	KMC / Sydney Water	Install wetland in the south part of Harold Frazer Reserve with upstream GPT that treats oil/sediments/litter	500,000	20,00 0	20	400,000	All	9	40%	50%
KC40	KMC	Install 'end of line' GPT for outlets to the southern end of Sydney Water channel	20,000	2,000	20	40,000	Litter	3	70%	10%
KC41	KMC	Install GPTs for stormwater affecting Carss Park catchment	75,000	5,000	20	100,000	Litter	3	70%	40%
[KC42]	KMC	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Stuart Park, Meade Park and Empress Reserve	100,000	2,000	20	40,000	Sedim ents	4	40%	20%
KC43	KMC / Hurstvill e / RAC	Investigate and provide treatment measures in the upper catchment north of Empress Res	40,000	10,00 0	20	200,000	All	9	70%	10%
KC44	KMC / RTA	Install an inline GPT for oil/sediment/litter in Grosvenor St Reserve	15,000	2,000	20	40,000	Oils & Greas e	4	70%	10%
KC45	KMC	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from Harold Frazer Reserve to northern end of Wonora Rd School	100,000	1,000	15	15,000	All	9	40%	10%
KC46	KMC / RTA	Install GPT for oil/sediment/litter at the intersection of King Georges Rd and Blakesley Road	25,000	2,000	20	40,000	Oils & Greas e	4	70%	10%
KC47	KMC	Install GPT/infiltration system in Augusta Street	50,000	2,000	20	40,000	Sedim ents	6	60%	10%
KC48	KMC / RTA	Install GPT for oil/sediment in Todd Park	50,000	4,000	20	80,000	Oils & Greas e	2	70%	30%
KC49	KMC	Strategically install litter baskets at pits within the Kyle Bay catchments	5,160	2,000	20	40,000	Litter	2	60%	20%
KC50	KMC	Install GPTs for stormwater affecting Connells Bay waterways	63,000	5,000	20	100,000	Litter	2	70%	5%
KC51	KMC	Investigate the potential for constructing a 'natural creek' in Connells Point Reserve.	100,000	1,000	20	20,000	All	9	10%	10%
[KC52]	KMC	Investigate the possibility of using a wet pond/infiltration facility for stormwater treatment of low flows such as infiltration basins in Merriman Reserve	50,000	5,000	20	100,000	Sedim ents	6	40%	20%
KC53	KMC	Install GPTs and repair pipes for pipes discharging to Kyle Bay.	80,000	12,00 0	20	240,000	Litter	3	70%	10%
KC54	KMC	Install sediment basin for outlet in Kyle Williams Reserve	10,000	500	20	10,000	Sedim ents	1	60%	10%
KC55	KMC	Install GPTs for stormwater that affects Shipwrights Bay	30,000	1,000	20	20,000	Litter	3	70%	10%
KC56	KMC	Rehabilitate creeks in Shipwrights Bay catchments, providing water way crossings where unsealed vehicle access crosses natural drainage lines	100,000	10,00 0	10	100,000	All	9	10%	20%
KC57	KMC	Divert stormwater outlet to naturla creek at northern end of Woodlands Ave and include a sediment bay.	5,000	200	20	4,000	Sedim ents	1	10%	10%
KC58	KMC	Introduce a constructed "natural creek" to replace the use of the stormwater	100,000	10,00 0	20	200,000	All	9	40%	10%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life tim e yrs	Lifetime Maint. Cost $	Target Pollut ant	No. Pollut ants	Effec tiven ess	% Catch ment Benefit ed
		pipeline behind tennis courts in Shipwrights Bay Reserve, install a GPT upstream.								
KC59	KMC	Introduce a wet sediment basin in Shipwrights Bay Reserve	50,000	5,000	20	100,000	All	9	40%	10%
KC60	KMC	Educational program for medium density flats	2,000	2,000	5	10,000	Litter	3	M	40
KC61	KMC	Install GPT in Empress Reserve	90,000	2,000	20	40,000	Litter	3	70	20
KC62	KMC	Place sediment bays at outlets to bushland	20,000	500	20	10,000	Sedim ents	1	60	10
KC63	KMC, Sydney Water	Install litter boom in Carss Park Sydney Water Channel	10,000	4,800	10	48,000	Litter	3	70	20

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

Table 8.7: Rockdale LGA SMO Ranking Data

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life tim e yrs	Lifetime Maint. Cost $	Target Pollut ant	No. Pollut ants	Effec tiven ess	% Catchm ent Benefit ed
RC01	RCC	STREAMFLOW MGT & ENHANCE AQUATIC & RIPARIAN HABITATS IN SANS SOUCI DRAIN NO.S 1-3 to minimise scouring in earth channels	200,000	20,00 0	20	400,000	Sedim ents	2	H	10%
RC02	RCC	Create buffer strips between stormwater lines and horse stables such that sediment in water flowing from the stables is intercepted before reaching the waterways.	20,000	2,000	20	40,000	Nutrie nts	4	M	2%
RC03	RCC	Install litter collection devices on all drains feeding into Scarborough Ponds	100,000	10,00 0	20	200,000	Litter	5	H	5%
RC04	RCC	Point source collection of litter from major contributing areas such as the Ramgate Shopping area and fast food and shopping outlets along Rocky Point Road. (litter baskets)	35,000	10,00 0	20	200,000	Litter	5	H	5%
RC05	RCC	Install trash rack or GPT in Sans Souci Drain No. 2 downstream of the Ramsgate Shopping area to remove litter.	100,000	5,000	20	100,000	Litter	5	H	2%
RC06	RCC	Install trash rack or GPT in Sans Souci Drain No. 1 at Little Reserve downstream of the fast food/commercial areas on Rocky Point Road.	75,000	5,000	20	100,000	Litter	5	H	2%
RC07	RCC	Install trash rack or GPT in Sans Souci Drain No. 3	60,000	5,000	20	100,000	Litter	5	H	2%
RC08	RCC	Install Constructed Wetlands on Sans Souci Drain No.s 1-3 and upstream of Scarborough Ponds to treat elevated bacteria and oxygen demanding organic matter in stormwater. Note: concept plans have already been drawn up for Stan Moses Res in SS Drain No.2	250,000	10,00 0	20	200,000	All	9	H	2%

Ref. No.	Respon sibility	Stormwater Management Action	Capital $	Annu al Maint. Cost $	Life tim e yrs	Lifetime Maint. Cost $	Target Pollut ant	No. Pollut ants	Effec tiven ess	% Catchm ent Benefit ed
RC09	RCC	Install litter and sediment collection traps, preferrably as close to the source as possible, to intercept litter and sediment prior to it reaching Lady Robinsons Beach.	60,000	10,00 0	20	200,000	Litter	2	H	5%
RC10	RCC	Improve access along open drains to enhance safety	200,000	5,000	20	100,000	Litter	2	L	5%
RC11	RCC	Enable secondary contact recreation access in Scarborough Ponds by ensuring safe points which are clearly identifiable and accessible. This will increase enjoyment and education benefited from the ponds.	20,000	-	20	-	Litter	2	L	2%
[RC12]	RCC	BENCHMARK WATER QUALITY PROGRAM - Continue WQ monitoring program commenced in Dec 98 to establish benchmark WQ at 13 sites in Rockdale	5,000	20,00 0	3	60,000	All	9	H	10%

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

8.4 Benefit-Cost Ratio

To compare the options and prioritise them, a benefit-cost ratio was calculated using the methodology outlined below. This methodology was agreed to by Councils and stakeholders.

1. Calculation of Cost Index (*CI*)

The average of the capital and maintenance cost scores gives the *CI* value. (ie. [Capital Cost + Lifetime Cost]÷2 = *CI*)

2. Calculation of Benefit Index (*BI*)

The average of the five benefit scores gives the *BI* value. (ie. [Public Perception + Relative Harm + No. of Pollutants + Effectiveness of the Option + % Catchment Area Benefited]÷5 = *BI*)

3. Calculation of Benefit-Cost Ratio (*BC*)

This is calculated by dividing *BI* by *CI* (ie. *BI* ÷ *CI*). The larger the ratio the more benefit the option is deemed to have in relation to its cost.

8.5 Feedback Loop Multiplier

The scoring system defined so far reflects the overall values/goals of the entire Lower Georges River catchment. In order to “feedback” the more specific priorities and values defined at the sub-catchment level, the Feedback Loop Multiplier (FLM) is used.

The FLM is assigned a value between 1 and 10 to reflect the ability of a particular option to achieve the values and objectives for the specific sub-catchment and/or local area in which the option would be implemented according to their relative priorities.

The B/C ratio is multiplied by the FLM to give the final ranking of the stormwater management option with respect to other options and how well it is deemed to address the local issues and achieve the local objectives, defined earlier in **Sections 5 & 6**.

For example, if a high priority for a local area is to remove sediment but the option assessed removes only litter, then the FLM would be low, 2 - 4 perhaps. On the other hand, an option that removes sediment efficiently but doesn’t target litter, and the local priority for sediment removal is low, then the FLM will also be low. An option that targets a pollutant that the local priority for is high, then the FLM will also be high, 7 - 10 perhaps.

In some cases, the FLM is expressed as High, Low, Medium etc. The following table shows the score that applies when using this method.

Table 8.8: Factor Loop Multiplier Ranking Scores

Ability to achieve Values, Objectives	FLM Score
L	1
L-M	3
M	5
M-H	8
H	10

8.6 Final Ranking of Options

The following figures show the final rankings of stormwater management options for each Council LGA including both overall and local options combined.

The options were ranked from highest to lowest priority using the adjusted benefit-cost value. The results of this ranking showed that more source control options were ranked higher than using the BC value as they have greater ability to address the issues within the catchment.

8.6.1 Final Ranking of Sutherland LGA Options

The final ranking spreadsheet for stormwater management options in the Sutherland Shire LGA are given in **Table 8.9** below.

Table 8.9: Final Ranking of Sutherland LGA Options

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
1	OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	0.02	7.20	480.00	9	**4320**
2	OA34	Raise awareness of penalties for a range of poor practices related to stormwater	0.02	7.40	493.33	7	**3453**
3	OA63	Measure and report effectiveness of options for all issues	0.08	8.40	112.00	9	**1008**
4	LEFT BLANK INTENTIONALLY						
5	OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	0.11	8.60	81.90	10	**819**
6	[OA42]	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	0.08	6.60	88.00	8	**704**
7	OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	0.08	5.80	77.33	9	**696**
8	OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	0.10	7.60	76.00	9	**684**
9	OA60	Produce a simplified stormwater management plan with educational components (make accessible)	0.08	8.00	106.67	6	**640**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
10	[OA26]	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	0.10	7.40	77.89	8	**623**
11	OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	0.10	5.90	62.11	10	**621**
12	OA52	Promote "No junk mail" stickers	0.05	3.40	68.00	9	**612**
13	OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	0.06	5.20	83.20	7	**582**
14	[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	0.08	6.80	90.67	6	**544**
15	OA62	Identify stormwater system gaps in drainage map and update.	0.06	6.40	116.36	4	**465**
16	OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	0.11	4.80	45.71	10	**457**
17	OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	0.13	6.30	50.40	9	**454**
18	OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	0.10	4.40	44.00	10	**440**
19	SC13	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. Ref. Overall LGR SMO "OA23"	0.09	6.80	77.71	5	**389**
20	OA25	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	0.12	4.80	39.18	9	**353**
21	OA64	Develop litter management programs for recreational/park areas	0.08	4.40	58.67	6	**352**
22	LEFT BLANK INTENTIONALLY						
23	OA65	Provide updates of treatment device performance through various forms of media.	0.13	7.20	57.60	6	**346**
24	OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	0.18	6.50	37.14	9	**334**
25	LEFT INTENTIONALLY BLANK						
26	OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	0.21	7.60	36.19	9	**326**
27	OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	0.18	8.00	45.71	7	**320**
28	OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	0.25	8.00	32.00	10	**320**
29	SC08	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits to be installed around the Miranda Shopping precinct as well as additional bins.	0.15	5.30	35.33	9	**318**
30	OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen.	0.20	6.20	31.00	10	**310**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
		community - minimise point source					
31	OA46	Encourage rainwater tanks and on-site detention for new and existing developments	0.13	3.80	30.40	10	**304**
32	OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	0.15	4.90	32.67	9	**294**
33	[OA11]	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	0.16	4.60	29.21	10	**292**
34	SC15	WORK WITH PRIVATE FERTILISER USERS - golf courses, nurseries (Flower Power in particular) - to identify ways in which nutrients could be reaching the waterways and how to prevent it and/or treat it.	0.17	4.80	29.09	10	**291**
35	[SC10]	INVESTIGATE AIRCRAFT FUEL/OIL FALL-OUT - Ascertain if it is a pollution source and move towards ways of mitigating if it is found to be.	0.15	4.60	31.72	9	**286**
36	[SC12]	Investigate the need for installing Constructed Wetlands (or other treatment) on Oyster Creek, Gwawley Creek and other miscellaneous creeks where land availability permits to treat elevated bacteria and oxygen demanding organic matter in SW	0.24	7.80	32.50	8	**260**
37	OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	0.13	3.60	28.80	9	**259**
38	OA45	Waste Minimisation & Education Campaign at Rail Stations & Corridor	0.15	4.20	28.00	9	**252**
39	OA50	Encourage cleanup days at schools and combine with education program	0.12	3.60	31.30	8	**250**
40	OA57	Promote bushcare groups and progress of bush regeneration	0.25	6.60	26.40	9	**238**
41	SC16	INTRODUCE BUFFER STRIPS BETWEEN NUTRIENT SOURCES & WATERWAYS - nurseries, Horse Stables on Captain Cook Drive, Cronulla STP, and major sewer overflow locations (where possible).	0.18	4.20	23.33	10	**233**
42	SC06	Install trash rack or litter boom for Gwawley Ck upstream of Sylvania Waters. Also investigate origin of litter and look at point source controls.	0.20	5.10	25.50	9	**230**
43	SC17	PREVENT STREET RUBBISH DUMPING - particularly in Kurnell. Clean-up when ever possible.	0.23	5.70	25.33	8	**203**
44	OA49	Identify and educate pamphlet and local paper deliverers	0.12	3.80	33.04	6	**198**
45	OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	0.40	7.80	19.50	10	**195**
46	SC11	INVESTIGATE POLLUTION in stormwater run-off from industrial sites including the Cronulla STP, Caltex Oil Refinery, AGL, Abbotts, etc to ascertain if these sites are polluting SW and develop mitigation strategies on basis of results of investigation	0.23	4.60	20.44	9	**184**
47	OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	0.35	6.50	18.57	9	**167**
48	OA22	Lobby State Govt. re: the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	0.35	6.50	18.57	9	**167**
49	SC07	Install trash rack or litter boom in un-named creek/drain downstream of Caringbah Residential area (drains into Woolooware Bay). Also investigate origin of litter and look at point source controls.	0.25	5.16	20.64	8	**165**
50	SC09	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits could be installed around the fast food and shopping outlets along Kingsway/Princes Highway.	0.30	5.30	17.67	9	**159**
51	OA14	Introduction of new planning policies providing incentives for	0.10	7.00	71.79	2	**144**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
		industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)					
52	[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	0.55	9.20	16.73	8	**134**
53	OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	0.28	4.60	16.73	8	**134**
54	OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	0.09	5.80	66.29	2	**133**
55	LEFT BLANK INTENTIONALLY						
56	OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	0.53	8.40	16.00	8	**128**
57	[SC04]	Investigate the expected improvement in sedimentation reduction in waterways by installing a sediment trap(s) or GPT(s) downstream of the permanent industrial zones such as Taren Point and Kurnell.	0.35	4.80	13.71	9	**123**
58	OA61	Develop methods to encourage wide community participation with stormwater management.	0.58	8.40	14.61	8	**117**
59	SC02	GWAWLEY WETLANDS STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	0.38	4.64	12.37	9	**111**
60	OA58	Develop and implement maintenance programs for treatment devices	0.58	7.00	12.17	9	**110**
61	[OA59]	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	0.55	6.60	12.00	9	**108**
62	OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Lobby State Govt. that existing disposal depots be retained with the approp. authority or industry body to continue to provide facilities for disposal of oils & make known to industrial/commercial mgrs & residents.	0.56	6.20	11.07	9	**100**
63	OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	0.50	5.20	10.40	9	**94**
64	SC14	Removal of weed species, particularly Bitou Bush upstream of the Towra Nature Reserve in Kurnell.	0.25	3.20	13.06	7	**91**
65	SC22	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	0.50	4.64	9.28	9	**84**
66	OA48	Place passive signage in parks for litter.	0.38	3.40	9.07	9	**82**
67	OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	0.56	4.60	8.21	9	**74**
68	SC01	GWAWLEY CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	0.60	4.76	7.93	9	**71**
69	OA31	Maintain bush walking tracks	0.35	2.74	7.83	9	**70**
70	OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	1.15	8.00	6.96	10	**70**
71	OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	0.55	4.20	7.64	9	**69**
72	SC23	INSTALL TRASH RACK at Seymour Shaw Park, The Boulevarde, Miranda	0.65	4.24	6.52	9	**59**
73	SC03	OYSTER CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	0.75	4.80	6.40	9	**58**
74	SC24	SIR JOSEPH BANKS DRIVE, KURNELL - GPT	0.71	4.04	5.69	10	**57**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
75	OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	1.30	8.20	6.31	9	**57**
76	OA66	Install GPTs for runoff from railway land	0.60	3.76	6.27	9	**56**
77	OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	0.25	6.60	26.40	2	**53**
78	OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	0.24	6.30	26.25	2	**53**
79	SC05	Install sediment trap (& litter) GPT in drain feeding into Sylvania Waters at Box Road. Currently being designed.	1.00	5.10	5.10	10	**51**
80	SC25	ENDEAVOUR ROAD, CARINGBAH - GPT	0.82	4.06	4.98	10	**50**
81	OA54	Compile inventory of riparian and aquatic habitats and their state	0.58	6.80	11.83	4	**47**
82	OA55	Develop a mangrove regeneration program	0.58	6.80	11.83	4	**47**
83	OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	1.08	4.40	4.09	10	**41**
84	SC26	SCYLLA BAY - GPT	1.00	4.04	4.04	10	**40**
85	OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	2.00	7.00	3.50	10	**35**
86	OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	2.00	6.60	3.30	10	**33**
87	OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	9.50	6.40	0.67	10	**7**
88	SC19	MAINTENANCE OF GPT located in Cronulla Golf Course, Hume Road, Cronulla	0.50	4.86	9.72	0*	**0**
89	SC18	MAINTENANCE OF GPT on Gwawley Ck, Box Road, Miranda	0.50	4.70	9.40	0*	**0**
90	SC20	MAINTENANCE OF GPT located in Cronulla Golf Course, Sturt Road, Cronulla	0.50	4.64	9.28	0*	**0**
91	SC21	MAINTENANCE GPT IN RESOLUTION DRIVE at the intersection of Edeavour Rd (sth), Woolooware	1.50	4.66	3.11	0*	**0**

* FLM values assigned zero to reflect that the options are already being undertaken by Council and do not need to rank in new options to be implemented as a result of this SMP.
[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

8.6.2 Final Ranking of Hurstville LGA Options

The final ranking spreadsheet for stormwater management options in the Hurstville LGA are given in **Table 8.10** below.

Table 8.10: Final Ranking of Hurstville LGA Options

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
1	OA34	Raise awareness of penalties for a range of poor practices related to stormwater	0.0	7.4	493.33	1.0	**493**
2	OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	0.0	7.2	480.00	1.0	**480**
3	OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	0.1	8.6	81.90	5.0	**410**
4	[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	0.1	6.8	90.67	4.0	**363**
5	OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	0.2	7.6	36.19	10.0	**362**
6	[OA42]	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	0.1	6.6	88.00	4.0	**352**
7	OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	0.1	4.8	45.71	7.0	**320**
8	OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	0.3	8.0	32.00	10.0	**320**
9	OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	0.1	5.8	77.33	4.0	**309**
10	OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	0.1	7.6	76.00	4.0	**304**
11	OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	0.2	8.0	45.71	6.0	**274**
12	OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	0.2	6.2	31.00	7.0	**217**
13	OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	0.4	7.8	19.50	10.0	**195**
14	OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	0.4	6.5	18.57	10.0	**186**
15	OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	0.1	5.8	66.29	2.5	**166**
16	LEFT BLANK INTENTIONALLY						
17	OA22	Lobby State Govt. re: the required changes in legislation to introduce compulsory inspections of sewer lines of private	0.4	6.5	18.57	8.0	**149**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
		properties at conveyance stage					
18	LEFT BLANK INTENTIONALLY						
19	HC03	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in the gully creek downstream of Brewer Place which flows into Boggywell Ck	0.3	4.6	14.28	10.0	**143**
20	OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	0.1	5.9	62.11	2.0	**124**
21	OA62	Identify stormwater system gaps in drainage map and update.	0.1	6.4	116.36	1.0	**116**
22	OA63	Measure and report effectiveness of options for all issues	0.1	8.4	112.00	1.0	**112**
23	OA60	Produce a simplified stormwater management plan with educational components (make accessible)	0.1	8.0	106.67	1.0	**107**
24	OA25	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	0.1	4.8	39.18	2.6	**103**
25	**LEFT BLANK INTENTIONALLY**						
26	OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	0.2	4.9	32.67	3.0	**98**
27	OA46	Encourage rainwater tanks and on-site detention for new and existing developments	0.1	3.8	30.40	3.0	**91**
28	OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	0.1	4.4	44.00	2.0	**88**
29	[OA11]	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.		29.2	29.21	3.0	**88**
30	[HC11]	Investigate the use of safer alternative products for bank stabilisation, particularly in the un-named creek upstream of Lime Kiln Bay where bark chips are currently being used.	0.0	3.0	85.71	1.0	**86**
31	[OA59]	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	0.6	6.6	12.00	7.0	**84**
32	OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	0.1	5.2	83.20	1.0	**83**
33	[OA26]	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	0.1	7.4	77.89	1.0	**78**
34	OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	0.2	6.5	37.14	2.0	**74**
35	HC09	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. After Overall LGR SMO "OA23"	0.1	6.5	74.29	1.0	**74**
36	OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	0.1	7.0	71.79	1.0	**72**
37	OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	1.2	8.0	6.96	10.0	**70**
38	OA52	Promote "No junk mail" stickers	0.1	3.4	68.00	1.0	**68**
39	OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	1.3	8.2	6.31	10.0	**63**
40	OA66	Install GPTs for runoff from railway land	0.6	3.8	6.27	10.0	**63**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
41	OA50	Encourage cleanup days at schools and combine with education program	0.1	3.6	31.30	2.0	**63**
42	OA58	Develop and implement maintenance programs for treatment devices	0.6	7.0	12.17	5.0	**61**
43	OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	0.2	6.3	26.25	2.3	**60**
44	OA64	Develop litter management programs for recreational/park areas	0.1	4.4	58.67	1.0	**59**
45	OA65	Provide updates of treatment device performance through various forms of media.	0.1	7.2	57.60	1.0	**58**
46	[HC10]	CONDUCT FEASIBILITY STUDY FOR RE-ESTABLISHING HEALTHY RIPARIAN & AQUATIC HABITATS in Boggywell Ck drain, Hurstville G.C drain and the un-named creek upstream of Lime Kiln Bay where appropriate.	0.2	6.6	28.70	2.0	**57**
47	OA54	Compile inventory of riparian and aquatic habitats and their state	0.6	6.8	11.83	4.6	**54**
48	HC06	INSTALL BARAMY TRASH RACK (currently being considered by Council) in un-named creek as part of Lime Kiln Bay wetland development.	1.0	5.3	5.30	10.0	**53**
49	OA57	Promote bushcare groups and progress of bush regeneration	0.3	6.6	26.40	2.0	**53**
50	OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	0.3	6.6	26.40	2.0	**53**
51	OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	0.1	6.3	50.40	1.0	**50**
52	LEFT BLANK INTENTIONALLY						
53	OA55	Develop a mangrove regeneration program	0.6	6.8	11.83	4.0	**47**
54	OA61	Develop methods to encourage wide community participation with stormwater management.	0.6	8.4	14.61	3.0	**44**
55	OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	0.6	4.6	8.21	5.0	**41**
56	OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	1.1	4.4	4.09	10.0	**41**
57	OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	0.6	4.2	7.64	5.0	**38**
58	OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	0.3	4.6	16.73	2.0	**33**
59	[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	0.6	9.2	16.73	2.0	**33**
60	OA49	Identify and educate pamphlet and local paper deliverers	0.1	3.8	33.04	1.0	**33**
61	OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	2.0	6.6	3.30	10.0	**33**
62	OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	0.5	8.4	16.00	2.0	**32**
63	[HC07]	Investigate the feasibility of installing Constructed Wetlands downstream of the major landfill areas (Boggywell Ck, Hurstville G.C.) to treat elevated bacteria and oxygen demanding organic matter in stormwater as well as sewer overflows.	0.2	7.6	31.50	1.0	**32**
64	OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	0.1	3.6	28.80	1.0	**29**
65	OA45	Waste Minimisation & Education Campaign at Rail Stations &	0.2	4.2	28.00	1.0	**28**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
		Corridor					
66	OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Lobby State Govt. that existing disposal depots be retained with the approp. authority or industry body to continue to provide facilities for disposal of oils and harmful chemicals & make known to industrial/commercial mgrs & residents.	0.6	6.2	11.07	2.0	**22**
67	HC01	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek upstream of Lime Kiln Bay	0.7	4.7	6.48	2.0	**13**
68	HC02	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek downstream of Peakhurst Industrial Area	0.7	4.7	6.48	2.0	**13**
69	HC04	Increase and implement an approved street and stormwater pit cleaning program	5.0	6.4	1.28	10.0	**13**
70	HC08	Install Constructed Wetlands upstream of Lime Kiln Bay in un-named creek - this will act as a back-up to Sydney Waters SOLP operation for reducing faecal, bacteria and nutrient load to the LGR.	6.0	7.6	1.26	10.0	**13**
71	LEFT BLANK INTENTIONALLY						
72	HC12	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	0.6	5.6	9.40	1.0	**9**
73	OA48	Place passive signage in parks for litter.	0.4	3.4	9.07	1.0	**9**
74	HC13	Investigate and provide treatment measures in the upper catchment north of Empress Res	0.7	5.7	8.20	1.0	**8**
75	OA31	Maintain bush walking tracks	0.4	2.7	7.83	1.0	**8**
76	OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	9.5	6.4	0.67	0*	**0**
77	[HC05]	INVESTIGATE THE INSTALLATION OF TRASH RACK OR GPT in un-named creek downstream of the Oatley Shopping area prior to the Gunga Bay wetlands to remove litter. Possible location is beneath Mulga Rd where the pipe(s) discharge into the wetlands.	0.1	5.3	106.00	0**	**0**
77	OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	2.0	7.0	3.50	0***	**0**
78	OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	0.5	5.2	10.40	0****	**0**

* covered by HC04 therefore redundant for Hurstville.
** this options was later agreed to be the responsibiltiy of Kogarah Council only.
*** the only major road within the Hurstville LGA in the LGR catchment drains to a different catchment (Cooks River) therefore does not apply to Hurstville.
**** RTA action only.
[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

8.6.3 Final Ranking of Kogarah LGA Options

The final ranking spreadsheet for stormwater management options in the Kogarah LGA are given in **Table 8.11** below. Note that Kogarah has grouped the stormwater management actions according to a category down the left hand side of the table and therefore the order in the table does not necessarily represent the rank of the action. The rank of each action is given in the second column.

Table 8.11: Final Ranking of Kogarah LGA Options

Category	**Rank**	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	**Multiplied Index**
Education /Residential	**11**	OA45	State Rail	Waste Minimisation & Education Campaign at Rail Stations & Corridor	0.15	4	26.67	8	**213.33**
	21	OA60	All Councils	Produce a simplified stormwater management plan with educational components (make accessible)	0.075	8	106.67	1	**106.67**
	22	LEFT BLANK INTENTIONALLY							
	25	OA34	All Councils	Raise awareness of penalties for a range of poor practices related to stormwater	0.09	7.4	82.22	1	**82.22**
	27	OA08	All Councils	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	0.1	7.6	76.00	1	**76.00**
	28	KC60	KMC	Educational program for medium density flats	0.06	4.4	73.33	1	**73.33**
	33	OA28	All Councils, Waterways	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	0.0875	5.8	66.29	1	**66.29**
	34	OA52	All Councils	Promote "No junk mail" stickers	0.05	3.2	64.00	1	**64.00**
	37	OA65	All Councils	Provide updates of treatment device performance through various forms of media.	0.125	7.2	57.60	1	**57.60**
	44	OA02	All Councils, RTA, RAC	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	0.175	8	45.71	1	**45.71**
	55	OA03	All Councils, RTA, RAC	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	0.25	8	32.00	1	**32.00**
	58	OA49	All Councils	Identify and educate pamphlet and local paper deliverers	0.115	3.6	31.30	1	**31.30**
	62	OA50	All Councils	Encourage cleanup days at schools and combine with education program	0.115	3.4	29.57	1	**29.57**
	66	OA57	All Councils	Promote bushcare groups and progress of bush regeneration	0.25	6.6	26.40	1	**26.40**
	95	OA48	All Councils	Place passive signage in parks for litter.	0.375	3.2	8.53	1	**8.53**
	97	OA61	All Councils	Develop methods to encourage wide community participation with stormwater management.	1.075	8.4	7.81	1	**7.81**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	Multiplied Index
	107	OA07	All Councils	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	1.05	4.2	4.00	1	**4.00**
	111	OA56	All Councils	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	0.25	6.6	26.40	0.1	**2.64**
Education - Industrial	**8**	OA04	All Councils, RTA, RAC	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	0.1	4.2	42.00	8	**336.00**
	9	OA01	All Councils, RTA, RAC	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	0.2	6.4	32.00	8	**256.00**
	23	OA05	All Councils, RTA, RAC, EPA	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	0.4	7.8	19.50	5	**97.50**
	63	OA29	All Councils	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	0.15	4.3	28.67	1	**28.67**
Auditing & Monitoring	**15**	OA20	Sydney Water, All Councils, EPA	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	0.35	6.5	18.57	10	**185.71**
	20	OA63	All Councils	Measure and report effectiveness of options for all issues	0.075	8.4	112.00	1	**112.00**
	51	OA21	Sydney Water, All Councils	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	0.175	6.5	37.14	1	**37.14**
	54	LEFT BLANK INTENTIONALLY							
	68	OA40	All Councils	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	1.65	8	4.85	5	**24.24**
	70	OA39	All Councils	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	1.575	4.6	2.92	8	**23.37**
	98	LEFT BLANK INTENTIONALLY							
	103	OA54	All Councils	Compile inventory of riparian and aquatic habitats and their state	1.075	6.8	6.33	1	**6.33**
Maintenance	**19**	OA62	All Councils	Identify stormwater system gaps in drainage map and update.	0.055	6.4	116.36	1	**116.36**
	38	OA64	All Councils	Develop litter management programs for recreational/park areas	0.075	4.2	56.00	1	**56.00**
	45	KC06	KMC	Maintain dog faeces disposal bins, including supply of bags for disposal.	0.1	4.5	45.00	1	**45.00**
	88	OA31	All Councils	Maintain bush walking tracks	0.35	4.2	12.00	1	**12.00**
	102	OA58	All Councils	Develop and implement maintenance programs for treatment devices	1.075	7	6.51	1	**6.51**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	**Multiplied Index**
	115	OA13	All Councils, RTA	IMPROVE EXISTING STREET SWEEPING(new truck for each Council)	10	6.6	0.66	1	**0.66**
Policy & Planning	**1**	OA30	All Councils	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	0.105	8.6	81.90	10	**819.05**
	3	[OA42]	RTA, All Councils	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	0.075	6.6	88.00	8	**704.00**
	4	OA19	RTA, RAC, All Councils, EPA	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	0.0625	5.2	83.20	8	**665.60**
	5	OA33	All Councils	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	0.015	7.2	480.00	1	**480.00**
	6	OA10	All Councils	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	0.21	7.6	36.19	10	**361.90**
	7	OA14	All Councils	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	0.0975	7	71.79	5	**358.97**
	26	[OA26]	All Councils	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	0.095	7.4	77.89	1	**77.89**
	35	OA67	All Councils	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	0.095	5.9	62.11	1	**62.11**
	39	OA24	All Councils	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	0.125	6.3	50.40	1	**50.40**
	41	OA09	All Councils	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	0.105	5	47.62	1	**47.62**
	55	OA46	All Councils	Encourage rainwater tanks and on-site detention for new and existing developments	0.125	4	32.00	1	**32.00**
	59	[OA11]	All Councils	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	0.1575	4.8	30.48	1	**30.48**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	Multiplied Index
	65	OA51	All Councils	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	0.125	3.4	27.20	1	**27.20**
	72	OA35	All Councils	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	1.8	8.2	4.56	5	**22.78**
	83	OA37	All Councils	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	0.275	4	14.55	1	**14.55**
	96	OA44	All Councils	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	1.025	8.4	8.20	1	**8.20**
GPT - Screening	**47**	KC40	KMC	Install 'end of line' GPT for outlets to the southern end of Sydney Water channel	0.3	4.2	14.00	3	**42.00**
	76	KC49	KMC	Strategically install litter baskets at pits within the Kyle Bay catchments	0.2258	4	17.71	1	**17.71**
	78	KC55	KMC	Install GPTs for stormwater that affects Shipwrights Bay	0.25	4.2	16.80	1	**16.80**
	92	KC28	KMC	Install 'end of line' GPTs for Kogarah Bay Foreshore	1.24	3.8	3.06	3	**9.19**
	99	KC53	KMC	Install GPTs and repair pipes for pipes discharging to Kyle Bay.	1.9	4.2	2.21	3	**6.63**
	108	KC11	KMC	Strategically Install litter baskets at pits within Oatley Bay catchment	1.054	4.2	3.98	1	**3.98**
	109	KC27	KMC	Strategically install litter baskets at pits within the Kogarah Bay catchments	1.05	4	3.81	1	**3.81**
GPT - Sediment	**29**	KC21	KMC	Place erosion controls that affect Poulton park catchment current landfill site	0.0625	4.5	72.00	1	**72.00**
	73	KC61	KMC	Install GPT in Empress Reserve	0.65	4.4	6.77	3	**20.31**
	77	KC34	KMC	Install GPT that will not be affected by the tide in the South East side of Beverley Park	2	4.4	2.20	8	**17.60**
	90	KC41	KMC	Install GPTs for stormwater affecting Carss Park catchment	1.375	4.8	3.49	3	**10.47**
	94	KC50	KMC	Install GPTs for stormwater affecting Connells Bay waterways	1.315	3.9	2.97	3	**8.90**
	101	KC33	KMC	Install GPTs affecting Beverley Park catchment	2	4.4	2.20	3	**6.60**
	18.5	KC63	KMC	Divert small stormwater flow at northern end of Woodlands Ave to a sediment bay leading to the natural creek for prevention of erosion on the unsealed road and improvement of environmental flows.	0.29	4.4	15.17	8	**121.38**
GPT - Oil	**16**	KC44	KMC, RTA	Install an inline GPT for oil/sediment/litter in Grosvenor St Reserve	0.275	4.8	17.45	8	**139.64**
	18	KC46	KMC, RTA	Install GPT for oil/sediment/litter at the intersection of King Georges Rd and Blakesley Road	0.325	4.8	14.77	8	**118.15**
	36	KC48	KMC, RTA	Install GPT for oil/sediment in Todd Park	0.65	4.8	7.38	8	**59.08**
	60	KC32	KMC, RTA	Install GPTs to collect oil/sediment along the Princes Highway at the intersections of Battie Ave, Jubilee Ave and Harslett Cres.	1.45	5.4	3.72	8	**29.79**
	74	OA18	RTA, All Councils	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors,	3	7	2.33	0	**0.00**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	**Multiplied Index**
				media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive					
	116	OA66	RAC	Install GPTs for runoff from railway land	1.1	5.4	4.91	0	**0.00**
Sediment Bays	**49**	KC54	KMC	Install sediment basin for outlet in Kyle Williams Reserve	0.1	4	40.00	1	**40.00**
	57	KC09	KMC	Place sediment basins at outlets to bushland for Oatley Bay catchment.	0.13	4.1	31.54	1	**31.54**
	86	KC62	KMC	Place sediment bays at oulets to bushland	0.15	4	26.67	0.5	**13.33**
	87	KC12	KMC	Expand and improve sediment bay below Ada St*	0.315	4.1	13.02	1	**13.02**
	91	KC20	KMC, RTA	Install GPTs/sediment bay for Poulton Park catchment	1.275	4.2	3.29	3	**9.88**
	93	KC07	KMC	Install GPTs with sediment bays for Moore Res catchment in Oatley Bay	1.3	3.9	3.00	3	**9.00**
	99	KC26	KMC	Install GPTs/Sediment Bays other than Moore Reserve and Poulton Park catchments for Neverfail/Oatley Bay	1.9	4.2	2.21	3	**6.63**
Wetlands	**53**	KC47	KMC	Install GPT/infiltration system in Augusta Street	0.45	5	11.11	3	**33.33**
& infiltration	**61**	KC08	KMC	Use Moore Reserve wetland as an educational opportunity on stormwater pollution	0.25	7.4	29.60	1	**29.60**
	79	KC38	KMC	Install wetland in the south part of Carss Park with upstream GPT that treats oil/sediments/litter	4.5	7.2	1.60	10	**16.00**
	84	KC17	KMC	Construct a wetland in the northern part of Moore Reserve with upstream GPT.	5	7	1.40	10	**14.00**
	85	KC30	KMC	Install offline wetland with upstream GPT to treat sediment/oil/litter on western side of Beverley Park Golf Course. Investigate the possibility of diverting stormwater from Moore Park to place wetland further upstream.	5	6.8	1.36	10	**13.60**
	106	KC59	KMC	Introduce a wet sediment basin in Shipwrights Bay Reserve	1.25	6.4	5.12	1	**5.12**
	112	KC19	KMC, RTA	Construct a wetland in the quarry site with upstream GPT to cater for litter, sediment and oil	4.5	7	1.56	1	**1.56**
	113	KC39	KMC, Sydney Water	Install wetland in the south part of Harold Frazer Reserve with upstream GPT that treats oil/sediments/litter	5	7.2	1.44	1	**1.44**
Stream	**46**	KC14	KMC	Rehabilitate creeks in Moore Reserve	1.35	5.7	4.22	10	**42.22**
restoration	**50**	KC25	KMC	Construct a 'natural creek to replace foreshore pipe in Oatley Pleasure Grounds	0.775	5.8	7.48	5	**37.42**
rehabilitation	**67**	KC51	KMC	Construct a 'natural creek' in Connells Point Reserve.	1.12	5.8	5.18	5	**25.89**
	69	KC15	KMC	Introduce a constructed "natural creek" to replace the use of the western stormwater pipeline in Moore Reserve	2.5	6	2.40	10	**24.00**
	79	KC58	KMC	Introduce a constructed "natural creek" to replace the use of the stormwater pipeline behind tennis courts in Shipwrights Bay Reserve, install a GPT upstream.	2	6.4	3.20	5	**16.00**
	82	KC56	KMC	Rehabilitate creeks in Shipwrights Bay catchments, providing water way crossings	2	6	3.00	5	**15.00**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	**Multiplied Index**
				where unsealed vehicle access crosses natural drainage lines					
	103	OA55	All Councils	Develop a mangrove regeneration program	1.075	6.8	6.33	1	**6.33**
	110	KC23	KMC	Introduce a constructed "natural creek" north of quarry site in passive area	2	5.8	2.90	1	**2.90**
Investigations	**2**	[OA41]	RAC, All Councils	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	0.075	6.8	90.67	8	**725.33**
	12	OA23	All Councils, DUAP,DLWC	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	0.24	6.3	26.25	8	**210.00**
	13	[KC52]	KMC	Investigate the possibility of using a wet pond/infiltration facility for stormwater treatment of low flows such as infiltration basins in Merriman Reserve	0.025	4.8	192.00	1	**192.00**
	14	[KC05]	KMC	Assess the health of the existing wetland on the university grounds and monitor the runoff for potential pollutants	0.04	7.6	190.00	1	**190.00**
	17	[KC24]	KMC, RTA	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Bell Park, Eastern side of Hurstville Rd.	0.025	6.8	272.00	0.5	**136.00**
	29	[KC63]	KMC	Investigate the installation of trash rack or GPT in unnamed creek downstream of the Oatley Shopping area prior to the Gunga Bay wetlands to remove litter. Possible location is beneath Mulga Rd where the pipes discharge into wetlands	0.05	3.6	72.00	1	**72.00**
	10	[KC42]	KMC	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Stuart Park, Meade Park and Empress Reserve	0.04	4.4	110.00	2	**220.00**
	24	[KC04]	KMC	Investigate the possibility of recycling stormwater for the use of irrigation in Moore Reserve.	0.075	7.2	96.00	1	**96.00**
	31	[KC37]	KMC	Investigate the possibility of recycling stormwater for the use of irrigation on Beverley Park Golf Club	0.05	7	140.00	0.5	**70.00**
	40	KC18	Hurstville Council, RAC	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	1.1	6.9	6.27	8	**50.18**
	43	KC43	KMC, Hurstville, RAC	Investigate and provide treatment measures in the upper catchment north of Empress Res	1.2	7	5.83	8	**46.67**
	52	OA25	All Councils	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	0.1225	4.2	34.29	1	**34.29**
	64	[KC01]	KMC	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from McRaes	0.05	7	140.00	0.2	**28.00**

Category	Rank	Ref. No.	Responsibility	Stormwater Management Action	Cost Index	Benefit index	Benefit /Cost Index	Factor Loop Multiplier	Multiplied Index
				Res to open space area in northern end of Moore Reserve Catchment.					
	71	[OA27]	All Councils	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	0.4	9.2	23.00	1	**23.00**
	75	OA22	Sydney Water	Investigate the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	0.35	6.5	18.57	1	**18.57**
	89	OA17	All Councils	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	3	6.6	2.20	5	**11.00**
	105	[OA59]	All Councils	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	1.05	6.6	6.29	1	**6.29**
	114	OA47	All Councils	Investigate and implement an appropriate street sweeping program	3.075	4	1.30	1	**1.30**
Misc	**32**	KC57	KMC	Divert stormwater outlet to natural creek at northern end of Woodlands Ave and include a sediment bay.	0.045	3	66.67	1	**66.67**
	42	OA15	All Councils	HARMFUL SUBSTANCES DISPOSAL DEPOT - Appropriate authority or industry body to provide facilities for disposal of oils and harmful chemicals and make known to industrial/ commercial managers and residents. Ref. Waste Services Authority	1.06	6.2	5.85	8	**46.79**
	48	OA06	RTA	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	1	5.2	5.20	8	**41.60**
	81	KC16	KMC	Collect and treat leachate at the southern end of Moore Reserve	5	7.8	1.56	10	**15.60**

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

8.6.4 Final Ranking of Rockdale LGA Options

The final ranking spreadsheet for stormwater management options in the Rockdale LGA are given in **Table 8.12** below.

Table 8.12: Final Ranking of Rockdale LGA Options

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
1	OA34	Raise awareness of penalties for a range of poor practices related to stormwater	0.02	7.40	493.33	7	**3453**
2	OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	0.02	7.20	480.00	6	**2880**
3	LEFT BLANK INTENTIONALLY						
4	OA60	Produce a simplified stormwater management plan with educational components (make accessible)	0.08	8.00	106.67	8	**853**
5	LEFT BLANK INTENTIONALLY						
6	OA63	Measure and report effectiveness of options for all issues	0.08	8.40	112.00	7	**784**
7	[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	0.08	6.80	90.67	7	**635**
8	OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	0.08	5.80	77.33	8	**619**
9	[OA42]	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	0.08	6.60	88.00	7	**616**
10	OA65	Provide updates of treatment device performance through various forms of media.	0.13	7.20	57.60	10	**576**
11	OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	0.11	8.60	81.90	7	**573**
12	OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	0.10	7.60	76.00	7	**532**
13	OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	0.10	7.00	71.79	7	**503**
14	OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	0.09	5.80	66.29	7	**464**
15	OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	0.11	4.80	45.71	10	**457**
16	LEFT BLANK INTENTIONALLY						
17	OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	0.10	5.90	62.11	7	**435**
18	OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	0.06	5.20	83.20	5	**416**
19	OA64	Develop litter management programs for recreational/park areas	0.08	4.40	58.67	7	**411**
20	OA52	Promote "No junk mail" stickers	0.05	3.40	68.00	6	**408**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
21	OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	0.18	6.50	37.14	10	**371**
22	[OA26]	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	0.10	7.40	77.89	4	**312**
23	OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	0.20	6.20	31.00	10	**310**
24	OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	0.10	4.40	44.00	7	**308**
25	OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	0.18	8.00	45.71	6	**274**
26	OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	0.21	7.60	36.19	7	**253**
27	OA25	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	0.12	4.80	39.18	6	**235**
28	OA62	Identify stormwater system gaps in drainage map and update.	0.06	6.40	116.36	2	**233**
29	OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	0.15	4.90	32.67	7	**229**
30	OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	0.25	8.00	32.00	7	**224**
31	OA49	Identify and educate pamphlet and local paper deliverers	0.12	3.80	33.04	6	**198**
32	OA45	Waste Minimisation & Education Campaign at Rail Stations & Corridor	0.15	4.20	28.00	7	**196**
33	[RC12]	BENCHMARK WATER QUALITY PROGRAM - Continue WQ monitoring program commenced in Dec 98 to establish benchmark WQ at 13 sites in Rockdale	0.33	7.60	23.38	8	**187**
34	OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	0.35	6.50	18.57	10	**186**
35	OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	0.53	8.40	16.00	10	**160**
36	OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	0.40	7.80	19.50	8	**156**
37	OA46	Encourage rainwater tanks and on-site detention for new and existing developments	0.13	3.80	30.40	5	**152**
38	OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	0.13	6.30	50.40	3	**151**
39	OA22	Lobby State Govt. re: the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	0.35	6.50	18.57	8	**149**
40	OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	0.13	3.60	28.80	5	**144**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	**Multiplied Index**
41	RC11	Enable secondary contact recreation access in Scarborough Ponds by ensuring safe points which are clearly identifiable and accessible. This will increase enjoyment and education benefited from the ponds.	0.10	2.84	28.40	5	**142**
42	OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	0.24	6.30	26.25	5	**131**
43	LEFT BLANK INTENTIONALLY						
44	OA58	Develop and implement maintenance programs for treatment devices	0.58	7.00	12.17	10	**122**
45	OA61	Develop methods to encourage wide community participation with stormwater management.	0.58	8.40	14.61	7	**102**
46	OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	0.28	4.60	16.73	6	**100**
47	RC02	Create buffer strips between stormwater lines and horse stables such that sediment in water flowing from the stables is intercepted before reaching the waterways.	0.30	4.04	13.47	7	**94**
48	OA50	Encourage cleanup days at schools and combine with education program	0.12	3.60	31.30	3	**94**
49	OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Lobby State Govt. that existing disposal depots be retained with the approp. authority or industry body to continue to provide facilities for disposal of oils & make known to industrial/commercial mgrs & residents.	0.56	6.20	11.07	8	**89**
50	[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	0.55	9.20	16.73	5	**84**
51	OA54	Compile inventory of riparian and aquatic habitats and their state	0.58	6.80	11.83	7	**83**
52	[OA59]	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	0.55	6.60	12.00	6	**72**
53	OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	0.55	4.20	7.64	9	**69**
54	OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	1.30	8.20	6.31	10	**63**
55	RC06	Install trash rack or GPT in Sans Souci Drain No. 1 at Little Reserve downstream of the fast food/commercial areas on Rocky Point Road.	0.88	5.24	5.99	10	**60**
56	OA55	Develop a mangrove regeneration program	0.58	6.80	11.83	5	**59**
57	[OA11]	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	0.16	4.60	29.21	2	**58**
58	OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	0.56	4.60	8.21	7	**58**
59	OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	1.15	8.00	6.96	8	**56**
60	OA31	Maintain bush walking tracks	0.35	2.74	7.83	7	**55**
61	OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	0.25	6.60	26.40	2	**53**
62	RC05	Install trash rack or GPT in Sans Souci Drain No. 2 downstream of the Ramsgate Shopping area to remove litter.	1.00	5.24	5.24	10	**52**
63	RC07	Install trash rack or GPT in Sans Souci Drain No. 3	0.80	5.24	6.55	8	**52**
64	OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	0.50	5.20	10.40	5	**52**
65	RC08	Install Constructed Wetlands on Sans Souci Drain No.s 1-3 and upstream of Scarborough Ponds to treat elevated bacteria and oxygen demanding organic matter in stormwater. Note: concept	1.50	7.44	4.96	10	**50**

Rank	Ref. No.	Management Options	Cost Index	Benefit Index	Benefit Cost Index	Factor Loop Multiplier	Multiplied Index
		plans have already been drawn up for Stan Moses Res in SS Drain No.2					
66	RC04	Point source collection of litter from major contributing areas such as the Ramgate Shopping area and fast food and shopping outlets along Rocky Point Road. (litter baskets)	0.68	5.30	7.85	6	**47**
67	RC09	Install litter and sediment collection traps, preferrably as close to the source as possible, to intercept litter and sediment prior to it reaching Lady Robinsons Beach.	0.80	4.70	5.88	8	**47**
68	OA48	Place passive signage in parks for litter.	0.38	3.40	9.07	5	**45**
69	OA66	Install GPTs for runoff from railway land	0.60	3.76	6.27	7	**44**
70	OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	1.08	4.40	4.09	10	**41**
71	RC03	Install litter collection devices on all drains feeding into Scarborough Ponds	1.00	5.30	5.30	7	**37**
72	OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	2.00	7.00	3.50	10	**35**
73	RC10	Improve access along open drains to enhance safety	1.00	2.90	2.90	10	**29**
74	OA57	Promote bushcare groups and progress of bush regeneration	0.25	6.60	26.40	1	**26**
75	OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	2.00	6.60	3.30	7	**23**
76	RC01	STREAMFLOW MGT & ENHANCE AQUATIC & RIPARIAN HABITATS IN SANS SOUCI DRAIN NO.S 1-3 to minimise scouring in earth channels	2.00	4.80	2.40	5	**12**
77	OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	9.50	6.40	0.67	10	**7**

[] stormwater management actions with Ref. No.s in brackets have follow-up actions – refer to **Section 8.7**

8.7 Follow-up Actions

Some of the actions require environmental studies, reviews or water quality monitoring. After completion of these activities, further action may be required. As the type of action required, and hence the cost associated with the action, will depend on the outcomes of the investigations the cost associated with any follow-up actions to the options has not been included in the cost-benefit analysis.

It is therefore essential that the options ranking is reviewed annually to incorporate any recommendations from studies, reviews or monitoring.

Where further action is likely to be required, the action reference number in the above tables is enclosed within square brackets eg. [RC12]. A list of the likely follow up actions and those responsible is given in **Table 8.13** below.

Table 8.13: Follow-up Actions

Ref. No.	Follow-up Action	Responsibility
[OA42]	Implement feasible management options for main roads & facilities construction, operations & maintenance arising from the investigations.	RTA
[OA26]	Implement recommendations from investigation on new carpark developments & retrofit on existing carpark lots where appropriate.	All Council
[OA41]	Implement the feasibile main options for railways & facilities for construction, operations & maintenance arising from the investigations.	RAC
[OA25]	Change suppliers of fertilizers/herbicides/pesticiedes & alter application methods accoriding to thte recommendations of the study.	All Council & Industry
[OA11]	Act on results of study into the impact of reducing impervious areas on stormwater run-off and stormwater quality.	All Councils
[SC10]	Act on results of aircraft fuel fall-out study in conjunction with FAC	SSC, FAC
[SC12]	Install wetlands where appropriate according to the results of the study.	SSC
[SC11]	Act on recommendations of investigation study into industrial pollution sources.	SSC, Industry
[OA27]	Install wetlands in schools and golf courses wherever appropriate accoriding to the recommendations of the study.	All Councils
[SC04]	Install sediment traps downstream of permanent industrial areas (such as aren point and Kurnell) according to the result of the study.	SSC, Industry
[OA59]	Develop guidelines for the requirement of developers funding stormwater works where they are seen to impact on stormwater of environmental quality.	All Councils, Industry, EPA
[HC11]	Change suppliers of bank stabilisation materials accoriding to the results of investigations. Alter application methods in accordance with best practices.	HC
[HC10]	Implement re-establishment of riparian and aquatic habitats in Boggywell Ck drain, Hurstville G.C. drain and the un-named creek upstream of Lime Kiln Bay in accordance with the outcomes of the feasibility study.	HC
[HC07]	Install wetlands downstream of major landfill areas according to the results of feasibility study.	HC
[HC05]	Install trash-rack or GPT according to recommendations of investigation in creek downstream of Oatley Shopping area.	HC
[KC52]	Implement recommendations of investigation in Merriman Reserve.	KMC
[KC05]	Assess the options for treatment of pollutants found as a result of the University wetlands study, and implement the appropriate treatment measure.	KMC, University
[KC24]	Install appropriate infiltation facility accoriding to studies in Bell Pk.	KMC
[KC42]	Implement the appropriate infiltration facility in Stuart Pk according to recommendations study.	KMC
[KC04]	Recycle stormwater in Moore Reserve according to the results of study.	KMC
[KC37]	Recycle stormwater in Beverley Pk G.C.	KMC
[KC01]	Implement outcomes of Water Sensitive Urban Design study in relation to flooding problemsna dn extending vegetation corridors in McRaes Reserve to Moore Reserve.	KMC
[RC12]	Assess the results of Benchmark water quality monitoring program and implement appropriate water quality controls where problem areas are identified.	RCC

Contents

9. Strategy for the Implementation of the Lower Georges River Catchment SMP for Each Council Area and Government Agency

9.1 Council Implementation Strategies

To ensure the stormwater management options identified in **Section 7** are implemented, it is essential that an implementation strategy be developed as pat of the SMP. As each Council has a separate procedure for obtaining funding for stormwater works within their Council area, a separate implementation strategy has been developed for each Council.

The stormwater management options discussed in the previous sections have been separated into the various Council strategies in accordance with the resonsibilites identified in the tables. Each Council strategy has only those options for which the Council has all or part responsibility. These implementation strategies are to form the basis for Council's strategic plans and works programs subject to the availability of Council and Government funds at the respective stages of the five year program. This is critical to the success of the SMP and has been developed in coordination with relevant Council officers.

It is recognised that there is insufficient funding and resource to be able to implement all options in the short term. Implementation of the options has therefore been divided in to the following time frames:

- 1st Year
- 2nd & 3rd Years
- 4th & 5th Years
- >5 Years (remaining actions)

The timeframe assigned to each option is in accordance with the catchment wide ranking of the options.

The Council implementation strategies are given on the following pages and are separated by clearly labelled dividers and printed on different coloured paper. This easily identifies each Council strategy and allows for each strategy to be removed, revised and then replaced into the SMP document without reprinting the entire document. Revision of each Implementation Strategy should occur annually, refer to **Section 11.2.**

Each strategy contains up to three components: a Council organisation structure and responsibility diagram; a diagram showing the position of the SMP in Council's planning process; and an action and financial

expenditure table. These are discussed in more detail below.

9.2 Council Structure and Responsibility

An attempt has been made to describe the present Council structure, identifying each section and subsection having responsibility for stormwater management within the council area. The person responsible within each section and subsection has also been identified. These people are likely to be involved with implementation of the options listed in the Action and Financial Expenditure Table. Communication between all stormwater managers will be required for implementation of the options.

Each structure and responsibility diagram was developed in coordination with Council officers.

9.3 Position of SMP in Council's Planning Process

The implementation of this SMP is reliant upon effective integration of its Implementation Strategy into Councils' management planning process under the *Local Government Act 1993* and their budgetary process. This important link is illustrated graphically to each Council in the pages following its Implementation Strategy.

9.4 Action and Financial Expenditure Tables

Each table contains the following information:

- **Ref. No.**:
  This is the unique standard reference number for each stormwater management action to allow easy cross-referencing of actions between tables. Ref. No.s that begin with OA are generally overall actions involving all Councils and in some cases other stormwater managers such as the RTA, RAC or Sydney Water. Other Ref. No.s indicate that the action is specific to the corresponding Council.
- **Action:**
  This is the description, in summary form, of the stormwater management option Council is to implement.
- **Rank:**
  The rank is the priority assigned by the corresponding Council to the stormwater management action. Options have been ranked within each Council in order of priority, from highest priority (rank=1) to lowest priority. The rank was based on the ranking of all stormwater management options for the catchment.

- **Financial Year and Expenditure:**
  The cost data for each action has been divided into capital cost and maintenance cost. Costs shown are applicable to Council and are apportioned to each stormwater manager (where there is more than one) as described in "Contribution" below.

  If an action is to be implemented in the first year, then capital and maintenance cost information is shown for the first and remaining years of its lifetime. If an action is not implemented until the second or third, or fouth or fifth years, then the same applies without any cost information shown for the years leading up to implementation of the action.
- **Performance Indicator:**
  At least one performance indicator (PI) is assigned to each action in the Implementation Strategy tables that follow. The PI is to be used by the stormwater managers to assess the effectiveness of the SMP as part of the on-going review process. The PI number provided refers to **Table 10.1** in the following section. Further information relating to the PI is provided in **Section 10**, Monitoring the effectiveness of the SMP.

Contribution

The contribution of Council is not shown in the financial year and expenditure tables.

Where all Councils are involved, the financial contribution for each Council has been calculated using the following percentage apportionment:

- Sutherland Shire Council: 57%
- Hurstville Council: 13%
- Kogarah Municipal Council: 20%
- Rockdale City Council: 10%

based on the percentage of the Lower Georges River catchment area in each LGA.

Where there are other stormwater managers such as the RAC or Sydney Water responsible, then the 100% cost of the action is shown. Costs for the RTA have been calculated using the Water Quality Cost Apportionment Methodology (WQCAM) developed by the RTA. A description of the WQCAM methodology is provided in **Section 9.11**. The exact apportionment of cost for the RAC and Sydney Water actions needs to be agreed to by all parties based on the load contribution from each area at the time of implementation.

The costs assigned to each action are indicative only and will need to be reassessed when further detail on each action is known.

9.5 Agency Implementation Strategies

Implementation strategies have also been developed for Sydney Water Corporation, Roads and Traffic Authority (RTA) and Rail Access Corporation (RAC) as well as the Environment Protection Authority (EPA). These strategies should form the basis for the agency strategic plans and works programs in relation to stormwater management. This is critical to the success of the SMP.

Each strategy contains similar information to that given in the Council Implementation Strategies. However, the cost given in the authority implementation strategies reflects the full implementation cost of each option. The exact contribution by the agency will need to be negotiated with Council at a later date.

9.6 Summary of Five Year Costs

A summary of the capital and maintenance costs for each Stormwater Manager is provided in **Table 9.1** below. Note that each stormwater manager is committed to the expenditure outlined in the following table, however, it is subject to the availability of Council and Government funds at the respective stages of the five year program.

Table 9.1: Summary of Five Year Implementation Costs

Stormwater Manager	1st Year		2nd & 3rd Years		4th & 5th Years		Total
	Capital ($)	Maint. ($)	Capital ($)	Maint. ($)	Capital ($)	Maint. ($)	
Sutherland Shire Council	1,541,390	266,205	317,210	660,600	142,700	683,440	3,611,545
Hurstville Council	1,416,710	434,040	73,560	900,020	557,920	1,019,830	4,402,080
Kogarah Municipal Council	1,495,160	118,600	740,700	328,300	1,778,000	506,400	4,967,160
Rockdale City Council	75,800	35,050	310,200	121,500	989,000	257,900	1,789,450
Sydney Water Corporation*	122,000	46,000	10,000	86,000	1,280,000	124,000	1,668,000
RTA	Refer to Table 9.9						405,479
RCA/ State Rail*	1,202,000	301,500	80,000	603,000	20,000	608,000	2,814,500
EPA*	85,000	28,500	-	54,000	-	57,000	224,500

* full cost shown - apportionment of costs between parties needs to be agreed to at implementation stage.

Details of the five year implementation strategy for stormwater management options for each Stormwater Manager are provided in the tables on the following coloured pages.

Note that not all the potential stormwater management options identified in **Section 7** are included in the implementation strategy tables for each of the Councils. The potential management options were developed so that a set of tools were available, out of which the actions for the implementation strategies would be selected. This explains why not all the potential management options appear in the implementation strategies.

9.7 Sutherland Shire Council Implementation Strategy

Table 9.2: Sutherland Shire Council Implementation Strategy

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	1	1,710	-	-	-	-	-	All Councils	Envir P & C, P& W	PI25 PI26 PI27
OA34	Raise awareness of penalties for a range of poor practices related to stormwater	2	1,710	-	-	-	-	-	All Councils	S & PU	PI19
OA63	Measure and report effectiveness of options for all issues	3	2,850	285	-	570	-	570	All Councils	S & PU	PI22 PI23 PI24
OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	5	3,420	855	-	1,710	-	1,710	All Councils	Envir P & C	PI25 PI26 PI27
[OA42]	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	6	-	-	5,700	1,140	-	1,140	RTA, All Councils	SWM	PI20 PI21
OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	7	3,420	1,710	-	3,420	-	-	All Councils	Envir P & C	PI03 PI04
OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	8	2,850	1,710	-	3,420	-	3,420	All Councils	Envir P & C	PI17 PI18
[OA26]	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	10	5,700	1,710	-	3,420	-	-	All Councils	Envir P & C	PI25 PI26 PI27
OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residential areas and commercial facilities - no car washing in the street - education &	11	5,700	1,710	-	3,420	-	-	All Councils	S & PU	PI25 PI26 PI27

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
	policing required										
OA62	Identify stormwater system gaps in drainage map and update.	15	570	285	-	570	-	570	All Councils	SWM	PI10 PI11
OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authorities/developers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	16	3,420	1,500	-	3,000	-	3,000	All Councils	S & PU, P& W	PI25 PI26 PI27
OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	17	-	-	5,700	3,420	-	3,420	All Councils	S & PU	PI25 PI26 PI27
SC13	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. Ref. Overall LGR SMO "OA23"	19	-	-	-	-	10,000	2,000	SSC	S & PU	PI12 PI13
OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	24	11,400	1,710	-	3,420	-	3,420	Sydney Water, All Councils	S & PU	PI07 PI08 PI09
OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	26	-	-	6,840	3,420	-	3,420	All Councils	Envir P & C	PI25 PI26 PI27
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	27	-	-	-	-	11,400	3,420	All Councils, RTA, RAC	P & W	PI17 PI18
OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	28	11,400	6,000	-	12,000	-	12,000	All Councils, RTA, RAC	SWM	PI17 PI18
SC08	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits to be installed around the Miranda Shopping precinct as well as	29	-	-	10,000	4,000	-	4,000	SSC	SWM	PI01 PI02

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
	additional bins.										
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	30	5,700	3,420	-	6,840	-	6,840	All Councils, RTA, RAC	S & PU	PI20 PI21
OA46	Encourage rainwater tanks and on-site detention for new and existing developments	31	2,850	570	-	1,140	-	1,140	All Councils	S & PU	PI25 PI26 PI27
[OA11]	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	33	-	-	13,680	3,000	-	3,000	All Councils	S & PU, P& W	PI25 PI26 PI27
[SC12]	Investigate the need for installing Constructed Wetlands (or other treatment) on Oyster Creek, Gwawley Creek and other miscellaneous creeks where land availability permits to treat elevated bacteria and oxygen demanding organic matter in SW	36	-	-	-	-	40,000	8,000	SSC, Sydney Water	S & PU	PI05 PI06 PI07 PI08 PI09
OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	37	-	570	-	1,140	-	1,140	All Councils	P & W	PI01 PI02
OA57	Provide onsite updateable signage showing progress of bush regeneration	40	-	-	5,700	4,000	-	4,000	SSC, /Sydney Water, RTA	P& W	PI17 PI18
SC16	INTRODUCE BUFFER STRIPS BETWEEN NUTRIENT SOURCES & WATERWAYS - nurseries, Horse Stables on Captain Cook Drive, Cronulla STP, and major sewer overflow locations (where possible).	41	-	-	-	-	30,000	6,000	SSC	SWM	PI05 PI06
SC06	Install trash rack or litter boom for Gwawley Ck upstream of Sylvania Waters. Also investigate origin of litter and look at point source controls.	42	-	-	20,000	4,000	-	4,000	SSC	S & PU	PI01 PI02
[SC11]	INVESTIGATE POLLUTION in stormwater run-off from industrial sites including the Cronulla STP, Caltex Oil Refinery, AGL, Abbotts, etc to ascertain if these sites are polluting SW and develop mitigation strategies on basis of results of investigation	46	-	-	30,000	6,000	-	6,000	SSC	S & PU	PI03 PI04 PI07 PI08 PI09

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No.*
OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	51	-	-	6,840	1,710	-	1,710	All Councils	S & PU	PI25 PI26 PI27
[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	52	-	-	-	-	45,600	11,400	All Councils	(5)S & PU, (1)SWM	PI05 PI06
OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	53	8,550	1,140	-	2,280	-	2,280	All Councils	P & W	PI25 PI26 PI27
OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	54	-	-	5,700	3,000	-	3,000	All Councils	Envir P & C	PI19
OA36	Increase enforcement and awareness of legislation related to stormwater	55	-	-	2,850	5,700	-	5,700	All Councils	Envir P & C	PI20 PI21
OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	56	2,850	5,000	-	10,000	-	10,000	All Councils	Envir P & C	PI25 PI26 PI27
OA61	Develop methods to encourage wide community participation with stormwater management.	58	-	-	8,550	5,700	-	5,700	All Councils	S & PU	PI17 PI18
[OA59]	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	61	-	-	5,700	5,700	-	5,700	All Councils	Envir P & C	PI25 PI26 PI27
OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	63	-	-	-	40,000	-	40,000	All Councils, RTA	S & PU	PI03 PI04
SC22	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	65		7,000	-	14,000	-	14,000	All Councils, RTA,	P & W	PI01 PI02

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
									RAC & Sydney Water		PI05 PI06
OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	67	6,840	11,400	-	22,800	-	22,800	All Councils, RTA, RAC & Sydney Water	Envir P & C	PI25 PI26 PI27
SC01	GWAWLEY CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	68	100,000	1,000	-	2,000	-	2,000	SSC	(3)S & PU, (1)SWM	PI01 PI02 PI12 PI13 PI14 PI15 PI16
OA31	Maintain bush walking tracks	69	17,100	1,140	-	2,280	-	2,280	All Councils	P & W	PI32
OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	70	17,100	8,550	-	17,100	-	17,100	All Councils	S & PU	PI22 PI23 PI24
OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	71	5,700	6,840	-	13,680	-	13,680	All Councils	Envir P & C	PI19
SC23	INSTALL TRASH RACK at Seymour Shaw Park, The Boulevarde, Miranda	72	-	-	70,000	6,000	-	6,000	SSC	SWM	PI01 PI02
SC03	OYSTER CK STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	73	-	-	100,000	20,000	-	20,000	SSC	S & PU	PI01 PI02 PI12 PI13 PI14 PI15 PI16
SC24	SIR JOSEPH BANKS DRIVE, KURNELL - GPT	74	42,000	7,000	-	14,000	-	14,000	SSC	SWM	PI01 PI02 PI05

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
											PI06
OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	75	-	-	-	-	-	-	RAC	SWM	PI20 PI21
OA66	Install GPTs for runoff from railway land	76	-	-	11,400	5,700	-	5,700	All Councils	P & W	PI03 PI04
OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	77	-	-	-	-	5,700	2,280	All Councils	P & W	PI32
SC05	Install sediment trap (& litter) GPT in drain feeding into Sylvania Waters at Box Road. Currently being designed.	79	100,000	7,000	-	14,000	-	14,000	SSC	SWM	PI01 PI02
SC25	ENDEAVOUR ROAD, CARINGBAH - GPT	80	63,000	8,000	-	16,000	-	16,000	SSC, RTA	SWM	PI01 PI02 PI05 PI06
OA54	Compile inventory of riparian and aquatic habitats and their state	81	-	-	8,550	5,700	-	5,700	All Councils	(3)Envir P & C, (5)Riverkeeper	PI14 PI15 PI16
OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	83	8,550	15,000	-	30,000	-	30,000	All Councils	(1)Envir P & C, (1,3,5)P&W	PI20 PI21
SC26	SCYLLA BAY - GPT	84	116,000	7,000	-	14,000	-	14,000	SSC	SWM	PI01 PI02 PI05 PI06
OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	85	171,000	17,100	-	34,200	-	34,200	RTA, All Councils	SWM	PI03 PI04
OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg.	88	570,000	114,000	-	228,000	-	228,000	All Councils, RTA	Waste	PI01 PI02

Ref. No.	Action		Financial Year & Expenditure*								
			Year 1		Years 2 & 3		Years 4 & 5				
		Rank	Capital	Maint.	Capital	Maint.	Capital	Maint.	Responsibility	SSC Dept.	PI No. *
	better equipment, larger areas etc.)										
SC19	MAINTENANCE OF GPT located in Cronulla Golf Course, Hume Road, Cronulla	89	-	6,000	-	12,000	-	12,000	SSC	C & PA	PI01 PI02 PI05 PI06
SC18	MAINTENANCE OF GPT on Gwawley Ck, Box Road, Miranda	90	-	8,000	-	16,000	-	16,000	SSC	C & PA	PI01 PI02 PI05 PI06
SC20	MAINTENANCE OF GPT located in Cronulla Golf Course, Sturt Road, Cronulla	91	-	5,000	-	10,000	-	10,000	SSC	C & PA	PI01 PI02 PI05 PI06
SC21	MAINTENANCE GPT IN RESOLUTION DRIVE at the intersection of Edeavour Rd (sth), Woolooware	92	250,000	8,000	-	16,000	-	16,000	SSC, RTA	C & PA	PI01 PI02 PI05 PI06

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**
* PI No. refers to **Table 10.1** in **Section 10**.

Table 9.3: Stormwater Management Actions not included in the 5 year Implementation Strategy for Sutherland Shire Council

Ref. No.	Action	Rank	Responsibility
OA32	Develop guidelines for residential and commercial fertiliser, pesticide and herbicide use, increase awareness the impact of these applications	4	All Councils
OA60	Produce a simplified stormwater management plan with educational components (make accessible)	9	All Councils
OA52	Provide "No junk mail" stickers	12	All Councils
OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	13	RTA, RAC, All Councils, EPA
[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	14	RAC, All Councils
OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	18	All Councils, RTA, RAC
[OA	Investigate alternative fertilisers/herbicides/pesticides & application methods	20	All

Ref. No.	Action	Rank	Responsibility
25]	in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.		Councils
OA64	Develop litter management programs for recreational/park areas	21	All Councils
OA53	Investigate the use of hot water and other alternatives to herbicides	22	All Councils
OA65	Provide updateable signage at various treatment devices showing statistics of what has been captured.	23	All Councils
OA68	Exercise regulations under the Clean Waters Act to require sewage holding tanks on pleasure craft boats to prevent direct sewage discharge into the LGR	25	All Councils
OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	32	All Councils
[SC15]	WORK WITH PRIVATE FERTILISER USERS - golf courses, nurseries (Flower Power in particular) - to identify ways in which nutrients could be reaching the waterways and how to prevent it and/or treat it.	34	SSC
[SC10]	INVESTIGATE AIRCRAFT FUEL/OIL FALL-OUT - Ascertain if it is a pollution source and move towards ways of mitigating if it is found to be.	35	SSC, FAC?
OA50	Encourage cleanup days at schools and combine with education program	39	All Councils
SC17	PREVENT STREET RUBBISH DUMPING - particularly in Kurnell. Clean-up when ever possible.	43	SSC
OA49	Identify and educate pamphlet and local paper deliverers	44	All Councils
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	45	All Councils, RTA, RAC, EPA
OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	47	Sydney Water, All Councils, EPA
SC07	Install trash rack or litter boom in un-named creek/drain downstream of Caringbah Residential area (drains into Woolooware Bay). Also investigate origin of litter and look at point source controls.	49	SSC
SC09	POINT SOURCE COLLECTION OF LITTER - litter baskets in pits could be installed around the fast food and shopping outlets along Kingsway/Princes Highway.	50	SSC
[SC04]	Investigate the expected improvement in sedimentation reduction in waterways by installing a sediment trap(s) or GPT(s) downstream of the permanent industrial zones such as Taren Point and Kurnell.	57	SSC
SC02	GWAWLEY WETLANDS STREAMFLOW MGT & BANK STABILISATION - to minimise scouring & therefore erosion, particularly where concrete pipes/channels discharge into natural streams. Use natural materials	59	SSC
OA58	Develop and implement maintenance programs for treatment devices	60	All Councils
[OA15]	HARMFUL SUBSTANCES DISPOSAL DEPOT - Appropriate authority or industry body to provide facilities for disposal of oils and harmful chemicals and make known to industrial/ commercial managers and residents. Ref. Waste Services Authority	62	All Councils
SC14	Removal of weed species, particularly Bitou Bush upstream of the Towra Nature Reserve in Kurnell.	64	SSC
OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	78	All Councils
OA55	Develop a mangrove regeneration program	82	All Councils
OA48	Place passive signage in parks for litter.	66	All Councils
OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	86	All Councils

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**

9.8 Hurstville Council Implementation Strategy

Table 9.4: Hurstville Council Implementation Strategy

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
OA34	Raise awareness of penalties for a range of poor practices related to stormwater	1	390	-	-	-	-	-	All Councils	PI19
OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	2	390	-	-	-	-	-	All Councils	PI25 PI26 PI27
OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	3	780	195	-	390	-	390	All Councils	PI25 PI26 PI27
[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	4	1,300	130	-	260	-	260	RAC, All Councils	PI20 PI21
OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	5	1,560	390	-	780	-	780	All Councils	PI25 PI26 PI27
[OA42]	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	6	1,300	130	-	260	-	260	RTA, All Councils	PI20 PI21
OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	7	780	195	-	390	-	390	All Councils	PI25 PI26 PI27
OA03	STORMWATER PIT STENCILLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	8	-	-	2,600	1,560	-	1,560	All Councils, RTA, RAC	PI17 PI18
OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	9	780	390	-	780	-	-	All Councils	PI03 PI04

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	10	650	390	-	780	-	780	All Councils	PI17 PI18
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	11	-	-	2,600	780	-	780	All Councils, RTA, RAC	PI17 PI18
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	12	1,300	780	-	1,560	-	1,560	All Councils, RTA, RAC	PI20 PI21
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	13	-	-	-	-	2,600	1,560	All Councils, RTA, RAC, EPA	PI20 PI21
OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	14	-	-	-	-	5,200	1,500	Sydney Water, All Councils, EPA	PI07 PI08 PI09
OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	15	1,300	195	-	390	-	390	All Councils	PI19
OA68	Lobby State Govt. to give the Waterways Authority the power-by amendment to the Clean Waters Act to require sewage holding tanks on pleasure craft boats to prevent direct sewage discharge into the LGR	16	650	195	-	390	-	-	All Council & Waterways Authority	PI07 PI08 PI09
OA36	Increase enforcement and awareness of legislation related to stormwater	18	650	650	-	1,300	-	1,300	All Councils	PI20 PI21
HC03	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in the gully creek downstream of Brewer Place which flows into Boggywell Ck	19	-	-	-	-	50,000	5,000	HC	PI01 PI02 PI12 PI13 PI14 PI15 PI16

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
OA67	CAR WASHING BAYS – review policies relating to the provision of car wash facilities in high rise developments – also single dwelling residetial areas and commercial faciliites – no car washing in the street – eductation & policing required	20	1,300	390	-	780	-	-	All Councils	PI25 PI26 PI27
OA62	Identify stormwater system gaps in drainage map and update.	21	130	65	-	130	-	130	All Councils	PI10 PI11
OA63	Measure and report effectiveness of options for all issues	22	650	65	-	130	-	130	All Councils	PI22 PI23 PI24
OA60	Produce a simplified stormwater management plan with educational components (make accessible)	23	650	65	-	130	-	130	All Councils	PI17 PI18
[OA25]	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	24	-	-	1,560	-	-	-	All Councils	PI20 PI21
OA32	Develop guidelines for residential and commercial fertiliser, pesticide and herbicide use, increase awareness the impact of these applications	25	260	260	-	520	-	520	All Councils	PI19
OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	26	1,300	260	-	520	-	520	All Councils	PI20 PI21
OA46	Encourage rainwater tanks and on-site detention for new and existing developments	27	650	130	-	260	-	260	All Councils	PI25 PI26 PI27
OA04	LITTER REDUCTION EDUCATION – target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	28	650	390	-	780	-	780	All Councils, RTA, RAC	PI20 PI21
[OA11]	REDUCTION OF % IMPERVIOUS AREA – investigate the expected improvement in erosion reduction and sedimentation of waterways.	29	-	-	-	-	3,120	380	All Councils	PI25 PI26 PI27
[HC11]	Investigate the use of safer alternative products for bank stabilisation, particularly in the un-named creek upstream of Lime Kiln Bay where bark chips are currently being used.	30	-	-	-	-	5,000	1,000	HC	PI01 PI02 PI05 PI06
[OA59]	Investigate mechanisms that would require developers to	31	1,300	650	-	1,300	-	1,300	All Counci	PI25 PI26

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
	fund works in the catchment for impacts they may have								ls	PI27
OA19	REVIEW EMERGENCY PROCEDURES – for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	32	650	195	-	380	-	380	RTA, RAC, All Councils, EPA	PI03 PI04 PI07 PI08 PI09
[OA26]	CAR PARK LOT STORAGE & TREATMENT – investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	33	1,300	390	-	780	-	-	All Councils	PI25 PI26 PI27
OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	34	-	-	2,600	780	-	780	Sydney Water, All Councils	PI07 PI08 PI09
HC09	ACTION A PLAN TO PRESERVE AQUATIC HABITATS, initially by controlling access in sensitive areas. After Overall LGR SMO "OA23"	35	-	-	10,000	3,000	-	3,000	HC	PI12 PI13
OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	36	1,560	195	-	380	-	380	All Councils	PI25 PI26 PI27
OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	37	-	-	3,900	3,900	-	3,900	All Councils	PI22 PI23 PI24
OA52	Provide "No junk mail" stickers	38	650	130	-	260	-	260	All Councils	PI17 PI18
OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and …	39	-	-	7,800	3,120	-	3,120	All Councils	PI20 PI21
OA50	Encourage cleanup days at schools and combine with education program	41	390	130	-	260	-	260	All Councils	PI17 PI18
OA58	Develop and implement maintenance programs for treatment devices	42	1,950	650	-	1,300	-	1,300	All Councils	PI10 PI11
OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT – consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	43	-	-	5,200	1,040	-	1,040	All Councils	PI12 PI13

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
OA64	Develop litter management programs for recreational/park areas	44	650	65	-	130	-	130	All Councils	PI01 PI02
OA65	Provide updateable signage at various treatment devices showing statistics of what has been captured.	45	-	-	1,950	130	-	130	All Councils	PI17 PI18
[HC10]	CONDUCT FEASIBILITY STUDY FOR RE-ESTABLISHING HEALTHY RIPARIAN & AQUATIC HABITATS in Boggywell Ck drain, Hurstville G.C drain and the un-named creek upstream of Lime Kiln Bay where appropriate.	46	-	-	-	-	40,000	6,000	HC	PI12 PI13 PI14 PI15 PI16
OA54	Compile inventory of riparian and aquatic habitats and their state	47	-	-	1,950	1,300	-	1,300	All Councils	PI14 PI15 PI16
HC06	INSTALL BARAMY TRASH RACK (currently being considered by Council) in un-named creek as part of Lime Kiln Bay wetland development.	48	130,000	10,000	-	20,000	-	20,000	HC	PI01 PI02
OA57	Promote local bushcare groups and their progress	49	-	-	10,000	4,000	-	4,000	All Councils	PI17 PI18
OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	50	-	-	1,300	520	-	520	All Councils	PI32
OA24	DELINEATE RIPARIAN BUFFERS IN LEPs – implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	51	-	-	1,300	780	-	780	All Councils	PI25 PI26 PI27
OA53	Investigate the use of hot water and other alternatives to herbicides	52	-	-	1,300	260	-	260	All Councils	PI20 PI21
OA55	Develop a mangrove regeneration program	53	1,950	650	-	1,300	-	1,300	All Councils	PI14 PI15 PI15
OA61	Develop methods to encourage wide community participation with stormwater management.	54	1,950	650	-	1,300	-	1,300	All Councils	PI17 PI18
OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	55	1,560	2,600	-	5,200	-	5,200	All Councils, RTA, RAC & Sydney Water	PI25 PI26 PI27
OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	56	-	-	1,950	3,900	-	3,900	All Councils	PI20 PI21
OA07	ANIMAL FAECES PICK-UP EDUCATION – provide "poop"	57	-	-	1,300	3,120	-	3,120	All Counci	PI19

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
	bags in public parks and educate community on the use of them.								ls	
OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	58	1,950	260	-	520	-	520	All Councils	PI25 PI26 PI27
[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	59	-	-	10,400	2,600	-	1,300	All Councils	PI05 PI06
OA49	Identify and educate pamphlet and local paper deliverers	60	390	130	-	260	-	260	All Councils	PI20 PI21
OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION – monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	61	-	-	-	-	52,000	10,400	All Councils	PI07 PI08 PI09
OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	62	650	650	-	1,300	-	1,300	All Councils	PI25 PI26 PI27
[HC07]	Investigate the feasibility of installing Constructed Wetlands downstream of the major landfill areas (Boggywell Ck, Hurstville G.C.) to treat elevated bacteria and oxygen demanding organic matter in stormwater as well as sewer overflows.	63	-	-	-	-	40,000	8,000	HC	PI01 PI02 PI05 PI06
OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	64	650	130	-	260	-	260	All Councils	PI01 PI02
OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT – Lobby State Govt. that existing disposal depots be retained with the approp. Authority or industry body to continue to provide facilities for disposal of oils & make known to industrial/commercial mgrs & residents.	66	1,560	1,300	-	2,600	-	2,600	All Councils	PI03 PI04
HC01	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek upstream of Lime Kiln Bay	67	-	-	-	-	150,000	30,000	HC	PI01 PI02 PI12 PI13 PI14

Ref No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Years 2 & 3		Years 4 & 5			
										PI15 PI16
HC02	STREAMFLOW MGT & BANK STABILISATION to minimise scouring in un-named creek downstream of Peakhurst Industrial Area	68	-	-	-	-	150,000	30,000	HC	PI01 PI02 PI12 PI13 PI14 PI15 PI16
HC04	Increase and implement an approved street and stormwater pit cleaning program	69	-	370,000	-	740,000	-	740,000	HC	PI01 PI02
HC08	Install Constructed Wetlands upstream of Lime Kiln Bay in un-named creek – this will act as a back-up to Sydney Waters SOLP operation for reducing faecal, bacteria and nutrient load to the LGR.	70	1,070,000	30,000	-	60,000	-	60,000	HC	PI01 PI02 PI05 PI06
HC12	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	72	-	-	-	-	20,000	10,000	Hurstville Council / RAC	PI01 PI02 PI05 PI06
OA48	Place passive signage in parks for litter.	73	-	-	1,950	780	-	780	All Councils	PI01 PI02
HC13	Investigate and provide treatment measures in the upper catchment north of Empress Res	74	-	-	-	-	40,000-	20,000	KMC / Hurstville / RAC	PI01 PI02 PI05 PI06
OA31	Maintain bush walking tracks	75	-	-	3,900	390	-	390	All Councils	PI32
HC14	Install litter control devices in Gannons Park (Bogywell Ck).	75a	180,000	10,000	-	20,000		20,000	HC	PI01 PI02

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**

* PI No. refers to **Table 10.1** in **Section 10**.

9.9 Kogarah Municipal Council Implementation Strategy

Table 9.5: Kogarah Municipal Council Implementation Strategy

Category	Ref. No.	Action	Rank	Financial Year and Expenditure							PI No.*
				Year 1		Years 2 & 3		Years 4 & 5		Responsibility	
				Capital	Maint.	Capital	Annual	Capital	Annual		
Education - Residential	OA45	Waste Minimisation & Education Campaign at Rail Stations & Corridor	11	-	-	-	-	-	-	RAC	PI17 PI18
	OA60	Produce a simplified stormwater management plan with educational components (make accessible)	21	-	-	1,000	200	-	200	All Councils	PI17 PI18
	OA32	Develop guidelines for residential and commercial fertiliser, pesticide and herbicide use, increase awareness the impact of these applications	22	400	400	-	800	-	800	All Councils	PI19
	OA34	Raise awareness of penalties for a range of poor practices related to stormwater	25	600	600	-	1,200	-	1,200	All Councils	PI19
	OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	27	1,000	600	-	1,200	-	1,200	All Councils	PI17 PI18
	KC60	Educational program for medium density flats	28	2,000	2,000	-	4,000	-	4,000	KMC	PI17 PI18
	OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	32	-	-	2,000	600	-	600	All Councils / Waterways	PI19
	OA52	Promote "No junk mail" stickers	33	1,000	200	-	400	-	400	All Councils	PI17 PI18
	OA65	Provide updateable signage at various treatment devices showing statistics of what has been captured.	36	-	-	3,000	200	-	200	All Councils	PI17 PI18
	OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	43	-	-	4,000	1,200	-	1,200	All Councils, RTA, RAC	PI17 PI18
	OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	54	4,000	1,200	-	2,400	-	2,400	All Councils, RTA, RAC	PI17 PI18
	OA49	Identify and educate pamphlet and local paper deliverers	57	600	200	-	400	-	400	All Councils	PI20 PI21

	OA50	Encourage cleanup days at schools and combine with education program	61	600	200	-	400	-	400	All Councils	PI17 PI18
	OA57	Promote bushcare groups and progress of bush regeneration	65	-	-	2,000	800	-	800	All Councils	PI17 PI18
	OA48	Place passive signage in parks for litter.	94	3,000	600	-	1,200	-	1,200	All Councils	PI01 PI02
	OA61	Develop methods to encourage wide community participation with stormwater management.	96	-	-	3,000	2,000	-	2,000	All Councils	PI17 PI18
	OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	106	2,000	2,400	-	4,800	-	4,800	All Councils	PI19
	OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	110	-	-	2,000	400	-	800	All Councils	PI32
Education - Industrial	OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	8	-	-	1,000	1,200	-	1,200	All Councils, RTA, RAC	PI20 PI21
	OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	9	2,000	1,200	-	2,400	-	2,400	All Councils, RTA, RAC	PI20 PI21
	OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	23	4,000	2,400	-	4,800	-	4,800	All Councils, RTA, RAC, EPA	PI20 PI21
	OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	62	2,000	400	-	800	-	800	All Councils	PI20 PI21
Auditing & Monitoring	OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	15	8,000	1,200	-	2,400	-	2,400	Sydney Water, All Councils, EPA	PI07 PI08 PI09
	OA63	Measure and report effectiveness of options for all issues	20	1,000	100	-	200	-	200	All Councils	PI22 PI23 PI24
	OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	50	-	-	4,000	1,200	-	1,200	Sydney Water, All Councils	PI07 PI08 PI09

	OA68	Excercise regulations under the Clean Waters Act to require sewage holding tanks on pleasure craft boats to prevent direct sewage discharge into the LGR	53	-	-	1,000	600	-	600	All Councils, Waterways	PI07 PI08 PI09
	OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	67	6,000	3,000	-	6,000	-	6,000	All Councils	PI22 PI23 PI24
	OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	69	3,000	3,000	-	6,000	-	6,000	All Councils	PI20 PI21
	OA36	Increase enforcement and awareness of legislation related to stormwater	97	1,000	1,000	-	2,000	-	2,000	All Councils	PI20 PI21
	OA54	Compile inventory of riparian and aquatic habitats and their state	102	3,000	1,000	-	2,000	-	2,000	All Councils	PI14 PI15 PI16
Maintenance	OA62	Identify stormwater system gaps in drainage map and update.	19	200	100	-	200	-	200	All Councils	PI10 PI11
	OA64	Develop litter management programs for recreational/park areas	37	1,000	100	-	200	-	200	All Councils	PI01 PI02
	KC06	Maintain dog faeces disposal bins, including supply of bags for disposal.	44	-	2,000	-	4,000	-	4,000	KMC	PI07 PI08 PI09
	OA31	Maintain bush walking tracks	87	6,000	400	-	800	-	800	All Councils	PI32
	OA58	Develop and implement maintenance programs for treatment devices	101	3,000	1,000	-	2,000	-	2,000	All Councils	PI10 PI11
Policy & Planning	OA30	Incorporate all relevant Georges River REP requirements into all Council planning policies relating to stormwater	1	1,200	300	-	600	-	600	All Councils	PI25 PI26 PI27
	OA42	Assess stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	3	2,000	200	-	400	-	400	RTA, All Councils	PI20 PI21
	OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	4	1,000	300	-	600	-	600	RTA, RAC, All Councils, EPA	PI03 PI04 PI07 PI08 PI09
	OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	5	600	-	-	-	-	-	All Councils	PI25 PI26 PI27
	OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	6	2,400	600	-	1,200	-	1,200	All Councils	PI25 PI26 PI27

OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	7	2,400	300	-	600	-	600	All Councils	PI25 PI26 PI27
OA26	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	26	-	-	2,000	1,200	-	1,200	All Councils	PI25 PI26 PI27
OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	34	2,000	600	-	1,200	-	1,200	All Councils	PI25 PI26 PI27
OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	38	2,000	600	-	1,200	-	1,200	All Councils	PI25 PI26 PI27
OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	40	1,200	300	-	600	-	600	All Councils	PI25 PI26 PI27
OA46	Encourage rainwater tanks and on-site detention for new and existing developments	54	1,000	200	-	400	-	400	All Councils	PI25 PI26 PI27
OA11	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	58	4,800	300	-	600	-	600	All Councils	PI25 PI26 PI27
OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	64	1,000	200	-	400	-	400	All Councils	PI01 PI02
OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	71	12,000	2,400	-	4,800	-	4,800	All Councils	PI20 PI21
OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	82	3,000	400	-	800	-	800	All Councils	PI25 PI26 PI27

	OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	95	1,000	1,000	-	2,000	-	2,000	All Councils	PI25 PI26 PI27
GPT - Screening	KC40	Install 'end of line' GPT for outlets to the southern end of Sydney Water channel	46	-	-	20,000	4,000	-	4,000	KMC	PI01 PI02
	KC49	Strategically install litter baskets at pits within the Kyle Bay catchments	75	5,160	2,000	-	4,000	-	4,000	KMC	PI01 PI02
	KC55	Install GPTs for stormwater that affects Shipwrights Bay	77	-	-	-	-	30,000	2,000	KMC	PI01 PI02
	KC28	Install 'end of line' GPTs for Kogarah Bay Foreshore	91	48,000	10,000	-	20,000	-	20,000	KMC	PI01 PI02
	KC11	Strategically Install litter baskets at pits within Oatley Bay catchment	107	-	-	10,800	6,000	-	12,000	KMC	PI01 PI02
	KC27	Strategically install litter baskets at pits within the Kogarah Bay catchments	108	-	-	10,000	6,000	-	12,000	KMC	PI01 PI02
	KC63	Install litter boom in Carss Park Sydney Water Channel	18.5	10,000	4,800	-	9,600	-	9,600	KMC, Sydney Water	PI01 PI02
GPT - Sediment	KC21	Place erosion controls that affect Poulton park catchment current landfill site	29	-	-	7,500	2,000	-	2,000	KMC	PI01 PI02
	KC61	Install GPT in Empress Reserve	72	90,000	2,000	-	4,000	-	4,000	KMC	PI01 PI02
	KC34	Install GPT that will not be affected by the tide in the South East side of Beverley Park	76	-	-	100,000	20,000	-	20,000	KMC	PI01 PI02
	KC41	Install GPTs for stormwater affecting Carss Park catchment	89	-	-	75,000	5,000	-	10,000	KMC	PI01 PI02
	KC50	Install GPTs for stormwater affecting Connells Bay waterways	93	-	-	-	-	63,000	5,000	KMC	PI01 PI02
GPT - Oil	KC44	Install an inline GPT for oil/sediment/litter in Grosvenor St Reserve	16	-	-	15,000	4,000	-	4,000	KMC, RTA	PI03 PI04
	KC46	Install GPT for oil/sediment/litter at the intersection of King Georges Rd and Blakesley Road	18	-	-	25,000	2,000	-	4,000	KMC, RTA	PI03 PI04
	KC48	Install GPT for oil/sediment in Todd Park	35	-	-	50,000	4,000	-	8,000	KMC, RTA	PI03 PI04
	KC32	Install GPTs to collect oil/sediment along the Princes Highway at the intersections of Battie Ave, Jubilee Ave and Harslett Cres.	59	-	-	-	-	90,000	15,000	KMC, RTA	PI03 PI04
	OA66	Install GPTs for runoff from railway land	115	-	-	-	-	-	-	RAC	PI03 PI04
Sediment Bays	KC54	Install sediment basin for outlet in Kyle Williams Reserve	48	-	-	10,000	1,000	-	1,000	KMC	PI28 PI29 PI30 PI31 PI01 PI02
	KC09	Place sediment basins at outlets to bushland for Oatley Bay catchment.	56	-	-	6,000	2,000	-	2,000	KMC	PI28 PI29 PI30 PI31 PI01

											PI02
	KC62	Place sediment bays at oulets to bushland	85	-	-	20,000	500	-	1,000	KMC	PI28 PI29 PI30 PI31 PI01 PI02
	KC12	Expand and improve sediment bay below Ada St*	86	3,000	3,000	-	6,000	-	6,000	KMC	PI28 PI29 PI30 PI31 PI01 PI02
	KC20	Install GPTs/sediment bay for Poulton Park catchment	90	-	-	-	-	55,000	10,000	KMC, RTA	PI28 PI29 PI30 PI31 PI01 PI02
	KC07	Install GPTs with sediment bays for Moore Res catchment in Oatley Bay	92	-	-	-	-	60,000	5,000	KMC	PI28 PI29 PI30 PI31 PI01 PI02
Wetlands & infiltration	KC47	Install GPT/infiltration system in Augusta Street	52	50,000	2,000	-	4,000	-	4,000	KMC	PI05 PI06
	KC08	Use Moore Reserve wetland as an educational opportunity on stormwater pollution	60	-	-	10,000	4,000	-	4,000	KMC	PI17 PI18
	KC38	Install wetland in the south part of Carss Park with upstream GPT that treats oil/sediments/litter	78	500,000	20,000	-	40,000	-	40,000	KMC	PI05 PI06
	KC17	Construct a wetland in the northern part of Moore Reserve with upstream GPT.	83	600,000	20,000	-	40,000	-	40,000	KMC	PI05 PI06
	KC59	Introduce a wet sediment basin in Shipwrights Bay Reserve	105	-	-	-	-	50,000	10,000	KMC	PI05 PI06
	KC39	Install wetland in the south part of Harold Frazer Reserve with upstream GPT that treats oil/sediments/litter	112	-	-	-	-	600,000	20,000	KMC, Sydney Water	PI05 PI06
Stream restoration rehabilitation	KC14	Rehabilitate creeks in Moore Reserve	45	70,000	5,000	-	10,000	-	10,000	KMC	PI14 PI15 PI16
	KC25	Construct a 'natural creek to replace foreshore pipe in Oatley Pleasure Grounds	49	-	-	75,000	8,000	-	8,000	KMC	PI12 PI13
	KC51	Construct a 'natural creek' in Connells Point Reserve.	66	-	-	180,000	1,200	-	2,400	KMC	PI12 PI13
	KC15	Introduce a constructed "natural creek" to replace the use of the western stormwater pipeline in Moore Reserve	68	-	-	-	-	250,000	10,000	KMC	PI12 PI13
	OA55	Develop a mangrove regeneration program	102	3,000	1,000	-	2,000	-	2,000	All Councils	PI14 PI15 PI16

Investigation	OA41	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	2	2,000	200	-	400	-	400	RAC, All Councils	PI20 PI21
	OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	12	1,200	800	-	1,600	-	1,600	All Councils, DUAP, DLWC	PI22 PI23 PI24 PI12 PI13
	KC52	Investigate the possibility of using a wet pond/infiltration facility for stormwater treatment of low flows such as infiltration basins in Merriman Reserve	13	-	-	5,000	-	-	-	KMC	PI05 PI06
	KC05	Assess the health of the existing wetland on the university grounds and monitor the runoff for potential pollutants	14	3,000	1,000	-	2,000	-	2,000	KMC	PI22 PI23 PI24
	KC24	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Bell Park, Eastern side of Hurstville Rd.	17	-	-	5,000	-	-	-	KMC, RTA	PI05 PI06
	KC42	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Stuart Park, Meade Park and Empress Reserve	10	-	-	8,000	-	-	-	KMC	PI05 PI06
	KC04	Investigate the possibility of recycling stormwater for the use of irrigation in Moore Reserve.	24	10,000	5,000	-	10,000	-	10,000	KMC	PI20 PI21
	KC37	Investigate the possibility of recycling stormwater for the use of irrigation on Beverley Park Golf Club	30	-	-	10,000	-	-	-	KMC	PI20 PI21
	KC18	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	39	-	-	-	-	-	-	Hurstville Council, RAC	PI10 PI11
	KC43	Investigate and provide treatment measures in the upper catchment north of Empress Res	42	-	-	40,000	10,000	-	20,000	KMC, Hurstville, RAC	PI10 PI11
	OA25	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	51	-	-	2,400	1,000	-	1,000	All Councils	PI20 PI21
	KC01	Investigate the use of Water Sensitive Urban Design to solve existing flooding problems and extend vegetation corridors from McRaes Res to open space area in northern end of Moore Reserve Catchment.	63	-	-	10,000	-	-	-	KMC	PI25 PI26 PI27

	OA27	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	70	-	-	16,000	-	-	-	All Councils	PI05 PI06
	OA22	Investigate the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	74	-	-	-	-	-	-	Sydney Water	PI07 PI08 PI09
	OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	88	-	-	-	-	80,000	16,000	All Councils	PI07 PI08 PI09
	OA59	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	104	2,000	1,000	-	2,000	-	2,000	All Councils	PI25 PI26 PI27
	OA47	Investigate and implement an appropriate street sweeping program	113	3,000	6,000	-	12,000	-	12,000	All Councils	PI10 PI11
Misc	KC57	Divert small stormwater flow at northern end of Woodlands Ave to a sediment bay leading to the natural creek for prevention of erosion on the unsealed rd and improvement environmental flows	31	-	-	5,000	400	-	400	KMC	PI28 PI29 PI30 PI31 PI01 PI02
	OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Appropriate authority or industry body to provide facilities for disposal of oils and harmful chemicals and make known to industrial/ commercial managers and residents. Ref. Waste Services Authority	41	2,400	2,000	-	4,000	-	4,000	All Councils	PI03 PI04 PI07 PI08 PI09
	OA06	TRAFFIC REDUCTION PROGRAM - continue and improve existing RTA road traffic reduction programs (public transport, T2/3 lanes etc.) - reduction of diffuse sources	47	-	-	-	-	-	-	RTA	PI03 PI04
	KC16	Collect and treat leachate at the southern end of Moore Reserve	80	-	-	-	-	500,000	50,000	KMC	PI07 PI08 PI09

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**

* PI No. refers to **Table 10.1** in **Section 10**.

Table 9.6: Stormwater Management Actions not funded in the 5 year Implementation Strategy for Kogarah Municipal Council

Ref.	Action	Capital	Maint.	Responsiblity
OA13	IMPROVE EXISTING STREET SWEEPING(new truck for each Council)	200,000	40,000	All Councils, RTA
KC53	Install GPTs and repair pipes for pipes discharging to Kyle Bay.	80,000	12,000	KMC
KC33	Install GPTs affecting Beverley Park catchment	120,000	5,000	KMC
KC26	Install GPTs/Sediment Bays other than Moore Reserve and Poulton Park catchments for Neverfail/Oatley Bay	80,000	12,000	KMC
KC30	Install offline wetland with upstream GPT to treat sediment/oil/litter on western side of Beverley Park Golf Course. Investigate the possibility of diverting stormwater from Moore Park to place wetland further upstream.	600,000	20,000	KMC
KC19	Construct a wetland in the quarry site with upstream GPT to cater for litter, sediment and oil	450,000	20,000	KMC, RTA
KC58	Introduce a constructed "natural creek" to replace the use of the stormwater pipeline behind tennis courts in Shipwrights Bay Reserve, install a GPT upstream.	100,000	10,000	KMC
KC56	Rehabilitate creeks in Shipwrights Bay catchments, providing water way crossings where unsealed vehicle access crosses natural drainage lines	100,000	10,000	KMC
KC23	Introduce a constructed "natural creek" north of quarry site in passive area	150,000	7,500	KMC

9.9 Rockdale City Council Implementation Strategy

Table 9.7: Rockdale City Council Implementation Strategy

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	
			Year 1		Year 2 & 3		Year 4 & 5			PI No. *
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
OA34	Raise awareness of penalties for a range of poor practices related to stormwater	1	300	-	-	-	-	-	All Councils	PI19
OA33	Condition of consent for commercial developments to require installation of appropriate stormwater treatment devices including for their car parks.	2	300	-	-	-	-	-	All Councils	PI25 PI26 PI27
OA68	Lobby State Govt. to give the Waterways Authority the power- by amendment to the Clean Waters Act to require sewage holding tanks on pleasure craft boats to prevent direct sewage discharge into the LGR	3	500	150	-	300	-	-	All Council & Waterways Authority	PI07 PI08 PI09
OA60	Produce a simplified stormwater management plan with educational components (make accessible)	4	-	-	500	100	-	100	All Councils	PI17 PI18
OA32	Develop guidelines for residential and commercial fertiliser, pesticide and herbicide use, increase awareness the impact of these applications	5	-	-	200	400	-	400	All Councils	PI19
OA63	Measure and report effectiveness of options for all issues	6	-	-	500	100	-	100	All Councils	PI22 PI23 PI24
[OA41]	Liaise with RAC to identify stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	7	1,000	100	-	200	-	200	RAC, All Councils	PI20 PI21
OA16	Encourage the installation of coalescing plate interceptors, triple interceptors or media filters in industrial sites where oil & grease is identified as a problem.	8	-	-	600	600	-	300	All Councils	PI03 PI04
[OA42]	Liaise with RTA to identify stormwater management options specific to main roads & facilities for construction, operation & maintenance activities.	9	1,000	100	-	200	-	200	RTA, All Councils	PI20 PI21
OA65	Provide updateable signage at various treatment devices showing statistics of what has been captured.	10	-	-	1,500	100	-	100	All Councils	PI17 PI18
OA30	Incorporate all relevant Georges River REP requirements into all Council planning	11	-	-	600	300	-	300	All Councils	PI25 PI2

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No.*
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
	policies relating to stormwater									6 PI27
OA08	"STATE THE OBVIOUS" EDUCATION PROGRAM - inform the general community that stormwater discharges untreated to creeks/waterways & the ocean NOT into the sewer.	12	500	300	-	600	-	600	All Councils	PI17 PI18
OA14	Introduction of new planning policies providing incentives for industry and commerce to install pollution prevention and interception devices as well as incorporate better managerial practices (eg. right to pollute licences, different rate brackets etc)	13	-	-	1,200	300	-	300	All Councils	PI25 PI26 PI27
OA28	TARGET PRIVATE BOAT USERS, possibly through marinas, to education them not to discharge sewer to the river.	14	1,000	150	-	300	-	300	All Councils	PI19
OA09	REFERENCE SOIL EROSION & SEDIMENTATION CONTROL GUIDELINES for all construction authoritiesdevelopers, contractors & Councils to use (eg. Dept of Housing "Soils and Construction" Manual, DLWC &/or EPA handbooks) in planning policies, DCPs catchment wide.	15	600	150	-	300	-	300	All Councils	PI25 PI26 PI27
OA53	Investigate the use of hot water and other alternatives to herbicides	16	1,000	100	-	200	-	200	All Councils	PI19
OA67	CAR WASHING BAYS - review policies relating to the provision of car wash facilities in high rise developments - also single dwelling residetial areas and commercial faciliites - no car washing in the street - eductation & policing required	17	1,000	300	-	600	-	-	All Councils	PI25 PI26 PI27
OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	18	500	150	-	300	-	300	RTA, RAC, All Councils, EPA	PI03 PI04 PI07 PI08 PI09
OA64	Develop litter management programs for recreational/park areas	19	500	50	-	100	-	100	All Councils	PI01 PI02
OA52	Provide "No junk mail" stickers	20	500	100	-	200	-	200	All Councils	PI17 PI18
OA21	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER	21	2,000	300	-	600	-	600	Sydney	PI07

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No. *
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
	in coordination with Council								Water, All Councils	PI08 PI09
[OA26]	CAR PARK LOT STORAGE & TREATMENT - investigate for existing & proposed car parks, the viability of storing & treating SW onsite using buffer strips & modified underground drainage/storage cells	22	-	-	1,000	600	-	300	All Councils	PI25 PI26 PI27
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	23	-	-	1,000	1,200	-	1,200	All Councils, RTA, RAC	PI20 PI21
OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	24	500	300	-	600	-	600	All Councils, RTA, RAC	PI20 PI21
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	25	2,000	300	-	600	-	600	All Councils, RTA, RAC	PI17 PI18
OA10	ADOPT WATER SENSITIVE DESIGN CRITERIA & TREATMENT BMP' in DCP's catchment wide (consistency) as part of all new development & provide reference to a Best Management Practice manual.	26	-	-	1,200	600	-	600	All Councils	PI25 PI26 PI27
[OA25]	Investigate alternative fertilisers/herbicides/pesticides & application methods in parks & golf courses operated by Council, & work with private operators to do the same. Develop guidelines for commercial & residential use.	27	1,200	250	-	500	-	500	All Councils	PI20 PI21
OA62	Identify stormwater system gaps in drainage map and update.	28	100	50	-	100	-	100	All Councils	PI10 PI11
OA29	Promote BMP for bowling clubs and Golf clubs and promote cleaner production campaign	29	-	-	1,000	400	-	400	All Councils	PI20 PI21
OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	30	-	-	2,000	1,200	-	1,200	All Councils, RTA, RAC	PI17 PI18
OA49	Identify and educate pamphlet and local paper deliverers	31	300	100	-	200	-	200	All Councils	PI20 PI21

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No. *
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
[RC12]	BENCHMARK WATER QUALITY PROGRAM - Continue WQ monitoring program commenced in Dec 98 to establish benchmark WQ at 13 sites in Rockdale	33	5,000	20,000	-	40,000	-	-	RCC	PI22 PI23 PI24
OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR catchment.(in context of current SOLPs)	34	300	-	-	-	-	-	Sydney Water, All Councils, EPA	PI07 PI08 PI09
OA44	Provide ongoing review of planning controls to be appropriate with progressive changes in the catchment, technology and management	35	-	-	500	1,000	-	1,000	All Councils	PI25 PI26 PI27
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	36	-	-	2,000	2,400	-	2,400	All Councils, RTA, RAC, EPA	PI20 PI21
OA46	Encourage rainwater tanks and on-site detention for new and existing developments	37	500	100	-	200	-	200	All Councils	PI25 PI26 PI27
OA24	DELINEATE RIPARIAN BUFFERS IN LEPs - implement planning controls through the LEP, delineating riparian buffers to provide future protection of riparian habitats. Foreshore building line?	38	-	-	1,000	600	-	600	All Councils	PI25 PI26 PI27
OA22	Lobby State Govt. re: the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	39	5,000	1,000	-	1,000	-	-	Sydney Water	PI07 PI08 PI09
OA51	Give responsibility to group users of parks to clean up and implement a fee or a deposit bond	40	500	100	-	200	-	200	All Councils	PI01 PI02
RC11	Enable secondary contact recreation access in Scarborough Ponds by ensuring safe points which are clearly identifiable and accessible. This must be done with the preservation of the environment in mind and will increase enjoyment and education benefited from the ponds.	41	-	-	20,000	-	-	-	RCC	PI17 PI18 PI32

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No. *
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
OA23	STUDY to DETERMINE ORIGINAL AQUATIC & RIPARIAN HABITAT - consult with DLWC, Fisheries & local specialists to establish what the original aquatic & riparian habitat consisted of	42	-	-	4,000	800	-	-	All Councils	PI12 PI13
OA36	Increase enforcement and awareness of legislation related to stormwater	43	500	500	-	1,000	-	1,000	All Councils	PI20 PI21
OA58	Develop and implement maintenance programs for treatment devices	44	1,500	500	-	1,000	-	1,000	All Councils	PI10 PI11
OA61	Develop methods to encourage wide community participation with stormwater management.	45	-	-	1,500	1,000	-	1,000	All Councils	PI17 PI18
OA37	Establish a street/parks tree database to allow for improved tree planting selection. Review policies discouraging use of deciduous trees and pipe damaging trees, and encouraging the use of natives.	46	-	-	1,500	400	-	400	All Councils	PI25 PI26 PI27
RC02	Create buffer strips between stormwater lines and horse stables such that sediment in water flowing from the stables is intercepted before reaching the waterways.	47	-	-	20,000	4,000	-	4,000	RCC	PI05 PI06
OA50	Encourage cleanup days at schools and combine with education program	48	300	100	-	200	-	200	All Councils	PI17 PI18
OA15	HARMFUL SUBSTANCES DISPOSAL DEPOT - Lobby State Govt. that existing disposal depots be retained with the approp. authority or industry body to continue to provide facilities for disposal of oils & make known to industrial/commercial mgrs & residents.	49	1,200	1,000	-	2,000	-	2,000	All Councils	PI03 PI04 PI07 PI08 PI09
[OA27]	INVESTIGATE THE FEASIBILITY OF INSTALLING SW TREATMENT WETLANDS IN GOLF COURSES & SCHOOL YARDS. Consideration of health risks associated with re-use of stormwater on active areas needs to be made.	50	8,000	1,000	-	2,000	-	-	All Councils	PI05 PI06
OA54	Compile inventory of riparian and aquatic habitats and their state	51	-	-	1,500	1,000	-	1,000	All Councils	PI14 PI15 PI16
[OA59]	Investigate mechanisms that would require developers to fund works in the catchment for impacts they may have	52	-	-	1,000	1,000	-	1,000	All Councils	PI25 PI26 PI2

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No. *
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
										7
OA07	ANIMAL FAECES PICK-UP EDUCATION - provide "poop" bags in public parks and educate community on the use of them.	53	1,000	1,200	-	2,400	-	2,400	All Councils	PI19
OA35	Establish an EMS for council operational areas such as parks and gardens, waste management, road work, construction and ...	54	-	-	6,000	2,400	-	2,400	All Councils	PI20 PI21
RC06	Install trash rack or GPT in Sans Souci Drain No. 1 at Little Reserve downstream of the fast food/commercial areas on Rocky Point Road.	55	-	-	75,000	10,000	-	10,000	RCC	PI01 PI02
OA55	Develop a mangrove regeneration program	56	-	-	1,500	1,000	-	1,000	All Councils	PI14 PI15 PI16
[OA11]	REDUCTION OF % IMPERVIOUS AREA - investigate the expected improvement in erosion reduction and sedimentation of waterways.	57	-	-	2,400	300	-	300	All Councils	PI25 PI26 PI27
OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	58	1,200	2,000	-	4,000	-	4,000	All Councils, RTA, RAC & Sydney Water	PI25 PI26 PI27
OA40	Develop a catchment based WATER QUALITY MONITORING PROGRAM using appropriate indicators and procedures	59	3,000	1,500	-	3,000	-	3,000	All Councils	PI22 PI23 PI24
OA31	Maintain bush walking tracks	60	3,000	200	-	400	-	400	All Councils	PI32
OA56	Develop a network of access routes with a map showing points of interest for community and providing educational and interpretational signage	61	-	-	1,000	400	-	400	All Councils	PI32
RC05	Install trash rack or GPT in Sans Souci Drain No. 2 downstream of the Ramsgate Shopping area to remove litter.	62	-	-	100,000	10,000	-	10,000	RCC	PI01 PI02 PI05 PI06
RC07	Install trash rack or GPT in Sans Souci Drain No. 3	63	-	-	60,000	10,000	-	10,000	RCC	PI01 PI02 PI0

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	PI No. *
			Year 1		Year 2 & 3		Year 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
										5 PI06
RC08	Install Constructed Wetlands on Sans Souci Drain No.s 1-3 and upstream of Scarborough Ponds to treat elevated bacteria and oxygen demanding organic matter in stormwater. Note: concept plans have already been drawn up for Stan Moses Res in SS Drain No.2	65	-	-	-	-	250,000	20,000	RCC	PI01 PI02 PI05 PI06
RC04	Point source collection of litter from major contributing areas such as the Ramgate Shopping area and fast food and shopping outlets along Rocky Point Road. (litter baskets)	66	-	-	-	-	35,000	20,000	RCC	PI01 PI02
RC09	Install litter and sediment collection traps, preferrably as close to the source as possible, to intercept litter and sediment prior to it reaching Lady Robinsons Beach.	67	-	-	-	-	60,000	20,000	RCC	PI01 PI02
OA48	Place passive signage in parks for litter.	68	-	-	-	-	1,500	600	All Councils	PI01 PI02
OA39	Regular auditing of construction activities issuing warnings and penalties. Educate and define responsibilities of contractor and developer	70	-	-	-	-	1,500	3,000	All Councils	PI20 PI21
RC03	Install litter collection devices on all drains feeding into Scarborough Ponds	71	-	-	-	-	100,000	20,000	RCC	PI01 PI02
OA18	INTERCEPT OIL & GREASE FROM MAJOR ROADS - (coalescing plate interceptors, media filters etc) Rocky Pt Road, President Ave, General Holmes Drive, King Georges Rd, Princes Highway, Taren Pt Rd, Kingsway, Port Hacking Rd & Captain Cook Drive	72	30,000	3,000	-	6,000	-	6,000	RTA, All Councils	PI03 PI04
RC10	Improve access along open drains to enhance safety	73	-	-	-	-	200,000	10,000	RCC	PI32
OA57	Provide onsite updateable signage showing progress of bush regeneration	74	-	-	-	-	1,000	400	All Councils	PI17 PI18
OA17	INVESTIGATE LANDFILL LEACHATE POLLUTION - monitor all landfill sites, assess water treatment requirements to mitigate potential impacts	75	-	-	-	-	40,000	8,000	All Councils	PI07 PI08 PI09
RC01	STREAMFLOW MGT & ENHANCE AQUATIC & RIPARIAN HABITATS IN SANS SOUCI DRAIN NO.S 1-3 to minimise scouring in earth	76	-	-	-	-	200,000	40,000	RCC	PI01 PI02

Ref. No.	Action	Rank	Financial Year & Expenditure						Responsibility	
			Year 1		Year 2 & 3		Year 4 & 5			PI No. *
			Capital	Maint.	Capital	Maint.	Capital	Maint.		
	channels									PI12 PI13 PI14 PI15 PI16
OA13	CONTINUE & IMPROVE EXISTING STREET SWEEPING and investigate ways of improving if necessary (eg. better equipment, larger areas etc.)	77	-	-	-	-	100,000	40,000	All Councils, RTA	PI01 PI02

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**
* PI No. refers to **Table 10.1** in **Section 10**.

9.10 Sydney Water Implementation Strategy

Sydney Water will be responsible for undertaking a broad range of actions (both stand alone and shared) in each of the 17 SMPs in which it has participated. The specific timing of Sydney Water actions listed in **Table 9.8** is indicative only and will be finalised in coordination with Council in the Corporation's Stormwater Environmental Improvement Program (SEIP).

Note that Sydney Water do not take responsibility at this stage for all actions listed in **Table 9.8**. Sydney Water's comments in relation to these actions are provided on the following page. Actions to be included in Sydney Water's SEIP are not yet finalised and therefore all actions are left in **Table 9.8** for further discussion.

The expenditure quoted in **Table 9.8** is the 100% project cost. Agreement between LGRSMC and Sydney Water is required before the exact apportionment of cost can be decided.

Table 9.8: Sydney Water Corporation Implementation Strategy

Ref. No.	Rank*	Action	Financial Year & Expenditure***						Responsibility	
			Year 1		Years 2 & 3		Years 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		PI No.**
[SC 12]	100	Investigate the need for installing Constructed Wetlands (or other treatment) on Oyster Creek, Gwawley Creek and other miscellaneous creeks where land availability permits to treat elevated bacteria and oxygen demanding organic matter in SW	-	-	-	-	80,000	8,000	SSC, Sydney Water	PI01 PI02 PI05 PI06
OA57	65	Provide onsite updateable signage showing progress of bush regeneration	-	-	10,000	4,000	-	4,000	SSC, /Sydney Water, RTA	PI17 PI18
SC22	70	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	-	7,000	-	14,000	-	14,000	All Councils, RTA, RAC & Sydney Water	PI01 PI02 PI05 PI06
OA20	25	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR	40,000	6,000	-	12,000	-	12,000	Sydney Water, All Councils, EPA	PI07 PI08 PI09

Ref. No.	Rank*	Action	Financial Year & Expenditure***						Responsibility	
			Year 1		Years 2 & 3		Years 4 & 5			
			Capital	Maint.	Capital	Maint.	Capital	Maint.		PI No.**
		catchment.(in context of current SOLPs)								
OA22	45	Lobby State Govt. re: the required changes in legislation to introduce compulsory inspections of sewer lines of private properties at conveyance stage	50,000	10,000	-	10,000	-	-	Sydney Water	PI07 PI08 PI09
OA21	35	CONTINUE TO IDENTIFY ILLEGAL SEWER CONNECTIONS TO STORMWATER in coordination with Council	20,000	3,000	-	6,000	-	6,000	Sydney Water, All Councils	PI07 PI08 PI09
OA12	73	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	12,000	20,000	-	40,000	-	40,000	All Councils, RTA, RAC & Sydney Water	PI25 PI26 PI27
KC39	97	Install wetland in the south part of Harold Frazer Reserve with upstream GPT that treats oil/sediments/litter	-	-	-	-	1,200,000	40,000	KMC, Sydney Water	PI05 PI06
KC63	15	Install litter boom in Carss Park Sydney Water Channel	10,000	4,800	-	9,600	-	9,600	KMC, Sydney Water	PI01 PI02

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**
* Rank provided is equivalent to the average rank out of 100 potential options for all actions where 1 is highest and 100 is lowest.
** PI No. refers to **Table 10.1** in **Section 10**.
*** The 100% project cost is quoted, agreement between LGRSMC & Sydney Water is needed for apportionment of costs.

Sydney Water offered the following comments in relation to the actions listed above in **Table 9.8**:

- SC21 – this location is not associated with a Sydney Water stormwater asset. Issues and projects associated with overflow will be referred to the Overflow Abatement Program;
- OA57 – this project will be referred to the existing Maintenance program;
- SC22 – the location is not associated with a Sydney Water stormwater asset;
- OA20 – this project will be referred to the existing Overflow Abatement Program;
- OA22 - this project will be addressed in the Management component of the SEIP;
- OA21 – this project will be referred to the existing Overflow Abatement Program;

- OA12 – thi sporject will be addressed in the Management component fo the SEIP;
- KC39 – this project has been considered within the ranking of Water Quality Improvement projects. The specific timing for implementation can not be confirmed until all SMPs are finalised. Please refer to the statement above (before Table 9.8); and
- KC63 – this project will be considered within the ranking of Water Quality Improvement projects. The specific timing for implementation can not be confirmed until all SMPs are finalised. Please refer to the statement above (before Table 9.8).

For projects, which are associated with the existing program, to avoid redundancy, these actions will be referred to the appropriate section within Sydney Water for implementation or response. Progress on these actions will be reported in the SEIP annual report.

The above comments have been taken from Sydney Water facsimile dated 25 June, 1999 addressed to Sinclair Knight Merz. Contacts at Sydney Water include Jim Walsh (ph: 9551 4630) and Bronwen Buntine (ph: 9350 6335).

9.11 Roads and Traffic Authority Implementation Strategy

To facilitate the assessment of the various catchments Stormwater Management Plans (SMPs) and the development of the actions proposed for the RTA within these plans, a document was used to evaluate each action proposed for the RTA. The title of the document used to evaluate the actions is Water Quality Cost Apportionment Methodology for Stormwater Management Plans (WQCAM).

The WQCAM uses information such as land use, catchment value and the number of pollutants the proposed measure targeted to evaluate the proposed RTA actions. The WQCAM was developed for the RTA with input from the Environmental Protection Authority and Local Government Shire Association.

All options that included a RTA responsibility were identified, assessed and ranked using the RTA methodology and are shown in **Table 9.9**.

Once the options were identified, assessed and ranked, the projects with the highest Total Benefit Index (TBI) in each financial year were included in the Stormwater Environmental Improvement Program (SEIP) option table for the next five years based on available funding. Where the SMPs did not identify a particular financial year for implementation of an option, the identified options were distributed evenly over five years. Financial year 1 has been considered as 1999/2000.

The table below lists the treatment options that the RTA considers that it should contribute funding to for the next five years. The SEIP option table will be reviewed when the Group 2 catchment SMPs are completed and as Group 1 catchment SMPs are review and updated, as required in the EPA notice. The SEIP option table will also be reviewed if funding allocations change.

Support for an option is contingent upon the relevant council providing their proportion of funding in conjunction with the RTA's proportion.

In addition the RTA will identify what stormwater pollution control devices have been installed on State roads and develop appropriate maintenance schedules for them. The RTA will also investigate suitable options for treatment of runoff from State roads.

The Environment and Community Policy Branch of the RTA is developing a training course for RTA staff and

contractors, in conjunction with Department of Land and Water Conversation (DLWC) in management of stormwater.

If you have any questions regarding this matter, please do not hesitate to call Joseph Fanous on 9672 2516.

A statement by the RTA was sent to Council regarding the RTA's position in relation to actions arising from the SMP. This is attached on the following **Table 9.9** below.

Table 9.9: Roads and Traffic Authority Implementation Strategy

Ref. No.	Action	Financial year (Implementation year)	Total Capital Cost	Annual Recurrent Cost	Life Cycle Cost	Total Benefit Index	% RTA Responsibility	5 year RTA Expenditure	Comments**	PI No.*
SC25 (Gwawley Bay)	Endeavour Road, Caringbah - GPT	1	$63,000	$16,000	$280,445	545	5%	$13,559		PI01 PI02 PI05 PI06
SC22 (Oyster Bay)	Install GPT in Carina Ck, Wattle Road, Oyster Bay	1		$14,000	$190,265	545	4%	$7,746		PI01 PI02 PI05 PI06
SC21 (Kurnell Pen)	Maintenance GPT in Resolution Drive at the intersection of Endeavour Rd (south) Woolooware	1	$250,000	$16,000	$467,445	545	6%	$29,059		PI01 PI02 PI05 PI06
OA01	Catchment erosion and sedimentation in waterways education	1	$10,000	$12,000	$63,422	146	2%	$1,470		PI20 PI21
OA03	Stormwater pit labelling	1	$20,000	$12,000	$73,422	121	3%	$2,287		PI17 PI18
OA19	Review emergency procedures	1	$5,000	$3,000	$18,355	82	13%	$2,354		PI03 PI04 PI07 PI08 PI09
OA02	Catchment signage	1	$20,000	$6,000					Not in RTA scope	-
OA05	Industrial/commercial working visit education to reduce stormwater pollution.	1	$20,000	$24,000					Not in RTA scope	-
OA12	Maintain, monitor and audit existing OSD policies	1	$12,000	$40,000					Not in RTA scope	-
OA06	Traffic Reduction Program	1	$40,000						RTA already doing this.	PI03 PI04
OA42	Assess stormwater management options specific to main roads and facilities for construction , operation and maintenance operations.	1	$10,000	$2,000					RTA to participate in this.	PI20 PI21
OA13	Continue and improve existing street sweeping	1	$1,000,000	$400,000					RTA will investigate this practice	PI01 PI02
OA04	Litter reduction education	1							RTA will investigat	PI20 PI21

									e this practice	
KC44 (Kogarah Bay)	Install online GPT for oil/litter/sediment in Grosvenor St Reserve.	2	$30,000	$4,000	$84,361	545	6%	$4,655		PI03 PI04
KC48 (Kogarah Bay)	Install GPT for oil/sediment in Todd Park	2	$100,000	$8,000	$208,723	292	7%	$13,641		PI03 PI04
KC24 (Kogarah Bay)	Investigate the possibility of using an appropriate infiltration facility for stormwater treatment of low flows such as infiltration basins in Bell Park, eastern side of Hurstville Road.	2	$10,000						RTA can participate in kind.	PI05 PI06
KC46 (Kogarah Bay)	Install GPT for oil/litter/sediment at the intersection of King Georges Rd and Blakesley Road	3	$50,000	$4,000	$104,361	412	3%	$3,302		PI03 PI04
OA57	Provide onsite updateable signage showing progress of bush regeneration	3	$10,000	$4,000					Not in RTA scope	-
KC19 (Kogarah Bay)	Construct a wetland in the quarry site with upstream GPT to cater for litter, sediment and oil.	4	$900,000	$40,000	$1,443,613	918	5%	$74,377		PI05 PI06
KC32	Install GPT's to collect for oil/sediment along the Prices Highway at the intersection of Battie Ave, Jubilee Ave and Harslett Cres.	4	$180,000	$15,000	$383,855	291	83%	$317,029		PI03 PI04
KC20 (Oyster Bay)	Install GPT's/sediment bay for Poulton Park catchment	5	$110,000	$10,000	$245,903	659	6%	$14,073		PI01 PI02
Total								**$405,479**		

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**

* PI No. refers to **Table 10.1** in **Section 10**.

** Glossary of RTA Comments:

Insufficient information to calculate RTA funding and Insufficient data to establish RTA funding.	Landuse area information is required for sub-catchments or proposed water quality devices or strategy. This information is required for input into the WQCAM spreadsheet to determine the most accurate assessment/determination of the RTA's contribution to a water quality device or strategy. Not all SMPs contained this information. An attempt was made to obtain this information but it was not supplied in time to be included in this version of the SEIP option table. When additional landuse information is supplied the SEIP option table will be reviewed to take this additional information into account for future RTA SEIP option tables (ie. years 2, 3, etc.).
RTA will investigate this practice & RTA to investigate this option.	Many SMPs received from councils identified that the RTA should contribute to a number of common identified similar actions, such as Development of a hazardous spill response, Street Sweeping, Identification of road runoff pollutants, Continued participation in the SMP process, In house training in stormwater management, and Review Maintenance Practices. The RTA will review, develop, improve and implement the above actions where necessary as they have RTA wide implications.
RTA will participate in kind & RTA to participating in this.	A representative form the RTA will be available to attend meetings or participate in reviews, strategies, etc for the catchment. RTA will also assist in gathering information to assist in the process where appropriate.

9.12 Rail Access Corporation Implementation Strategy

Table 9.10: Rail Access Corporation/State Rail Implementation Strategy

Ref. No.	Action	Financial Year & Expenditure						Responsibility	
		Year 1		Years 2 & 3		Years 4 & 5			
		Capital	Maint.	Capital	Maint.	Capital	Maint.		PI No. *
SC22	INSTALL GPT IN CARINA CK, Wattle Rd, Oyster Bay	-	7,000	-	14,000	-	14,000	All Councils, RTA, RAC & Sydney Water	PI01 PI02 PI05 PI06
[OA41]	Assess stormwater management options specific to railways & facilities for construction, operation & maintenance activities.	10,000	1,000	-	2,000	-	2,000	RAC, All Councils	PI20 PI21
OA03	STORMWATER PIT LABELLING - raising awareness in new residential development areas, construction sites, industrial zones and generally (Yellow Fish SIA program)	20,000	6,000	-	12,000	-	12,000	All Councils, RTA, RAC	PI17 PI18
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	20,000	3,000	-	6,000	-	6,000	All Councils, RTA, RAC	PI17 PI18
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	10,000	6,000	-	12,000	-	12,000	All Councils, RTA, RAC	PI20 PI21
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	20,000	12,000	-	24,000	-	24,000	All Councils, RTA, RAC, EPA	PI20 PI21
OA04	LITTER REDUCTION EDUCATION - target shopping centres, commercial zones and fast food outlets in association with "Keep Australia Beautiful" programs.	5,000	3,000	-	6,000	-	6,000	All Councils, RTA, RAC	PI20 PI21
OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	5,000	1,500	-	3,000	-	3,000	RTA, RAC, All Councils, EPA	PI03 PI04 PI07 PI08 PI09
OA66	Install GPTs for runoff from railway land	20,000	5,000	-	10,000	-	10,000	RAC	PI03 PI04
OA12	MAINTAIN, MONITOR & AUDIT EXISTING OSD POLICIES	12,000	20,000	-	40,000	-	40,000	All Councils,	PI25 PI2

Ref. No.	Action	Financial Year & Expenditure						Responsibility	
		Year 1		Years 2 & 3		Years 4 & 5			
		Capital	Maint.	Capital	Maint.	Capital	Maint.		PI No. *
								RTA, RAC & Sydney Water	6 PI27
OA45	Waste Minimisation & Education Campaign at Rail Stations & Corridor	20,000	2,000	-	4,000	-	4,000	State Rail	PI17 PI18
HC12	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	-	-	-	-	20,000	5,000	Hurstville Council / RAC	
HC13	Investigate and provide treatment measures in the upper catchment north of Empress Res	40,000	10,000	-	-	-	-	KMC / Hurstville / RAC	
KC18	Investigate sources north of McRaes Res from Hurstville LGA and Railway land and provide appropiate treatment	20,000	5,000	-	10,000	-	10,000	KMC, HC, RAC	PI10 PI11
KC43	Investigate and provide treatment measures in the upper catchment north of Empress Res	-	-	80,000	20,000	-	20,000	KMC, HC, RAC	PI10 PI11

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**
* PI No. refers to **Table 10.1** in **Section 10**.

9.13 Environment Protection Authority Implementation Strategy

Table 9.11: Environmental Protection Authority Implementation Strategy

Ref. No	Action	Financial Year & Expenditure						Responsibility	
		Year 1		Years 2 &3		Years 4 & 5			
									PI No.*
OA02	CATCHMENT SIGNAGE - raising awareness in recreation park areas, commercial shopping centres, waterway crossings/bridges, major new development areas etc. (incl naming un-named cks & drains)	10,000	3,000	-	6,000	-	6,000	All Councils, RTA, RAC	PI17 PI18
OA01	CATCHMENT EROSION & SEDIMENTATION IN WATERWAYS EDUCATION - target industries, Council works, contractors & gen. community - minimise point source	10,000	6,000	-	12,000	-	12,000	All Councils, RTA, RAC	PI20 PI21
OA20	SEWER OVERFLOW & LEAKAGE CONTROL - SW to adopt & repot monitoring program of all sewer overflow locations. Incl Councils in strategy dev & lobby Sydney Water to prioritise sewer overflow control actions for the LGR	40,000	6,000	-	12,000	-	12,000	Sydney Water, All Councils,	PI07 PI08 PI09

Ref. No	Action	Financial Year & Expenditure						Responsibility	
		Year 1		Years 2 &3		Years 4 & 5			
									PI No.*
	catchment.(in context of current SOLPs)							EPA	
OA19	REVIEW EMERGENCY PROCEDURES - for major spill control on roads as well as rail (incl toxic spill containment, incl response into disaster plans; development of service agmnts for spill containment)	5,000	1,500	-	3,000	-	3,000	RTA, RAC, All Councils, EPA	PI03 PI04 PI07 PI08 PI09
OA05	INDUSTRIAL/COMMERCIAL WORKING VISIT EDUCATION - structured audits/visits with industry & commerce to work with management on improving managerial practices to reduce stormwater pollution. (5yr prog)	20,000	12,000	-	24,000	-	24,000	All Councils, RTA, RAC, EPA	PI20 PI21

[] stormwater management actions with Ref. No.s in brackets have follow-up actions - refer to **Section 8.7**
* PI No. refers to **Table 10.1** in **Section 10**.

Contents

10.6 Monitoring the Effectiveness of the Implementation Strategy

It is important that the effectiveness of the implementation strategy be monitored regularly.

The following questions typically need to be raised:
- are the objectives being met?
- is the implementation strategy on schedule?
- is community awareness increasing?

In order to do this, a coordinated approach involving all stormwater managers is required. Ideally, this would include the stormwater managers represented on the LGRSMC, namely:
- Sutherland Shire Council;
- Hurstville Council;
- Kogarah Municipal Council;
- Rockdale City Council;
- Georges River Catchment Management Committee (GRCMC);
- Roads and Traffic Authority (RTA);
- Sydney Water; and
- Rail Access Corporation (RAC).

Monitoring the effectiveness of the implementation strategy forms an integral part of the Stormwater Management Cycle discussed in more detail in **Section 11, Updating of the Lower Georges River SMP**. Monitoring the effectiveness of the implementation strategy directly feeds into the on-going reporting, review, planning and further implementation in the Stormwater Management Cycle.

To assist in monitoring the effectiveness of the SMP, performance indicators have been developed as listed in **Table 10.1** below. These performance indicators are grouped according to outcomes desired as part of the SMP.

Each action in the Implementation Strategy (**Section 9**) has a performance indicator(s) assigned to illustrate how the success of each individual action will be assessed.

In the first 12 months, it is recommended that the effectiveness of the SMP be reviewed at the half way point (6 months) to facilitate any necessary changes that result from the initial phase of implementation.

Table 10.1: Performance Indicators

Outcome	Performance Indicator	PI No.*
Reduction of litter and sediment entering waterways	Identified litter and sediment pollution sources addressed	PI01
	Observed reduction of litter and sedimentation in waterways	PI02
Reduction of oils and grease entering waterways	Identified oil and grease pollution sources addressed	PI03
	Observed reduction of oils and grease in waterways	PI04
Reduction of nutrients entering waterways through natural filtration methods	Identified nutrient pollution sources addressed	PI05
	Water quality sampling indicates a reduction of nutrients in waterways	PI06
Reduction of pathogens and toxicants entering waterways	Identified pathogen and toxicant pollution sources addressed	PI07
	Water quality sampling indicates a reduction of faecal coliforms	PI08
	Incidents of fish kills due to toxicants reduced	PI09
A well maintained stormwater system	A decrease in stormwater system information gaps	PI10
	stormwater system maintenance program is developed and is operating well	PI11
Stream construction and restoration	Potential restoration sites identified and assessed.	PI12
	Restored sites mimic the original ecological composition	PI13
Stream rehabilitation	Areas of bank erosion addressed	PI14
	Increased biodiversity of waterways and riparian zone	PI15
	A decrease of weed invasion.	PI16
A community that is aware of stormwater issues	Community have an increased awareness of stormwater issues.	PI17
	Community members actively involved in stormwater management	PI18
Poor practices within the community are minimised	A reduction in illegal dumping occurrences	PI19
Council, industry and commercial businesses use best management practices in their operations	Industry and commercial operators are aware of potential stormwater impacts and consequences.	PI20
	Feasible stormwater re-use options are identified	PI21
Successful local and regional catchment management programs involving schools, universities and other research organisations	Effective local water quality monitoring programs operating.	PI22
	Established relationships with learning institutions	PI23
	Study of waterway habitats complete	PI24
Water Sensitive Urban design integrated into planning	Increased perviousness in developments	PI25
Water Sensitive Urban design integrated into council's policies	Planning controls are uniform	PI26
	Policies meet the objectives of WSUD	PI27
Bushland areas are protected from stormwater impacts	Outlet erosion issues are addressed	PI28
	Weed dispersion from outlets is reduced	PI29

	Bushland links via waterways are improved	PI30
	A decrease in weed growth along natural drainage lines	PI31
Improvement of access to natural catchment features and bays	Riparian walkways are well maintained	PI32

* refers to performance indicators assigned to actions in **Section 9** (Implementation Strategies).

10.1 Water Quality and Biological Monitoring

Water quality monitoring within the Lower Georges River catchment is necessary:

- to establish baseline water quality conditions for assessing the prevailing conditions within the receiving waters and to obtain data for use in assessing new stormwater management practices;
- to monitor changes in catchment wide water quality with time as a result of structural and non-structural measures implemented as part of the SMP;
- to quantify water quality improvements locally due to water quality control measures such as gross pollutant traps, wetlands etc; and
- to determine the performance of existing stormwater management practices.

Baseline water quality data provides information on existing water quality conditions, the types and levels of pollutants in the water and in some cases, the sources of the pollutants. Sampling may be undertaken at a location within a river/creek or downstream of a known pollutant source and should be event based over a long period to determine trends.

A summary of existing water quality data available in the Lower Georges River catchment and waterway is provided in the description of existing conditions in **Section 3**.

10.1.1 Receiving Waterway Water Quality Monitoring Program

Receiving Waterway

The Receiving Waterway can be defined as the main Georges River and associated estuary bays and backwaters.

Existing data is collated and updated each year as part of the State of the Environment reporting and an assessment of the water quality for the Lower Georges River based on this information is carried out and reported.

Further, it is recommended as part of one of the overall stormwater management options (OA40) that a

catchment based water quality monitoring program be developed using appropriate indicators and procedures.

The water quality monitoring program needs to contain the following aspects:

- long-term waterway water quality monitoring;
- short to medium-term pollutant control water quality monitoring; and
- linked to flow rates and rainfall.

Long-term Waterway Water Quality Monitoring

This will provide an overall indicator of the performance of the SMP as a result of stormwater management actions implemented. Initially, this will provide baseline water quality data, which will be invaluable when comparing future water quality monitoring results to assess performance of individual stormwater actions or the SMP as a whole.

Long-term water quality monitoring stations should be located in the major water ways of the Lower Georges River catchment including:

- Georges River - two or three stations;
- Lime Kiln Bay;
- Boggywell Ck;
- Gungah Bay;
- Carina Bay;
- Oatley Bay;
- Oyster Bay;
- Kyle Bay;
- Gwawley Bay;
- Kogarah Bay;
- Woolooware Bay;
- Quibray/Weeney Bay; as well as
- Botany Bay at the mouth of the Georges River.

Existing water quality monitoring undertaken by Sydney Water through the Harbourwatch and Riverwatch programs as well as some Council monitoring already covers the stations recommended above and will be incorporated into the new catchment based water quality monitoring program for the receiving waters as part of this SMP.

Typical parameters that should be measured are as follows:

- Faecal Coliforms;
- Total Phosphorus;
- Total Nitrogen;
- Suspended Solids;
- Chlorine (below swimming pools)*;
- Oil & Grease*;
- Heavy Metals*; and
- Ammonia*.

* only necessary when pollution is suspected upstream.

The frequency of monitoring at the long-term water quality monitoring stations will be at least after every major rain event and weekly.

Short to Medium-term Pollution Control Water Quality Monitoring

This should be undertaken to assess the performance of specific stormwater management actions. Generally these stations should be located downstream of a known hot-spot or in an area where a stormwater management action has been implemented.

The frequency of monitoring in this case will depend on the type of the stormwater management action and how well it performs. For example, an action that yields good water quality monitoring results and maintains them is likely to need less monitoring in the future given it has performed well in the past.

Short to medium-term pollution control water quality monitoring will be crucial in assessing the performance of specific stormwater management actions. It can also be used as by stormwater managers to trace pollution to its source.

Parameters can be selected according to the need at the time, and will typically include all those listed in the long-term monitoring section described above.

There is often a large cost associated with monitoring and consequently monitoring options do not rank highly using the evaluation methodology discussed in **Section 8**. Community and school based monitoring can reduce the cost of monitoring however, the community based monitoring often lacks scientific credibility and should be used to “flag” pollution incidents.

Water quality monitoring should be considered before implementing each stormwater management option and continued until a reliable event based model can be determined.

Alternative water quality monitoring techniques such as observation based water quality monitoring and biological monitoring are discussed below. Modelling of water quality for planning and decision making purposes is also discussed.

Observation Based Water Quality Monitoring

Observation based monitoring can provide a non-technical indication of the conditions existing within the stormwater system and receiving waterways. This

monitoring can highlight the need for more scientific monitoring or for implementation of water quality control measures/practices.

Observation based monitoring can be done by council staff. However, it is an effective way of involving the public, particularly community environmental groups and school students, in stormwater related issues and stormwater management. The value of this type of monitoring can be enhanced if undertaken regularly and details documented on a pro-forma. The pro-forma may include the following information:

- Location
- Date
- Time
- Weather Conditions
- Flow Conditions
- Flow Depth
- Items Identified

Items that can be identified by this technique include:

- Litter
- Foam
- Surface Scum, Surface Oil
- Algae
- Odour
- Water Clarity
- Organic Matter
- Aquatic Plants
- Condition of Riparian Vegetation
- Fish
- Bank Erosion
- Sedimentation

Biological Monitoring

Biological monitoring is useful for the direct assessment of ecosystem health and diversity and involves the collection and testing of aquatic biota from the waterways.

This type of monitoring can be expensive and often changes are only apparent over a longer timeframe. Biological monitoring should therefore be used as longer term approach to monitoring changes in ecosystem diversity, health and resilience. There is need for a specialist to set up criteria (i.e. the number of species and numbers within each species).

10.1.2 Catchment Water Quality Monitoring Program

Catchment Waterways

Catchment waterways can be described as the creeks, drains and waterways that collect runoff from the catchment upstream of the receiving waterways.

As part of the overall action OA40, a catchment water quality monitoring program is to be developed that uses Streamwatch Program for schools and community groups including Council to monitor the following parameters:

- Temperature;
- pH;
- Biochemical Oxygen Demand, BOD;
- Sulphates, SO_4;
- Turbidity;
- Dissolved Oxygen, DO;
- Faecal Coliforms, FC; and
- Conductivity.

The frequency for the monitoring will be weekly and after major rainfall events.

Locations nominated for catchment water quality monitoring within each Council LGA are listed below in **Table 10.2**.

Table 10.2: Locations for Catchment Water Quality Monitoring

Council	Catchment WQ Monitoring Locations	
Sutherland Shire Council LGA*	– Production Road – Endeavour Road – Resolution Drive – Leagues Club Channel – Elourera Road Channel – Sir Joseph Banks Drive – Paraweena Road	– Oyster Bay West – Tivoly Esplanade – Carina Bay Reserve – Scylla Bay – Kareela Golf Course – Gwawley Creek – Silverwater Crescent
Hurstville Council LGA	– Boggywell Creek – Lime Kiln Bay (immediately D/S of wetland) – Hurstville Golf Course Drain	– Peakhurst Industrial Drain at Depot Road and Roberts Ave – Gungah Bay Drain at Mulga Road
Kogarah Municipal Council LGA	– Stormwater Channel in Beverley Park Golf Course – Kogarah Bay Creek – Carss Park Stormwater Channel – Stormwater outlet in Shipwrights Bay Reserve – Stormwater outlet near Kyle Bay Bowling Club	– Stormwater outlet in Donnelly Park – Poulton Creek – Stormwater outlet in Moore Reserve – Stormwater outlet in Oatley Pleasure Grounds – Stormwater outlet end of Wyong Street
Rockdale City Council LGA**	– Scarborough Ponds, Culver Street – Scarborough Ponds, West Botany Street – No. 2 Sans Souci Drain, Russel Ave – No. 3 Sans Souci Drain, Lawson Street	– No. 2 Sans Souci Drain, Riverside Drive – No. 1 Sans Souci Drain, Sanoni Ave

* Sutherland LGA water quality monitoring sites are from the current Strategic Water Program which will be continued as part of this SMP.
** Rockdale commenced water quality monitoring at the listed sites in December 1998. Monitoirng at these sites will be continued as part of this SMP.

10.5 Water Quality Modelling

Predictive water quality models are best management practice tools. They allow the user to assess the effectiveness of various stormwater management options implemented at different locations within the catchment. To improve the performance of a predictive water quality model, existing water quality data can be used to calibrate the model.

A consistent water quality model across the Lower Georges River catchment would:

- provide an understanding of the likely water quality improvements as a result of implementation of a stormwater management option;

- allow a comparison of the effectiveness of various water quality control measures on water quality within the catchment, at a concept design stage;
- identify the location at which a water quality control device would provide the greatest benefit to water quality;
- provide justification to community, stakeholders and EPA, for council decisions in selecting the type and location of the stormwater management measure; and
- provide a tool to measure the effectiveness of the Implementation Strategy.

Kogarah Council developed a stormwater quality model for the sub-catchments within Kogarah LGA. The main objective of this modelling exercise is to estimate pollutant export rates from Kogarah Bay and Oatley Bay catchments in their current state of urbanisation and to assess the pollutant removal efficiency of potential management measures on a sub-catchment basis. The developed model helped to set treatment objectives that were adopted in this management plan for post construction measures for both existing & proposed redevelopment areas. The methodology included using AUSQUAL model at Mode #1 for gross annual analysis. At this level, the model calculates pollutant exports based on average annual runoff and pollutant export rates based on literature for the different landuse of the catchment. Pollutant removal efficiencies for treatment measures were also estimated using literature and local experience. Results of the model were used to assess the effectiveness of different management measures such as using wetlands at strategic locations and using planning controls for new redevelopment areas. Based on this analysis, treatment objectives for these management measures were assessed and recommended values were adopted as treatment objectives for post construction phase. A copy of the modelling report is attached in Appendix (E).

It is recommended that a consistent water quality model be developed for the entire catchment.

Development of a water quality model should be considered as an important tool for assessing the various water quality control measures. It is therefore recommended that a water quality model be developed for the Lower Georges River catchment in each sub-catchment, or as a catchment based model.

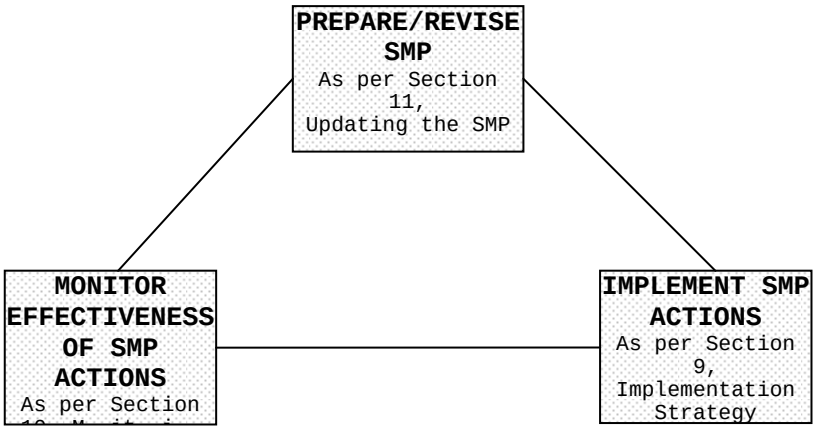
Contents

11. Updating of the Lower Georges River Catchment SMP

Stormwater management needs to be a continuous process in order to be effective. Preparation of the Lower Georges River SMP is only the first stage in the stormwater management process.

Following on from the preparation of the SMP, implementation of the actions agreed to by each Stormwater Manager in **Section 10** is required. However, stormwater management does not end there. Rather, a continuous cycle of implementation, monitoring and reviewing the SMP is required to ensure the most effective stormwater management in the Lower Georges River catchment. **Figure 11.1** below illustrates the stormwater management cycle.

Figure 11.1: Stormwater Management Cycle



The stormwater management cycle illustrates that the preparation of the SMP is just the beginning of the cycle. Implementation of the actions arising from the initial SMP should be monitored and assessed according to the objectives defined in **Section 5**. The monitoring results are then used to revise the SMP and develop a continuous cycle of improvement.

Review of the monitoring results and the SMP should be undertaken on an annual basis if not more frequently. It is recommended that for the first few years, review be undertaken every six months to familiarise the Stormwater Managers with the process.

11.1 Reporting

Progress with regards to the implementation of the SMP recommendations is to be reported in Council's State of the Environment Report. In particular, results of water quality monitoring programs, outcomes of environmental studies and effectiveness of pollution control devices are to be highlighted and a final assessment incorporated within Council's Management Plan with a comparison to the Implementation Strategy.

11.2 Revision of the SMP

Revision of the SMP is to be undertaken in two ways over two different time frames:

- revise/re-issue council and agency Implementation Strategies (at least annually)
- review/revise the SMP document (at least 3 yearly)

Each of these are described in more detail below.

11.2.1 Revise/Re-issue Council and Agency Implementation Strategies

The Implementation Strategy is important for:

- identifying works required to improve stormwater quality and ecosystem health within the Lower Georges River catchment;
- assigning responsibilities to the works;
- providing cost estimates for the works; and
- setting a timeframe in which to undertake the works.

This information forms the basis of Council and Agency stormwater works programs and ensures that stormwater related issues are being addressed on a catchment coordinated basis.

The implementation strategy is dynamic, changing as works are completed, additional works are required, or as new issues arise. These strategies should be updated annually and should consider:

- outcomes of any water quality monitoring programs and environmental studies;
- any additional stormwater management options that need to be included as part of Council's program.

The implementation strategy has been compiled as removable section to facilitate revision and updating.

11.2.2 Review/Revise the SMP Document

It is important that the SMP is reviewed and revised regularly to ensure that the SMP remains a relevant document and provides the necessary information

required for council and agency structural component in their works improvement program.

The SMP document should be reviewed regularly, preferably annually, to ensure that the objectives, issues and options identified within the SMP are still relevant. The SMP should be updated as required, but within 3 years from completion or the last revision (with the exception of the Implementation Strategy which is updated yearly, as discussed above).

When reviewing/revising the SMP, the following aspects should be considered:

- results from any water quality monitoring programs and environmental studies;
- the effectiveness of options implemented during the previous years;
- whether short term management objectives have been satisfied;
- any additional objectives that are required;
- any issues not previously addressed that need to be considered; and
- whether additional management options need to be developed.

The SMP should be revised earlier than the maximum 3 year period if:

- significant additional monitoring data becomes available which changes the stormwater management objectives or options;
- environmental studies or other investigations are completed and the outcomes of these change the stormwater management objectives or options;
- new issues are raised which require immediate consideration;
- additional funding for stormwater management becomes available;
- monitoring data or investigations indicate the SMP will not achieve its objective;. or
- grants for major infrastructure.

11.3 Coordinated Catchment Wide Approach

The on-going process of preparing and reviewing the SMP document, implementing actions and monitoring and reviewing the effectiveness of actions is an onerous task, and cannot be merely added to the job description of an already busy Council officer.

A coordinated catchment wide approach to the management of the Lower Georges River SMP is required to manage the stormwater management cycle. This is best managed

through the LGRSMC involving each of the four Council's as well as government authorities including Sydney Water, RTA, RAC and the EPA.

The on-going responsibilities of the LGRSMC would typically include the following:

- meeting on a regular basis (at least monthly) or as required to assess progress of the implementation strategy;
- managing the coordinated implementation of stormwater management actions, particularly those involving more than one Council or Government Agency;
- managing the coordinated monitoring program, including water quality monitoring, collating results and reporting on findings for the purposes of SMP revision;
- managing catchment based information data base systems such as water quality monitoring data, catchment conditions and water quality models;
- development of a catchment based "Sustainable Water Best Management Practices" manual for the Lower Georges River catchment which could be adopted in Council's policy documents (where required);
- coordinating combined community consultation and education events on a catchment wide basis to generally raise the awareness of stormwater quality in the catchment;
- assist individual Council's and Government Agencies in preparing and carrying out industry and commercial visits and audits to provide a catchment wide perspective and achieve the best result for the whole catchment as well as the individual location;
- report to Council Task Forces; and
- managing the SMP process in the context of the Greater Metropolitan Regional Environment Plan (REP) No. 2 - Georges River Catchment (DUAP).

This list is not exhaustive by any means and needs to be further developed with the assistance of all representatives on the LGRSMC.

The on-going coordinated involvement of all representatives on the LGRSMC will act to keep stormwater management in the Lower Georges River catchment in focus and as a high priority.

12. Conclusions

A significant amount of work in consultation with Councils, agencies, stakeholders and the community has been done in the preparation of the Lower Georges River SMP.

In summary, the SMP has:

- described the existing catchment conditions;
- identified values placed on the waterways and catchment by the community and stakeholders;
- developed stormwater objectives to achieve these values;
- identified stormwater management issues within the catchment;
- identified and ranked options for addressing these issues and to meet stormwater objectives;
- presented individual implementation strategies for all Councils, Sydney Water Corporation and Roads and Traffic Authority;
- provided the basis for monitoring the outcomes of the SMP; and
- presented a framework for the on-going management of stormwater management in the Lower Georges River catchment.

The major output of this SMP is the Implementation Strategy which is highlighted for each Council and Government Agency in different colour pages in **Section 9**. It is this strategy that defines the actions to be implemented to address stormwater issues, the priority of implementation, the timeframe for implementation and the estimated cost to implement the works. These works include a combination of studies and investigations, structural solutions and non-structural solutions.

Stormwater management within the Lower Georges River catchment requires a serious and long term commitment on behalf of Councils and Government Agencies to implement, resource and fund the necessary actions.

It is essential that the outcomes from the review and monitoring of works implemented as part of the SMP are presented to the community. Community and stakeholder consultation should continue to play a role during the implementation phase and also during the revision of the SMP.

Addressing stormwater within the catchment requires long term commitment on behalf of Councils, agencies, stakeholders and the community. All parties need to be involved in the process.

Appendix A - Minutes of Community Workshop Meetings

SINCLAIR KNIGHT MERZ **Minutes**

Project:	Lower Georges River SMP	Prepared by:	Damien Collins
		Job Number:	En00707
Place of Meeting:	St George Sailing Club, Sans Souci	Date of Meeting:	2/11/98
Present:	Cindy Cunningham Gary Williams Damien Collins Ken Robinson John Constandopoulos Mike Ward See also community attendance sheet attached	Organisation:	Rockdale City Council Sinclair Knight Merz Hurstville Council
Apologies:		Organisation:	
Distribution:		Organisation:	
Purpose of Meeting:	Rockdale Community Workshop - Issues and Values		

Item	Description	Action by/Date
1	Ken Robinson - welcome and introductions	
2	Cindy Cunningham- Introduction	
3	Damien Collins - Progress So Far & Values	
	Issues raised by the community during this session:	
	◻ Fisheries Information on swamps - Scarborough Ponds Wetlands	note
	◻ Sewage overflows	
	◻ Hosing down by Council of street rubbish	
	◻ Horses pollution?	
	◻ Rockdale is doing something to clean it up already	
	◻ Mcdonalds - long opening hours allowed by Council	
	◻ RTA's lack of maintenance (grass mowing) - along the freeway corridor?	
	◻ Car washes descharging detergent into creeks	
	◻ The Ide street wetland was raised as an important wetland (on Sans Souci Drain No. 2)	
	◻ there are frogs in Drain No. 2	
	◻ Kids being able to get into the open drains to look at frogs etc. is a secondary contact value	
	◻ seagrass exists in Drain No. 3 - educational values	
	◻ Drain No. 1 is lost - but we should do our best to keep	

Project: Lower Georges River SMP

Item	Description	Action by/Date
	and improve Drain No. 2	
	◻ Scarborough Park - experienced a very warm period of weather and strification occurred which killed many fish	
	◻ Scarborough Park - small motorised boats are harmfull to the wetlands	
	◻ Mud flats to be noted downstream of Drain No. 2 & 3 manually	note
	◻ No sand to be taken away from the beach on Botany Bay	
4	Damien Collins - Specific Issues from the Community	
	◻ Horses at u/s side of Drain No.2 near Ida and Ney St Park Rd and Alice St	
	◻ Police Horses are OK - they are away from the creek	
	◻ Industrial Areas	
	◻ Litter in Parks	
	◻ Russel Ave between Napolean and Claron - dumping of construction materials	
	◻ Behind Daryll Lee? Milky substance - Civic Ave/Fairway ave	
	◻ Mortgate Street - white substance	
	◻ Sandringham Street - detergent? & oil floating	
	◻ Marshall/Scott Sts - chinese markets - market garden, fertilizer/wetland runoff is high in nutrients, wetland should be developed as a WQ treatment device & consider frogs	
	◻ Insecticides used on Horses near creek	
	◻ Bonanza Pde sewer O/F during heavy rains	
	◻ Industrial areas Park Rd, auto mechanics? Nothing observed just highlighted as a potential problem	
	◻ Oil on road by young people hanging around at night spining wheels!	
	◻ Service stations runoff	
	◻ Accidental spill protection	
	◻ Structural controls for Scarborough wetlands	

Project: Lower Georges River SMP

Community Attendance Sheet - Rockdale Workshop

Name	Organisation	Phone	Fax
Cindy Cunningham	Rockdale City Council	9562 1703	9562 1653
Gary Williams	Rockdale City Council	9562 1643	9562 1653
Brian Peacock	Rockdale City Council/resident	9553 9328	
Mr R Jacobson	resident	9529 4573	
Mr R Rayner	RWPS	9567 4260	
Ms B Bush	resident		
Mike Ward	Hurstville City Council	9330 6214	
Ken Robinson	Sinclair Knight Merz	9928 2287	9928 2502
Damien Collins	Sinclair Knight Merz	9928 2192	9928 2502
John Constandopoulos	Sinclair Knight Merz	9928 2143	9928 2504

SINCLAIR KNIGHT MERZ **Minutes**

Project:	Lower Georges River SMP	**Prepared by:**	Damien Collins
		Job Number:	En00707
Place of Meeting:	Administration Building, SSC	**Date of Meeting:**	10/11/98
Present:	Mike Rogers Lara Damien Collins Ken Robinson John Constandopoulos See also community attendance sheet attached	**Organisation:**	Sutherland Shire Council Sinclair Knight Merz
Apologies:		**Organisation:**	
Distribution:		**Organisation:**	
Purpose of Meeting:	Sutherland Community Workshop - Issues and Values		

Item	Description	Action by/Date
1	Ken Robinson - welcome and introductions	
2	Mike Rogers- Introduction	
3	Damien Collins - Progress So Far & Values	
	Value setting was done by the group for: □ Kurnell Peninsula □ Gwawley Bay/Gwawley Creek □ the covered drains upstream of Gwawley Bay □ wetlands in creeks entering Gwawley Bay upstream of Sylvannia Waters and downstream of the covered drains □ Georges River Foreshore areas	
	Value setting was not done for Oyster Bay and Oyster Creek as the group was unfamiliar with that area.	
	Value Sets were ranked for these areas as well as the values them selves.	

Project: Lower Georges River SMP

Item	Description	Action by/Date
4	Damien Collins - Specific Issues from the Community □ it would be good to see the existing covered drains up stream of Gwawley Bay uncovered and restored to a natural waterway(s) in the future (value) □ the wetlands at the downstream ends of these covered drains are important to the community and should be maintained in the future and converted into stormwater treatment devices if necessary (value) □ additional stormwater quality monitoring stations are desired □ concern raised regarding the the future health of the Towra Point Nature Reserve park. The concern was more focussed on the impact of changes in wave formation as a result of dredging in Botany Bay, however this reinforced the community's high value on the area. □ there are only a few active oyster leases remaining mostly in Wooloware Bay and Quibray Bay/Weeney Bay. □ the industrial estates at Kurnell (Caltex Refinery) and Taren Point, as well as the commercial areas, particularly shopping centres were also mentioned as a concern. □ the marine residential development in Gwawley Bay, Sylvannia Waters, was mentioned as a possible issue in terms of stormwater quality, tidal flushing, and potential impact as a result of encroaching into the natural waterway.	

Project: Lower Georges River SMP

Community Attendance Sheet

Name	Organisation	Phone	Fax
Mike Rogers	Sutherland Shire Council	9710 0484	9710 0397
Lara Odell	Sutherland Shire Council	9330 6231	9330 6035
Jim Towart	resident & member of GRCMC & Oster Farmers Assoc.	9525 2478	
Narelle Towart	resident & member of Sutherland Shire Environment Centre & friends of Towra Point	9525 2478	
Ken Robinson	Sinclair Knight Merz	9928 2287	9928 2502
Damien Collins	Sinclair Knight Merz	9928 2192	9928 2502
Jenny Bradford	Sinclair Knight Merz	9928 2495	9928 2502

SINCLAIR KNIGHT MERZ **Minutes**

Project:	Lower Georges Stormwater Management Plan	**Prepared by:**	Jenny Bradford
		Job Number:	EN00707
Place of Meeting:	Hurstville Council	**Date of Meeting:**	16/11/98
Present:	see list attached	**Organisation:**	
Apologies:		**Organisation:**	
Distribution:		**Organisation:**	
Purpose of Meeting:	Hurstville Community Workshop - Issues and Values		

Item	Description	Action by/Date
1	Introduction by Ken Robinson to the meeting agenda, introduction and meeting of workshop participants	
2	General introduction to the catchment by Mike Ward	
3	Description of the SMP process by Damien Collins, description of existing land and waterway conditions in the catchment	
4	Value setting was done by the group for □ Boggywell Creek □ Lime Kiln Bay (constructed/piped areas) □ Lime Kiln Bay (natural areas) □ Foreshore □ Gungah Bay	
5	Value sets were ranked for these areas: □ all area were found to be of equal value but... □ priority should be given to treatment of upstream areas in a top down program	
6	Sources of water quality data in catchment □ Peakhurst high school - Streamwatch data □ Leachate testing - from Council □ Sharon Cullis - has snap shot f.coliform monitoring results from the catchment, has found high levels in minor drains	

Project: Lower Georges Stormwater Management Plan

Item	Description	Action by/Date
7	Issues □ need for urban bushland protection □ urban consolidation is seen as a major contributor to stormwater problems □ re-creation of freshwater wetlands - creates ecosystem as well as treatment of stormwater □ pollution should be controlled at the source □ sediment control □ general apathy and need for public education - drain stencilling, school sponsorship etc. □ community awareness - people needed at public meetings, advertising and targeting of stakeholders □ GPT's □ legislation and regulation □ treatment of low flow in upstream areas □ no piping of creeks were possible □ bank erosion from water skiing □ rubbish from roads □ use greenfield sites for creeks and wetlands	
8	Hot Spots □ Golf Course drain (landfill) □ Gannons Park □ Industrial Park □ Steep foreshores - source of silt, related to use of foreshore and development strategies □ Sewer overflows - asset maintenance and Woodlands Ave overflow	
9	Other questions and notes from the participants □ Question of cost - explained that the EPA provides dollar for dollar funding of up to $30,000 □ noted that Gannons park is native vegetation, scientific and educational purpose □ Acid Sulphate Soils - may limit waterways work	

Project: Lower Georges Stormwater Management Plan

Participants

Name	Organisation	Phone	Fax
Mick Ward	Hurstville City Council	9330 6214	9330 6035
Peter Green	Hurstville City Council	9330 6231	9330 6035
Bob Carter	Hurstville City Council	9330 6175	9330 6035
Mike Rowe	Hurstville City Council	9330 6210	9330 6035
Brad Fahey	Hurstville City Council	9330 6230	9330 6035
Vicki Willes	resident, bushcare	9533 2103	
Gordon Argent	resident	9153 5417	
Lyn Argent	resident	9153 5417	
Victor Nossar	resident	9533 1474	9828 5744
Jason Cockayne	Hurstville bushcare	9570 3420	
Bruce Peters	Hurstville residents association	9534 1045	
Stephen Black	resident plumber	9570 4681	
Sharyn Cullis	GR Environmental Alliance, GR Catchment Management Committee	9579 1262	9755 3190
Phillip Sansom	Councillor, GRCMC	9533 1543	9533 1543
Ken Robinson	Sinclair Knight Merz	9928 2287	9928 2502
Damien Collins	Sinclair Knight Merz	9928 2192	9928 2502
Jenny Bradford	Sinclair Knight Merz	9928 2495	9928 2502

SINCLAIR KNIGHT MERZ

Minutes

Project:	Lower Georges Stormwater Management Plan	**Prepared by:**	Jenny Bradford & Kogarah Council
		Job Number:	EN00707
Place of Meeting:	Oatley RSL	**Date of Meeting:**	17/11/98
Present:	See list (to be supplied by Kogarah	**Organisation:**	
Apologies:		**Organisation:**	
Distribution:		**Organisation:**	
Purpose of Meeting:	Kogarah Council, Oatley Bay Community Workshop - Issues and Values		

Item	Description	Action by/Date
1	Introduction from Mayor and Deputy Mayor	
2	Introduction to Catchment by Firas Naji □ Pressures include: new development, sewer overflows, industrial sites, leachate from landfill, catchment practices and community behaviour. □ Council Stormwater Strategy includes; integrated management, policy, treatment measures and stormwater management plans.	
3	Introduction to the Waterways by Bruce Taper □ formation of the Estuary Management Committee □ tidal flushing □ history of dredging and reclamation, seawalls and jetties □ contaminated sediments (Oatley bay increased PCB's) □ habitat loss	
4	General Questions and Comments from workshop participants □ Graham Austin (resident) – issues of new development in particular villa developments which create sites with mostly impervious surfaces. FN outlined that Council enforces stormwater treatment for new developments and redevelopments with impervious areas of greater than 55%. Stated that existing developments were the greater problem.	

Item	Description	Action by/Date
	◻ Question of how the volume of 1,000 million L of sewage into the Bay is calculated. Sydney Waters Sewage Overflow Licensing Environmental Impact Statements were discussed. ◻ John Lackey (resident and boat builder) – increasing population perceived as greatest pollution problem, as the sewage system is not designed to treat the current population; pollution should be treated at the source; sediment and sand movement down drains is a problem. Over time has seen the in-filling (sedimentation) of Oatley Bay which has been previously dredged. ◻ Bruce Taper discussed Councils design of a villa type development with total onsite tertiary level treatment and onsite use. Discussed the design (yet to be implemented) of a treatment system for leachate from the landfill site. ◻ Mrs Noel (?) recollected the location of a natural watercourse under Arrrowsmith Park ◻ Russ Nazarth (Neverfail Bay resident) problem with community apathy; education is necessary.	
5	Issues recorded during workshop sessions by Kogarah Council are as follows: General ◻ Who and which councils are involved? ◻ A community 'clean up the foreshores' day should be organised ◻ What is happening with the rubble/rubbish and condition of concrete by Hurstville Rd / Morshead Dr -(Improved access is needed here ◻ Bring kids to foreshore (for education?) ◻ Blanche Street (just below Moore Park) - tree/bush clippings are not removed by Depot ◻ Where are the street sweepers? - how regular do they sweep? We need more sweeping ◻ Moore Reserve - Dog Areas, Leash free areas - who will police? ◻ Loose dogs ◻ Cigarette butts throughout the catchment - millions of butts in the waterways are causing fish kills ◻ Fish are dead or gone ◻ Cigarette butts - $200 offence on the ground, $600 on	

Item	Description	Action by/Date
	the water. □ Nobody swims in the area any more because of the rubbish □ Wyong Street stormwater problem will cause the street to collapse □ Litter collection traps on all pits and drains, resource problems, collection up stream -COST! X5 □ More stencilling x2 □ All residents to take care of the environment □ Council leadership is important □ Clean healthy water is needed for all species □ Enjoyment of parks and water should be improved x2 □ Want lots of plants and animals to return to the area □ Want a voting system on most important qualities □ Moore Reserve Steering committee -Residents having a say □ Council weed spraying entering waterways and killing plants, mowing is causing erosion south western corner of Moore Reserve □ Education of Neverfail Bay history of oyster industry so people (children) will realise the degradation of the areas water quality □ Poulton Park is important for a whole range of education topics □ Moore Reserve - wetland education □ To improve the aquatic ecosystems all other values need to be improved □ Poulton Park has the best opportunity for improving aquatic plant life □ Parking will become increasingly a bigger problem for waterway access as population increases □ A more 'forward thinking' sewer management plans are needed □ Leachate and sewer overflows are of concern throughout the catchment □ Increase of population is putting to much pressure on the catchment and waterways x3 □ What funding is available to deal with present issues? □ Insurance for flooding / insurance claims / flood prone areas □ What is polluting the bay? - What is in the water? □ Illegal sewer connections □ Visible and non-visible pollution are both important concerns.	

Project: Lower Georges Stormwater Management Plan

Item	Description	Action by/Date
	◻ Increase street sweeping. ◻ Sediment/Pollutant traps should be on every outlet. ◻ What is councils position/responsibility in regards to flooding ◻ Development - loss of pervious areas ◻ Ratio of housing ◻ acre blocks (now villas/built out (increasing runoff ◻ Development (decreasing remnant trees (increasing runoff ◻ Council ? (to check sullage/grey water on private property ◻ Water smoke tests on connections ◻ Swimming pool drainage? - Sewer/stormwater ◻ Stormwater lids lifting during storms ◻ Can't divorce ourselves from Botany bay ◻ Are there any future wetland proposals in other areas ◻ Can stormwater be used in a positive way. ◻ Stormwater system is clogged with litter ◻ Sediment erosion control on building sites ◻ Increase policing of building sites - source controls ◻ Increase the trees in Moore Reserve ◻ Contribution from the greater catchment area, sewerage etc. ◻ Need to identify all stormwater outlets ◻ Education in upper catchment ("dob in a polluter" - street warden ◻ Council policy -- Dog owners must carry spade and bag ◻ Sustainable water use ◻ Need to exert pressure on Sydney water ◻ Controls on waterfront developments - old permissive occupancies ◻ DLWC enforcement of controls ◻ Sedimentation - quality and quantity ◻ Education of all age groups Oatley Bay ◻ Oatley Pleasure grounds (OPG) - drain is not maintained regularly ◻ OPG - Road spillage, clean up exposed bricks ◻ OPG - Channel scar/ugly, stormwater diversion ◻ North OPG - Weed infestation, need to remove ◻ Oatley Bay has cleaned up in the past 10 years - probably because of change in the tip ◻ OPG - Coral trees to be replaced with natives	

Project: Lower Georges Stormwater Management Plan

Item	Description	Action by/Date
	◻ Sedimentation is a problem ◻ Litter from Hurstville and Kogarah into Poulton Park and hence into Oatley Bay is a large problem. ◻ Northern end of Oatley Bay has become a sediment pond ◻ Poor flushing, can stormwater be used for flushing? ◻ Neverfail Bay ◻ Clean up the foreshore ◻ Now the oyster stacks have been removed there are more ducks using the area. ◻ Wyong street foreshore needs mowing ◻ There is no foreshore access ◻ Neverfail Bay was much cleaner 20 years ago ◻ Dog droppings - need bins with bags - education for dog owners Top 3 Values for the whole catchment 1 Aquatic Ecosystems 2 Aquatic Vegetation 3 Urban Bushland	

Project: Lower Georges Stormwater Management Plan

Community Attendance Sheet

Richard Stubbs	128 Letitia St	Oatley
Jeff Carson	84 Wyong St	Oatley
Russ Lazarus	67 Wyong St	Oatley
Jim Tennent	3a Asquith St	Oatley
M. ????	28 Blanche St	Oatley
A. Sellens	43 Ada St	Oatley
Cheryl & Janet Geary	28 Asquith St	Oatley
Jim Douglas	70 Algernon St	Oatley
Alan Douglas	5 Redin Pl	Connells Point
Matt Allin	33 Kitchener St	Oatley
Nola Davis	46 Herbert St	Oatley
J.& A Keach	24 Ada St	Oatley
John Pugak	42 Herbert St	Oatley
Janet & Graham Austin	13 Kitchener St	Oatley
Ralph Cole	26 Asquith St	Oatley
N. Woods & B. Clay	8 Neverfail Pl	Oatley
John Wright	16a Blanche St	Oatley
J. P. Bates	29 Kitchener St	Oatley
R. J. Lackey	47 Seymour St	Hurstville
R. & K. Wright	17 Kitchener St	Oatley
A. Allison	3 Russell St	Oatley
N. Bulters	36 Lawson St	Oatley
P. Cox	63 Wyong St	Oatley
A. Saivz	6 Lesley Cr	Mortdale
A. Pallpha	79 Canoline	Kingsgrove
D. O'Shea	56a Algernon St	Oatley

SINCLAIR KNIGHT MERZ

Minutes

Project:	Lower Georges Stormwater Management Plan	**Prepared by:**	Damien Collins & Kogarah Council
		Job Number:	EN00707
Place of Meeting:	Oatley RSL	**Date of Meeting:**	18/11/98
Present:	See list (to be supplied by Kogarah	**Organisation:**	
Apologies:		**Organisation:**	
Distribution:		**Organisation:**	
Purpose of Meeting:	Kogarah Council, Kogarah Bay Community Workshop - Issues and Values		

Item	Description	Action by/Date
1	Introduction from Mayor (Cr Nick Katris, President of the Estuary Management Committee)	
2	Introduction to Catchment by Firas Naji □ Pressures include: new development, sewer overflows, industrial sites, leachate from landfill, catchment practices and community behaviour. □ Council Stormwater Strategy includes; integrated management, policy, treatment measures and stormwater management plans.	
3	Introduction to the Waterways by Bruce Taper □ formation of the Estuary Management Committee □ tidal flushing □ history of dredging and reclamation, seawalls and jetties □ sedimentation in Kogarah Bay □ habitat loss	
4	General Questions and Comments from workshop participants: □ question of stormwater into sewers. Why? How? □ House connections to sewer □ Illegal connections to sewer add up but are not large compared to leaks □ Sydney Water doing Exfiltration Modelling to test how much water escapes from the pipes	

Item	Description	Action by/Date
	◻ Manhole in sewer just in Park Side St is an overflow ◻ Sydney Water drain into Kogarah Bay - siltation ◻ Sydney Water are a "courier" of the water, important issue is where is the siltation coming from? ◻ street sweeping ◻ concrete ending up in drains - blocking ◻ question of whether Council is picking particular streets where there are tourists and major thouroughfares near Bays? ◻ Beach St - only swepth when council is called ◻ Calton Cresc. - "can't remember when it was last swept" ◻ question of whether there is a continuity of exercises/programs over multi-Council terms? ◻ dredging required to remove silt from the Bay	
5	Issues recorded during workshop sessions by Kogarah Coucnil are as follows: ◻ Flooding in Carss Park (Parkside drv) channel ◻ Pollution from Carss Park (Parkside drv) channel – Litter and Leachate ◻ Flooding at Carss Park Bowling Club area ◻ Channel not designed to take flood levels ◻ Pollution is mostly from streets and industrial area ◻ Lack of commitment from council, Sydney Water, Waterway authority, EPA.x2 ◻ Need to use a range of different technologies to reduce the pollution – GPT, wetlands etc. ◻ Why do we have to tell the council how bad the bays are? – they already know they are bad, we just want action ◻ Dover Park has had suspect medical type waste dumped there ◻ Sewage discharge into the bay – colour and smell ◻ Litter in the bay ◻ Build up of a 'slick' ◻ Sedimentation is a big problem ◻ Too many people and too many cars ◻ Intercept pollution at the source via stronger enforcement – Litter, builders, developers etc. ◻ More research & development needed in how to best deal with pollution – pollution traps ◻ What to do with the litter once it is trapped (rebuild	

Item	Description	Action by/Date
	Cronulla dunes with rubbish than top it off with sand □ Fish kills from termite sprays and chemicals □ Remove kerb and gutters – replace with more environmentally friendly solutions eg grass swales □ All small solutions add up eg. on site detention, rainwater tanks □ Wetlands concern about mosquito □ More education especially for misunderstood soft solutions like wetlands. □ Educate the council □ More street sweeping by the council and residents □ Provide bins for refuse – north Carss Park □ Visible pollution from industry/households/dead animals –oil (boom and skirt – Syd Water channel □ Use a series of different sized booms to collect different materials □ Drain surveillance □ Widen canal (slower velocity (sediment & pollution closer to mouth of canal – smells; widening the canal will lead to less flooding – Syd Water channel □ Smell from mud flats – east of Carss park □ Industrial pollution has destroyed the mangroves, caused fish kills and siltation – – Syd Water channel □ Council should put bins with signs at boat ramps – as per "dog tidy bins", or charge for a bag and get a refund for the rubbish □ Pollution from road goes directly into bay □ Oil marks on legs when walking □ Residents with pools flush chlorinated water into the bay □ Residents flush laundry water into the bay. □ Stormwater use to be open – silt flowing from maintenance works – stormwater Carss Park □ Illegal pollution dumping – south end of main industrial area □ Regular canal maintenance especially at low tide – south end of Beverley Park channel □ Wind brings /takes pollution □ Clean litter from parks more regularly □ Holes are dangerous adjacent to canal -- – Syd Water channel □ Toxic slug 1/month chemicals etc – dead crabs/stingrays – water in drain fluorescent blue – white milky colour last week – Carss Park	

Item	Description	Action by/Date
	◻ Toxicity in commercial/recreational fish	
	◻ Fish fat from fertilisers	
	◻ Sand moving with wind and tides	
	◻ Problem with the use of blowers – lawn maintenance	
	◻ Increase in concrete/tile areas by residents	
	◻ Rainwater tanks	
	◻ Cigarette problem	
	◻ Gross pollution – from parks and streets	
	◻ Rubbish dumped in canals – grass clippings	
	◻ Fines need to be implemented	
	◻ Siltation – from road and building developments	
	◻ Trucks moving on and off site – soil on tyres	
	◻ ? Grids at building sites	
	◻ Hay bales ?	
	◻ Sediment erosion control	
	◻ Pit screening /cleaning	
	◻ Regular maintenance	
	◻ Trash racks – need more racks	
	◻ Maintenance – more frequency	
	◻ Sediment traps	
	◻ Education	
	◻ Building/development in Hurstville Railway pde area – controls need to be put in place	
	◻ Drains blocked with cement etc	
	◻ Street sweeping – more regularly	
	◻ Regular inspections on building/development sites	
	◻ Mechanised sweeper	
	◻ Stormwater retained on-site new development	
	◻ Driveway pavements	
	◻ Increase in impervious surfaces	
	◻ K Bay unsightly	
	◻ More trees now than 20 years ago – east side of the bay	
	◻ Ideas that don't work	
	◻ Absorption pit on-site – do not work? – maintenance	
	◻ Silt trap – workable?	
	◻ Rubble pit	
	◻ Grating	
	◻ Plans being considered for yacht access	
	◻ Council lobby scout govt. Cleaing/dredging the bay	
	◻ Sewerage over flows	
	◻ Council to lobby Syd water or State govt. Re: inspecting pipes/sewer/S.W. prior to selling	
	◻ PVC pipe vs. Terracotta	

Item	Description	Action by/Date
	◻ Education in different languages – NESB ◻ Target schools ◻ Educate public – New technology – Insert sleeves into old pipes ◻ Ban commercial/professional fishing in Kogarah Bay ◻ Concerns about the fall/gradient for a wetland – good in class room / not reality. ◻ Seawalls what are the affects – decrease ? – should we have a beach ◻ Prohibits access to water ; ie windsurfers launching ◻ More trees in Carss Park ◻ Concrete channels into natural creeks ◻ Mix of playing fields and wetland ◻ Educate developers and Bay/Park users and residents – other languages Top 3 values for the whole catchment ◻ Visual amenity ◻ Education ◻ Primary Recreation and Aquatic Ecosystems (tie).	

Project: Lower Georges Stormwater Management Plan

Community Attendance Sheet

P. Edwards	28 Torrens St	Bankstown
J. Powys	12a Gnarbo Ave	Carss Park
George Bodell	109 The Promenade	Sans Souci
Greg Aitkenhead	29 Endeavour St	Sans Souci
John McCormack	9 Vista St	Sans Souci
Clemt Sydem	46 Parkside Dr	Kogarah Bay
John Slattery	4a Carlton Cr	Kogarah Bay
Joyce Lun	91 The Promenade	Sans Souci
Fay Keech	8 Beach St	Blakehurst
Ron Handley	41 Benwerrin Ave	Carss park
Brain May	56 Wentworth Ave	Blakehurst
Margret Wilkinson	2/11 Paine St	Kogarah
Nina Vella	14 Allawah Ave	Carss Park
Stephen Griffitiy	32a Beach St	Blakehurst
Alison Britt	115 The Prornenade	Sans Souci
James Smith	33 Bunyala St	Carss Park
Eric Coulpasis	61 Vista St	San Souci
Jonh Brett	69 Vista St	San Souci
Louise Tapp	90 Carlton Crs	Kogarah Bay

SINCLAIR KNIGHT MERZ

Minutes

Project:	Lower Georges River Stormwater Management Plan - Kogarah Council	**Prepared by:**	Jenny Bradford & Kogarah Council
		Job Number:	EN00707
Place of Meeting:	Connells Point Sailing Club	**Date of Meeting:**	24/11/98
Present:	see list attached	**Organisation:**	
Apologies:		**Organisation:**	
Distribution:		**Organisation:**	
Purpose of Meeting:	Kogarah Council, Connells Point Community Workshop (Kyle Bay sub-catchment) - Issues and Values		

Item	Description	Action by/Date
1	Introduction by Patrick White and Councillor Jim Taylor	
2	Firas Naji Catchment and Waterways Introduction □ Kyle Bay, sedimentation problem □ Dead water zone in half the Bay no flushing	
3	Questions and Comments from the Floor □ A comparison of the Georges River and Hacking River should be made (Georges River used to have 3 STPs discharging into it) □ Heavy metals in sediment as well as nutrients and bacteria; problems with dredging but Bays are silted up so something needs to be done □ Discussion of Moore Park and the old landfill site (not in Kyle Bay sub-catchment) and Council actions to resolve problem □ Park above Kyle Bay used to have a river/creek running through it which has been piped □ Pipes discharging litter - broken and old pipes need to be fixed and removed □ Stormwater outlet in Kyle Bay has silt trap which is never emptied □ Infilling (sedimentation) of the Bay can now stand up in the middle of the Bay □ Need to do something about the discharge from the upper catchment □ Dead water in Connells Bay - coffer dam in 1962 by Water Board have sewer overflow and pipe □ Mullet in water 30 years ago □ Pollution problem from within the river ie speedboats	

Item	Description	Action by/Date
	etc □ Pollution washed over from the other side of the river	
4	Issues recorded during workshop sessions by Kogarah Council are as follows: □ Broken sewer pipes on beach (in water) □ All stormwater outlet pipes are broken □ Merriman Reserve is never cleaned □ Sedimentation must be reduced □ Home renovation paint stripping waste goes straight into the bay (trades practices need policing) □ Mangroves at Kyle Williams needs cleaning up □ Rubbish on the foreshore and vandals in Donnelly Park □ Both stormwater pipes at Donnelly need trash racks □ Most litter comes from Sutherland side in Southerly winds. □ More stencilling on drains □ The aquatic ecosystem has dramatically declined over 12 years - there were many types of aquatic fauna especially on the intertidal area. □ Siltation is a problem for all of the bays x2 □ Washing cars on the Street, Oils and sudds. □ Building sites are causing a lot of the siltation □ More education is required throughout the catchment □ Educational targets - schools, boat owners □ Water quality needs improving □ Annual community clean up days would be good □ Population increase is placing pressure on the catchment and waterways - an increase of impervious surfaces □ Detailed aerial photographs could be used for assessment of impervious area change and other changes in the catchment □ Sewer overflow - Connells Bay □ Railway sleepers burnt in Connells Bay. □ Clean up Australia Day for Kyle Bay □ Dredging required □ Analyse the sediments in the bay □ Comparison study between the Georges River and Port hacking River □ Rubbish/Gross pollutants in stormwater pipes □ Medical waste - Syringes - health risks □ Gross pollutant traps for SW pipes in all areas	

Project: Lower Georges River Stormwater Management Plan - Kogarah Council

Item	Description	Action by/Date
	◻ Sediment traps for SW pipes in all areas ◻ Greenwaste - difficult to disposed, Extending hours of operation (Quarry Sat 1 - 4) ◻ Boats with scoops to clean bay rubbish ◻ Kyle Bay outlet - Broken pipe (left over) - pipe itself is broken ◻ Fence required along reserve opposite Cross st ◻ Kyle Bay pipe - could it be diverted - good spot to place GPT ◻ Dredging not suitable - flushing required - reference to Lake Conjola ◻ Dredging (heavy metals (disposal of material ◻ Nutrients ◻ Reuse of Stormwater for park irrigation ◻ New developments - on site retention - existing developments also ◻ Rainwater tanks - special permission to install; council subsidise; tax free ◻ Drums of cleaner found at bottom of slope near Kyle Pde and Cross St intersection ◻ Connells Bay catchment used to be natural and rain went in to the ground - development in the 40s or 50s (septic tanks seeped into the bay ◻ Failure of sediment trap - silt fences and straw bales (inadequate in high rain fall ◻ Area between Connells Rd and Terry St previously wet sandy area - draining fresh water ◻ Litter ◻ Drains off Connell Bay flood in flood weather ◻ Loss of wetland areas which used to act as a filter ◻ Freshwater areas all along foreshore - spring used to be off Merriman St ◻ Litter; dog droppings down easement into Kyle Bay ◻ Drains fill with silt ◻ Development and subdivision ◻ Street sweeping not effective in all areas ◻ Need treatment back in the catchment to get rid of rubbish - need more collection, community involvement ◻ Need more policing of dogs etc ◻ Increasing paved areas means more run off ◻ Dissolved pollutants ◻ Sewer overflows ◻ High density housing (increases runoff ◻ Pumping stations at low point which are also tidal	

Appendix B - Kogarah Community Workshop Results

The following tables provide details of the outcomes of each of the Kogarah Municipal Council Community Workshops. These were held for Oatley Bay, Kyle Bay and Kogarah Bay subcatchments respectively in late November, 1998.

In Kogarah, values and priorities were assigned for more specific, local areas within each sub-catchment. Individuals indicated areas for each value they considered the highest priority. Collation of the current and potential values for areas is shown in Figure 4.4. Priorities are based on the number of people who held a value to that location. Where there was an insufficient comparison values are prioritised as medium. Each value set area has a priority according to the overall number who valued the area. The general priorities in each sub-catchment are results from a vote at the conclusion of each workshop. Details of workshop results are presented in the following pages.

Kogarah Councils prioritising method identifies which value the community held higher in comparison to others for a locality. All the values given at the workshops are important. The values ranked low are interpreted as a comparison and not to be discredited.

The value sets are a result of 74 residents and is by no means an extensive consultation program. Other matters to consider are due to some of community having sight of possible values and focus on areas requiring attention, and community values and their ranking may differ from scientific views.

Tables are provided on the following pages.

Oatley Bay Workshop

Grouping	Area	ʒ	δ	δ	)	Δ	ξ	|	□	λ	;	≅	Total
Neverfail Bay	1	3	1		1			4	4		1	2	16
totals		3	1		1			4	4		1	2	
Oatley Bay	2	3		1		1	1		1		1	1	9
	3	1	11					2	1			4	19
	4		2	2	1	1	2	2					10
	5	2			3			3			2		10
totals		6	13	3	4	2	3	7	2	0	3	5	
Moore Reserve	7	5						2		3	8	6	24
	8						3	2	3	4		4	16
	11									3		1	4
totals		5	0	0	0	0	3	4	3	10	8	11	
Poulton Park	6							9	1				10
	9				7		2	2	1		3	5	20
	10										1	5	6
totals		0	0	0	7	0	2	11	2	0	4	10	
	Total	20	27	6	16	4	11	33	13	10	19	33	144
Overall Vote		8	3	1	3	4	24	17	5	0	2	14	81

Kyle Bay Workshop

Grouping	Area	ʒ	δ	δ	)	Δ	ξ	|	□	λ	;	≅	Total
Connells Bay	1	1		1		2	1	1	1	1		1	9
	2	4	3	1		1	2	2	4		2	1	20
	3	3	1	3		1			2		2	1	13
Totals		8	4	5	0	4	3	3	7	1	4	3	
Kyle Bay	4	4	4				2	1	1	3	1		16
	5									2		1	3
	6		1	2	6		2	4	2		4	5	26
Totals		4	5	2	6	0	4	5	3	5	5	6	
Shipwrights	7							1				1	2
Bay	8				1						1		2
Totals		0	0	0	1	0	0	1	0	0	1	1	
Georges River	9		4	4	1	2	3	2					16
	10	4		3		4	3	1	3				18
Totals		4	4	7	1	6	6	3	3	0	0	0	
	Total	16	13	14	8	10	13	12	13	6	10	10	125
Overall Vote		14	7	7	3	2	9	4	4	3	0	1	54

Kogarah Bay Workshop

Grouping	Area	ʒ	δ	δ	)	Δ	ξ	|	□	λ	;	≅	Total
Carss Park	2	6	8	1	3	1	5	5	4	4	6	7	50
	3				1	1			2				4
Totals		6	8	1	4	2	5	5	6	4	6	7	
Beverley Park	4					1		1		3			5
	5	2		1	1			1		1	2	1	9
Totals		2	0	1	1	1	0	2	0	4	2	1	
Kogarah Bay	1	1		5	2	1		3	2			2	16
	6	2	3	4		7	3		3				22
	7	1		1	2				1			1	6
Totals		4	3	10	4	8	3	3	6	0	0	3	
	Total	12	11	12	9	11	8	10	12	8	8	11	58
Overall Vote		13	7	2	10	0	7	3	2	6	1	0	51

Appendix E - Kogarah Stormwater Quality Modelling

Appendix C - Summary of Submissions to the Draft Issues Report Exhibition

This list includes responses received in relation to the exhibition of the draft Issues Report as well as from the 1st Stakeholder Workshop conducted at the Georges River Sailing Club, Dolls Point on Tuesday night, 9 February, 1999.

Item	Respondent	Organisation	Summary	Action
1	Dr Olivia De Bergerac	Dolphin Society	Questions the pipe solution. Need to change paradigm thinking and use technologies based on three principles: – pervious surface – storage underground – recycle water Recommends the use of Atlantis technology, however the importance is to have the three principles right. Promotion and incentive for roof gardens, pervious paving, underground storage tanks, preserving green space with trees etc…. These are the solutions which need to be implemented at the local government level, road and traffic authorities and individuals.	Refer to Committee & Incorporate into Final SMP Report
2	Gordon Duff	Resident & Connell's Point Progress Association	Concern related to main drain on Connell's Point Beach Frontage: – 1/3 debris from recent heavy rainfalls was from straw bales – ½ of debris after storms with southerly winds is sea weed and jelly fish – concerned about sand being washed away at pipe outlet - also does not want to see the natural tidal sand circulation and retention cycle interfered with. Suggests that rubbish traps be placed back from pipe outlets so that their efficiency is not affected by tidal, waves, wind and weed action.	Refer to Committee & Incorporate into Final SMP Report
3	Graham Whitelaw	GRCCC Inc. River Keeper	Wants to see the reports, tables and graphics for all Georges River SMP's in standardised format, available on CD ROM and the integration of all sub-catchment reports into one combined report with combined recommendations for the whole GR system. Also wanted to chase up ferry discharge incident reported by Connell's Point Progress Assoc. at the 1st Stakeholder Workshop	Refer to Committee & Connell's Point Progress Assoc.
4	John McCormack	Resident Involved on the Estuary and Catchment Working Party with Kogarah Council	– Sedimentation build-up in Kogarah Bay – Worried about "splinter groups" which may have good intentions tend to slow down and duplicate many issues that have been previously addressed – Concerned that all the theories need to be converted into practices – Would like to see Council getting community support from people living away from the estuaries (eg. a block bounded by Railway Parade at Hurstville to Carlton and 400m to the east is claimed to contribute much of the debris and pollutants that flow into Kogarah Bay) – Would like to see Kogarah Council do the following:	Forwarded to Kogarah Council, Table at Committee Meeting

			– identify every street drain in terms of how it functions to minimise through-put of debris and pollutants from the top-down (look at the high-points topographically in the catchment first) – frame the wording of the development consents so that all contractors understand what is required of them, and state the range of penalties. – clearly define the role of Council Ordinance Officers and their accessibility to resident rate payers. – expand the number of honorary rangers by examining the need for such personnel in areas where high density development is occurring. – starting with concrete batching plants, carry out a public relations exercise to ensure that best practice is observed within their own locations. – Policy in place for construction work at Stadium Australia could well be adopted for Council – Hot-spot along Railway Parade extending from Hurstville to north of Allawah and extending to the east. Flows into the major Sydney Water canal and discharges into Kogarah Bay near the Carss Park playing fields. NOTED that Kogarah Council has re-scheduled the completion date of the litter trap device at Empress Gardens (end of Empress St, at the cnr of George St and Cole St) from 2000 to 2004 "… hardly a recognition of the needs of the real world, or is it simply a failure to properly plan and manage contributions from developers?"	
5	Philip Gray	Rail Services Australia	– Suggests that the operation of rail system is generally low in its capacity to impact stormwater quality. – Highlighted that there are industrial discharges (generally from small un-scheduled premises) onto the rail corridor that would affect SW quality – Noted that insecticides, herbicides, solvents etc. are freely available to householders and they may make a significant aggregate contribution to stormwater pollution. – Education of local populations (as well as industries) on the methods that should be employed to prevent degradation of their environment.	Refer to Committee & Include in Final Report
6	Ron Raynor (verbal response by telephone)	Rockdale Wetlands Protection Society	– Concerned about the velocity at the outlet of the pipe off Culver Street. – Noted that emergency response to spill incidents is with the Fire Brigade and that there is a draft Incident Response manual available.	Refer to Committee & obtain copy of draft manual if possible.

Appendix D - Summary of Submissions to the Draft SMP

This list includes responses received in relation to the exhibition of the draft Lower Georges River SMP as well as from the 2nd Stakeholder Workshop conducted at the Georges River Sailing Club, Dolls Point on Tuesday night, 1 June, 1999.

Item	Respondent	Organisation	Summary	Action
1	Sharyn Csanki	EPA	Compliance with Section 12 Directive: – Section 5 Stormwater Management Objectives: * Stormwater management objectives in relation to new or proposed development be clarified; * Table 5.1 clarification so that treatment objectives are more outcome based rather than rates of compliance. – Section 9 Implementation Strategy * State agencies to agree prior to finalisation of the Plan. * Clarification of graphical representation of link between Council's management planning processes with the SMP. – Section 10 Water Quality Monitoring * require a monitoring program to "assess the effectiveness of the Plan, and identify any necessary refinements". Other Comments: – Refer to EPA letter attached to this table in Appendix D for details of other EPA comments.	- Table 5.2 modified - Table 5.1 modified - Section 9 modified - Figures in Sect. 9 updated - Section 10 modified - all comments incorporated in relevant sections with the exception of: * Section 6 (pg5 of EPA letter, emoval of objectives, issues and actions relating to sewer overflows and STP discharges) – Committee decision to leave in due to the importance of the issue to stormwater quality; * Buffer/filter strips (pg6 of EPA letter) are not necessarily the best approach in relation to high nutrient

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				sources such as horse stables and nurseries, however, they are included given their ability to help reduce nutrient loads using a "soft engineering" measure; * the advise of the EPA in relation to triple plate interceptors (pg 6, EPA letter) is noted, however, the use of this technique was included as a potential option with modified stormwater flow conditions in mind (ie. reduced flow); * the Committee maintain that the EPA has inherent stormwater management responsibilities (pg7, EPA letter) and therefore actions/responsibilites including the EPA are included in the SMP.
2	Jim Walsh	Sydney Water	Table 9.9 - rank of actions across the whole catchment.	- average rank from all 4 Council LGAs provided
3	Jill McNeill	Georges River CMC	– "Pipecheck" is the term used for the inspection of private sewer lines at the time of conveyancing; – Need to highlight that Council's support actions OA22, SC14, OA17; – Concern that no testing being carried at old landfill sites; – Concern that secondary contact recreation in Scarborough Ponds will be dangerous to public safety and	- incorporated into action tables - Council's support all actions - Action OA17 provides for this - secondary contact still

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			compromise environmental protection; – Oyster Farming has never been banned in the Georges River. Oyster Farm leases were voluntarily returned to the Fisheries Dept due to the concentration of the QX organism in the river and Woolooware Bay. Quibray Bay is extensively farmed for oysters.	recommended by RCC but modified such that it is compatible with the environment. - acknowledged and incorporated into the report on page 3_45, Section 3.
4	Sam McKay	resident, Oyster Bay	– Flooding around the Carina Bay area; – Leachate escaping from fill in Carina Bay; – Dog exercising and dressage activities in the park. – Current and proposed uses of Carina Bay.	- not part of the SMP; - OA17 (landfill leachate monitoring incorporated into SSC 5yr plan) ; - OA02, OA07, OA08 education programs will cover horse and dog impacts; - refer to SSC Management Plan.
5	Chris Woodham	resident, Oyster Bay	– copy of letter sent to Healthy Rivers Commission in 1998 for the Woronora River; – calls for residents to adopt a pit for cleaning and cleaning of own front gutter/footpath area; – concerns with householder carelessness with respect to putting out recycling rubbish (contributing to litter in waterways);	- SMP incorporates numerous litter actions including installation of litter booms/traps in pits and education programs which attack the problem at the source. - stencilling of pits will raise the awareness of where stormwater ends up and may be incorporated with “adopt a pit” or “pit warden” ideas.
6	Graham Whitelaw	Georges Riverkeeper Programme	– supports CWSM and suggests an overall management structure for SW management in Georges River;	- the LGR SMP identifies the need for an overall combined approach with the rest of the Georges River. This may be through trusts, expanding the CMC,

Item	Respondent	Organisation	Summary	Action
			– Keywords to be capitalised and new tables generated according to keyword, ranking, primary sort, secondary sort, etc. – suggested that commercial and industrial audit actions be split given their individual priorities may be different; – OA28 and OA68 should have closer priority ranking; – 2 sites with 23 chemicals of potential concern as reported by Sydney Water. – request for COPC's acute exposures; – requested more information on chemicals modelled to occur on greater than 10% of days. – When will Georges River Water Quality Objectives guidelines be available and who will be responsible? – Catchment waterway monitoring site SSC35 - Hotspot; – requested dates (if known) of Oatley Bay dredging and more details of report. – Rockdale Industry Audit - when will report be produced? – Fig 4.4 Kogarah Map not the same standard as 4.1, 4.2, 4.3;	Riverkeeper, EPA from a State level etc. The LGR SMC needs to focus on just the LGR. See Section 11. - selected keywords are already capitalised. Committee decision to not generate new tables based on them being unnecessary and insufficient time prior to EPA deadline. - Industrial and commercial were deliberately grouped so that both were dealt with simultaneously using common material and resources. - these actions were combined into one action - ERA sites in Fig. 3.1 marked with a black diamond (Lady Robinson's Beach & downstream of Captain Cook's Bridge). - reference should be made to Sydney Water EIS's - ref. To Sydney Water EIS's - the Interim Objectives are avail. now, not known when the final objectives will be available. - Hotspots SS19 & SS14 are close to the SSC35 location and are indicative of the concerns

Item	Respondent	Organisation	Summary	Action
			– 5.13 Examples - so that visual is good, this means dredging - Yes/No? – Comments please 9.2 & 9.3, 9.3 (SSC), 9.5 (H'ville), 9.8 (Rockdale) and 11.3. – Strategy should be recast over 3 years and costed, similar ot what Kogarah did in 3rd year. – Keywords should be attached to these and sorted alphabetically to establish and confirm that most matters/issues were considered in the plan. – Strategic Focus (incl. Top, Middle & Bottom).	highlighted by the WQ monitoring results. - refer to Kogarah Municipal Council report - report already produced, refer to Rockdale City Council for more information. - Fig 4.4 was produced differently (by Kogarah MC) and based on information from Workshops conducted differently (by KMC). See Section 4 for explanation. - No - uncertain to what is required here. - uncertain to what is meant, however, there is a review of the SMP every 3 years and a revision of the SMP implementation plans every 12 months as part of Section 11. - this is already in the plan over a series of tables. Values & Objectives are linked to Issues & Hotspots which are linked to the Potential Mgt Options which feed into the Actions/Implementation Strategies for each LGA. - the strategic focus of the SMP is to attempt to fix the problem at the source and

Item	Respondent	Organisation	Summary	Action
				deal with known hot-spots that are problems now (top and bottom). Middle strategies are also included such as education programs, stormwater reuse and wetlands.
7	Gary Kedward	Buderim Ave/Box Rd Community Group	– Flooding, drainage mgt, flood mitigation. – request for additional water quality monitoring site upstream of Bates Drive Road Bridge. – request bank stabilisation measures & the installation of silt traps upstream of Bates Drive Bridge. – reduced width of Oyster Ck, siltation and raised water levels. – need for SSC to institute a study to identify the exten of sedimentation in the LGR as a result of activities in the Shire. – dogs and cats, pet dropping collection repository bins. – dug out using an excavator as opposed to dredging. – erosion near the Box Rd end of Carvers Rd, Oyster Bay and exposed mud/sedimentation flats/zones in the upstream section from Bates Drive Bridge. – photos taken over 20 years ago. – include involvement of “Clean Up Australia” campaign.	- focus of the SMP is on water quality, flooding is not a primary focus of the plan. - taken on board by SSC in action OA40 (WQ monitoring program). - action SC03 covers the bank stabilisation & erosion control in Oyster Ck. - action SC03 includes stream flow mgt of Oyster Ck. OA01, OA29 both catchment erosion reduction actions. - SC04 investigates sediment reduction resulting from actions, OA01, OA29 are source reduction actions. - OA07 addresses this problem. - these actions are regarded as synonymous for the purposes of this plan. - this is covered by action SC03, the OHS&W issue of the erosion near Box Rd was noted but is

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			– concern over the rank of Oyster Ck Streamflow Mgt & Bank Stabilisation (rank 73) w.r.t. stormwater pit labelling (28) and catchment signage (27). – Oyster Bay Precinct Committee (formed recently)	not a consideration for this SMP. - all photos used in the SMP report were taken in Summer 1998/99. - action OA04 incorporates Keep Australia Beautiful & CUA will also be considered. - the biggest reason why it ranked lower is the cost involved. It is scheduled to be undertaken in the 2nd year in any case. - OBPC will be added to the stakeholder list for further consultation regarding the SMP.
8	Ron Handley	resident, Kogarah Council	– Pgs 3 & 5 of Minutes of 24 November, 1998 meeting at Connells Point Sailing Club missing in draft SMP. – request for spending $500,000 in 1998 put to Council for Kogarah.	- these pages were inadvertently missed in photocopying for the draft SMP, however, are included in the final SMP. - Capital expenditure alone for Kogarah Council in 1st year of the implementation strategy is >$1.4M
9	Comments from 1 June 1999 draft SMP presentation workshop	stakeholders	– Will water quality monitoring results be available to the public? – Water quality monitoring should have a higher priority. – there needs to be an Environmental Officer that has the task of implementation of actions on the	- Yes, through the State of the Environment Reports, Streamwatch (web) and Council offices. - Water quality monitoring has an entire section (10) devoted to it in the SMP. It is an inherent part of measuring

Item	Respondent	Organisation	Summary	Action
			ground. – Council Hotline needed for pollution control. – After the plans are prepared will there be combined meetings with LGR SMC? – Lobbying government is an essential requirement for this plan.	the success of the SMP and is of paramount importance. - there will be a coordinated approach to implementation of actions across all 4 LGAs including the on-going involvement of the LGR SMC. - EPA Hotline exists and Sutherland Shire Council already have their own emergency hotline. - Yes, including on-going involvement of stakeholders and the community. - this is acknowledged and lobbying is already the subject of a number of non-structural actions to the implemented across the whole LGR catchment.

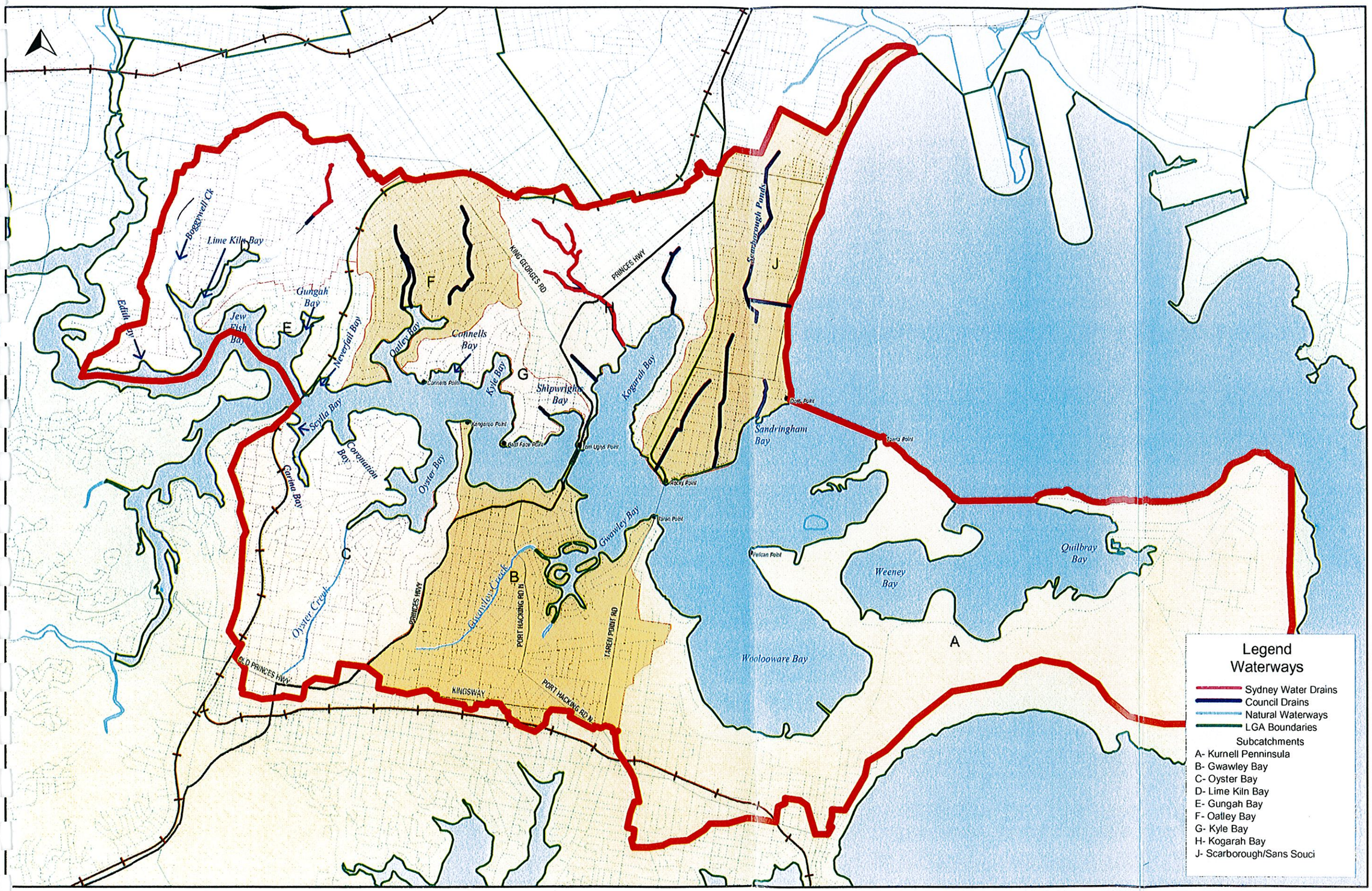

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Figure 2.1- Lower Georges River Catchment Waterways and Subcatchments

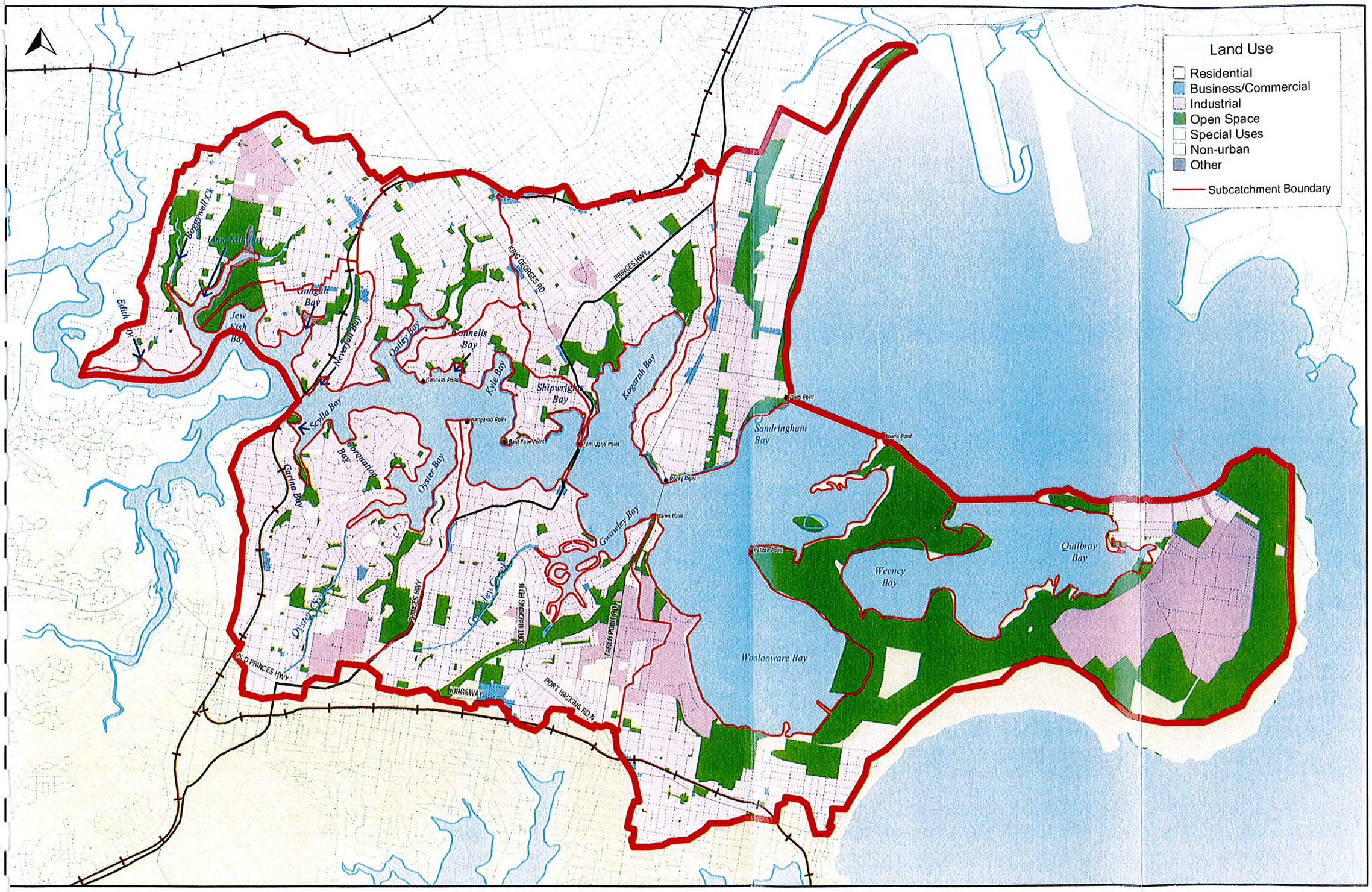

Figure 2.2- Lower Georges River Catchment
Land Use

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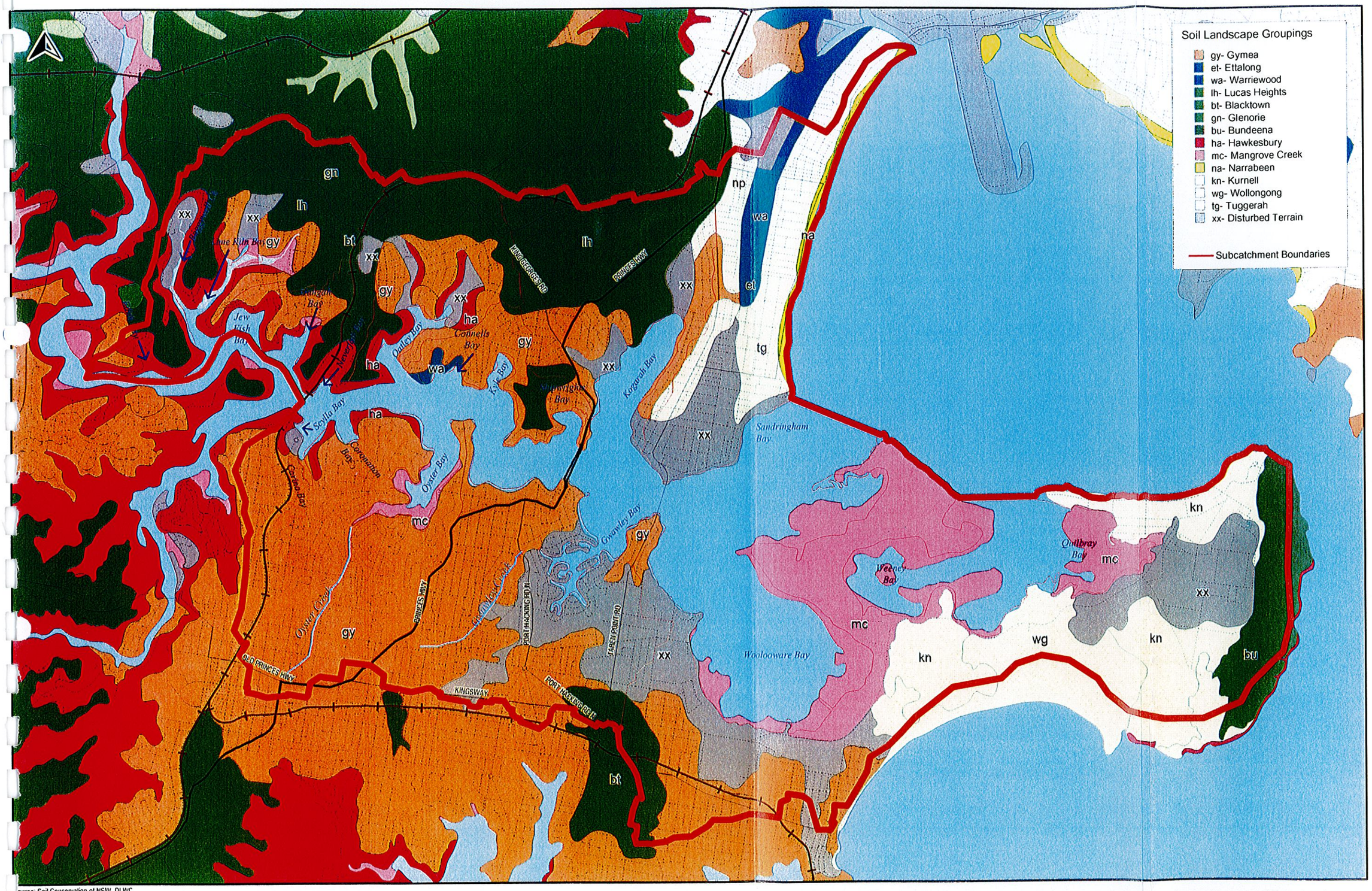

Source: Soil Conservation of NSW, DLWC

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Figure 2.3- Lower Georges River Catchment Soil Landscapes

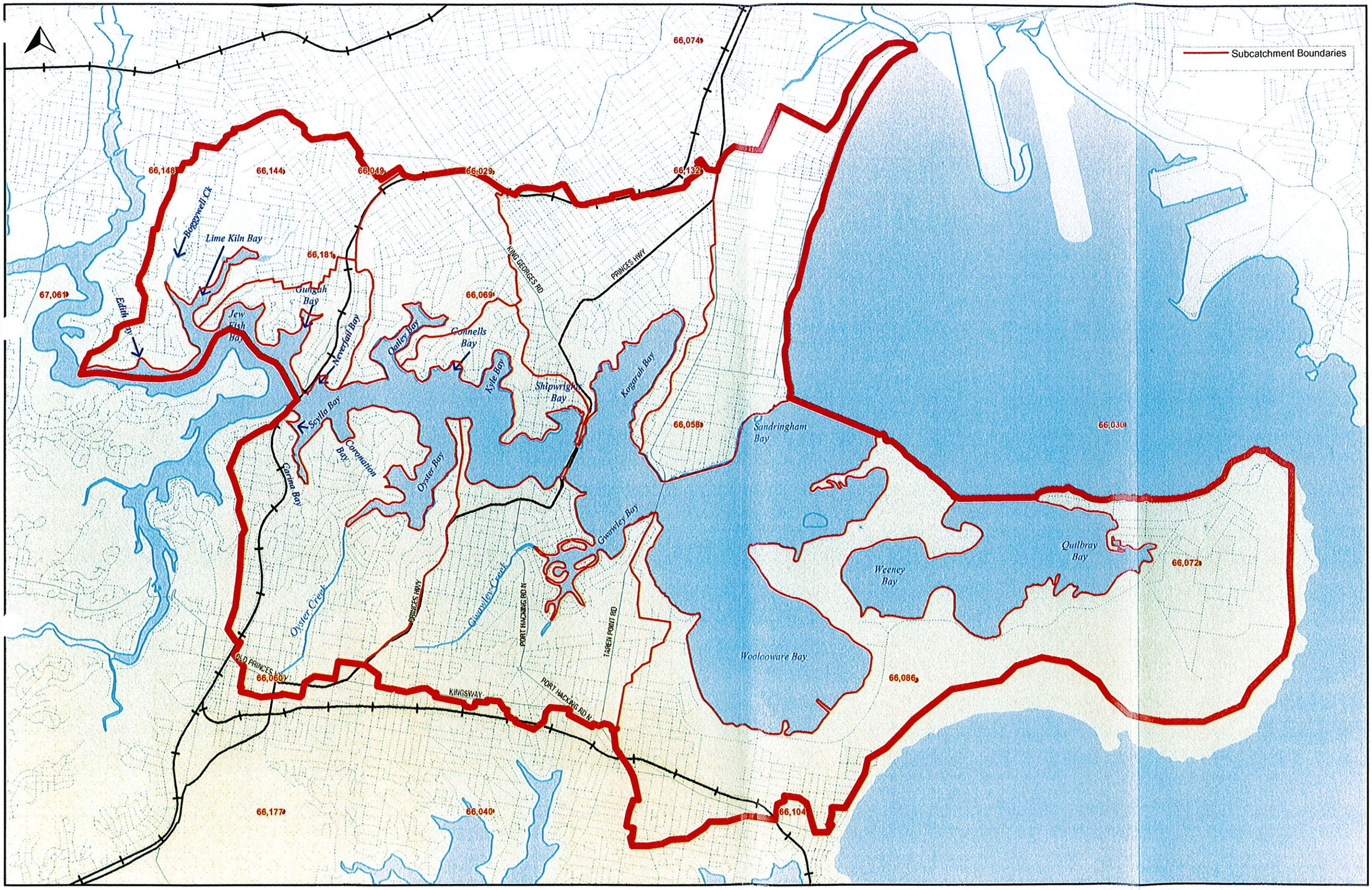

Figure 2.4- Lower Georges River Catchment
Meterological Stations

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Waterways Water Quality Monitoring Sites

Station	Description
30	Taren Point (ERA site)
G03/Ge03	Taren Point
G06/Ge06	Lugarno
GR02/HW1	Kymeeagh Baths
GR03/31	Brighton-le-Sands Baths
GR04	Monterey Baths
GR05	Ramsgate Baths
GR06	Sandringham-Dolls Point Baths
GR07	Silver Beach (ERA site)
GR09	Woolooware Bay
GR10	Sylvania Waters
GR11/HW10	Kogarah Bay/Carrs Pt Baths
GR12	Oyster Bay
GR13/HW7	Oatley Bay
GR16/HW5	Jewfish Bay
GR17	Lime Kiln Bay
GS1	Captain Cook Bridge
GS2	Oatley Point
HW02	Brighton-le-Sands Baths
HW03	Nth Ramsgate Baths
HW04	Sth Ramsgate Baths
HW06	Como Baths
HW08	Kyle Bay
HW09	Shipwrights Bay Beach
HW11	Sandringham Baths
HW12	Dolls Point Baths

Catchment Water Quality Monitoring Sites

Station	Description
KMC01	East Pipe, Moore Res
KMC02	West Pipe, Moore Res
KMC03	Centre of Moore Reserve
KMC04	Wetland of Moore Res
KMC05	Upper East Pipe, Moore Reserve
KMC06	Kogarah Bay Creek Channel

Station	Description
RCC01	Culver Street
RCC02	Marshall Street
RCC03	Presdent Avenue
RCC04	Bermill Street

Station	Description
SSC01	Production Road
SSC02	Endeavour Road
SSC03	Resoloution Drive
SSC04	Leagues Club Channel
SSC05	Elourera Road Channel
SSC06	Sir Joseph Banks Drive
SSC29	Oyster Bay West
SSC30	Tivoly Esplanade
SSC31	Carina Bay Reserve
SSC32	Scylla Bay
SSC33	Kareela Golf Course
SSC34	Gwawley Creek
SSC35	Silverwater Crescent
SSC36	Paraweena Rd

Legend

- ★ Stream gauging station (GS)
- ● Water quality monitoring site
- ▲ ERA - Environmental Risk Assessment site
- Subcatchment boundary

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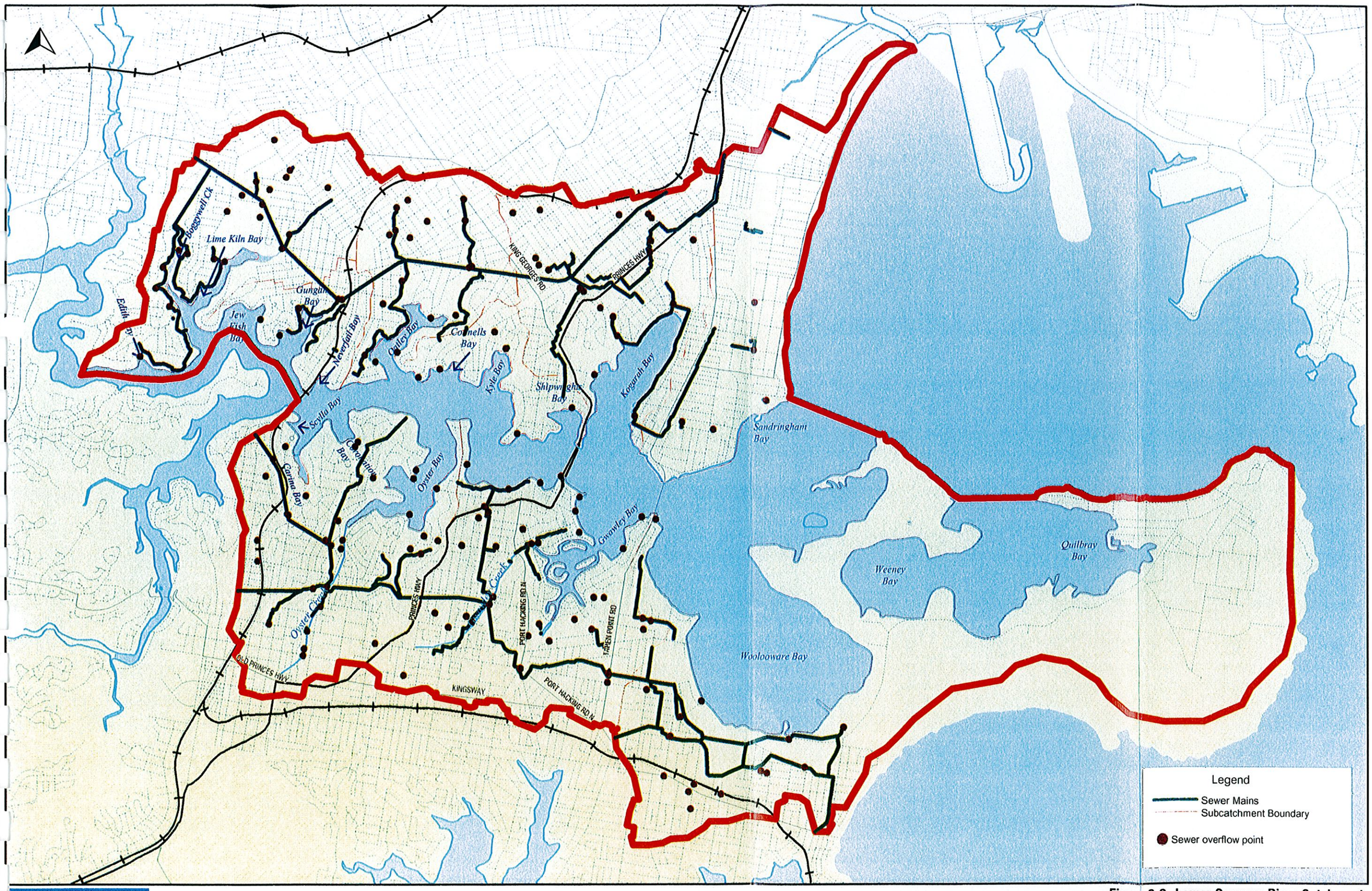

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Figure 3.2- Lower Georges River Catchment Sewer Mains & Sewer Overflow Locations

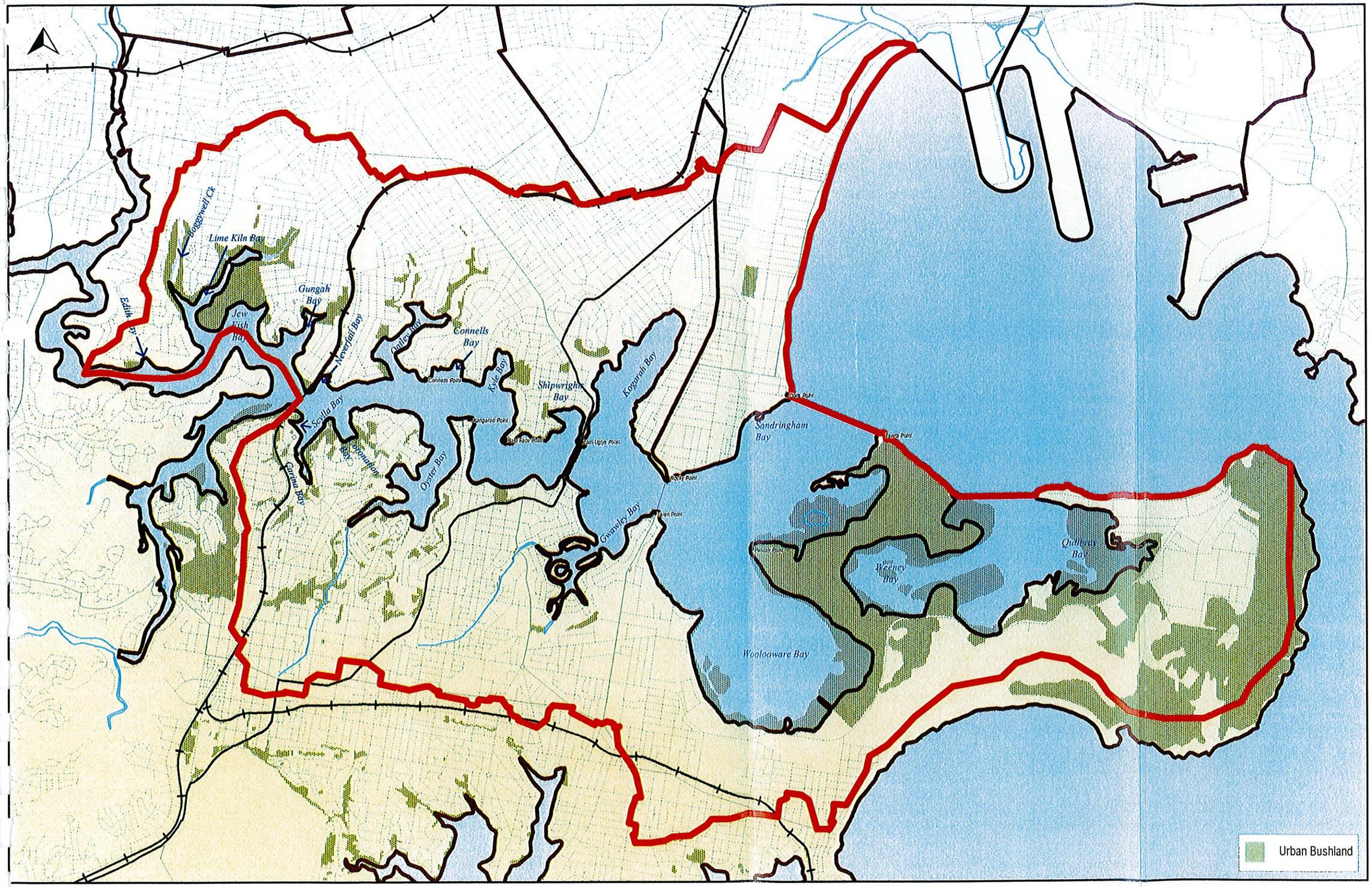

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Figure 3.3- Lower Georges River Catchment Urban Bushland Areas

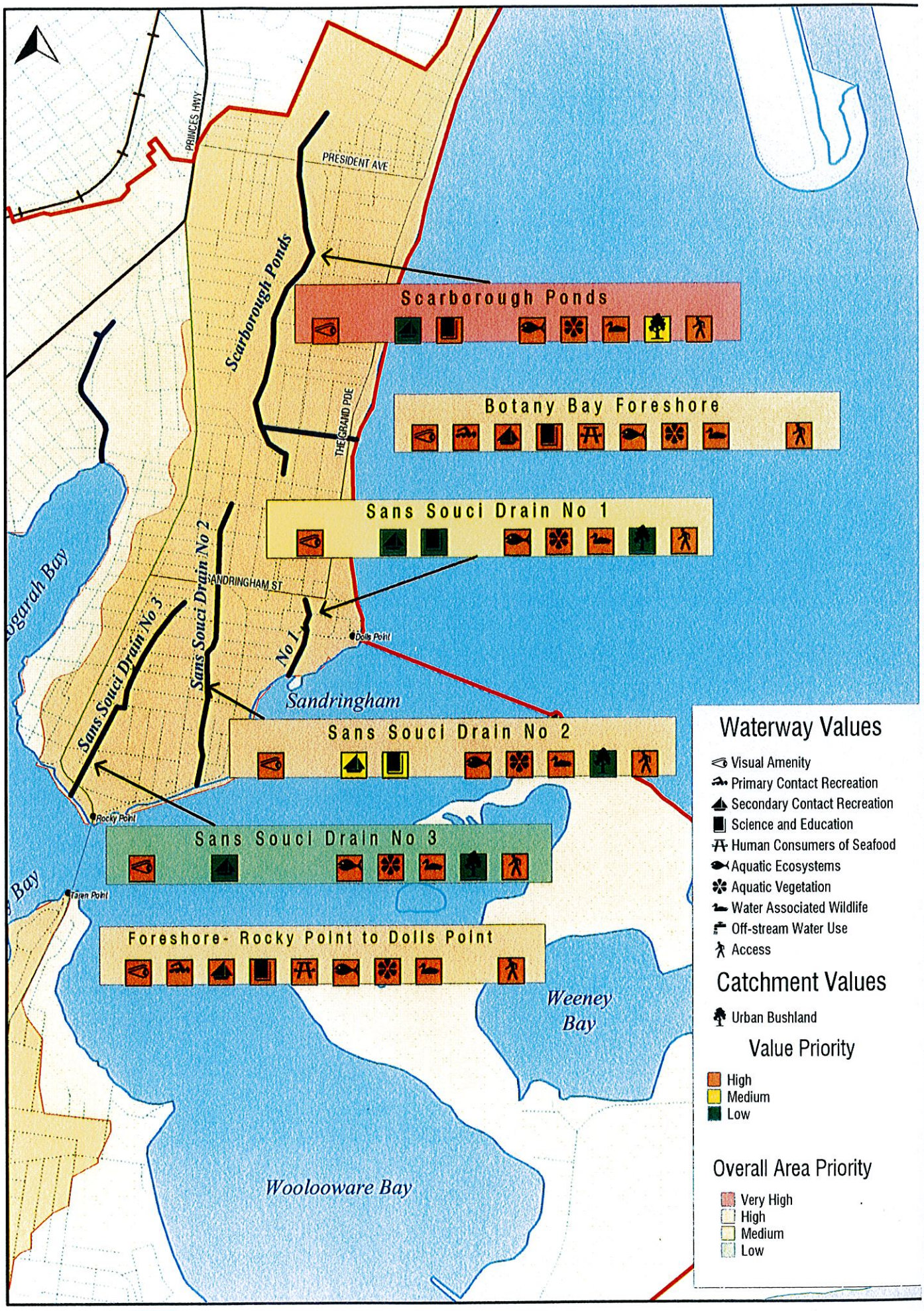

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Figure 4.1: Rockdale LGA Catchment & Waterway Values

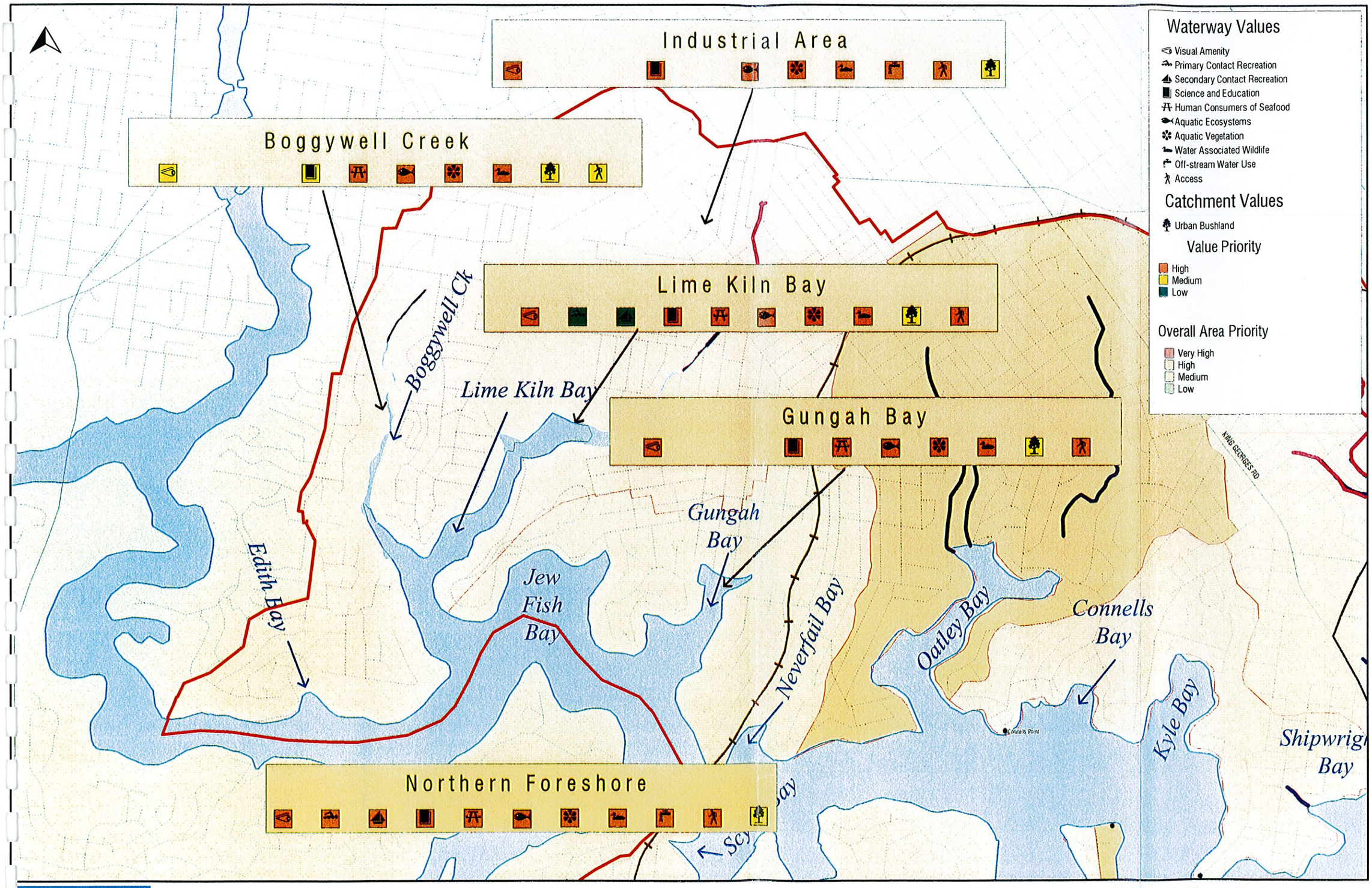

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Figure 4.2: Hurstville LGA Catchment & Waterway Values

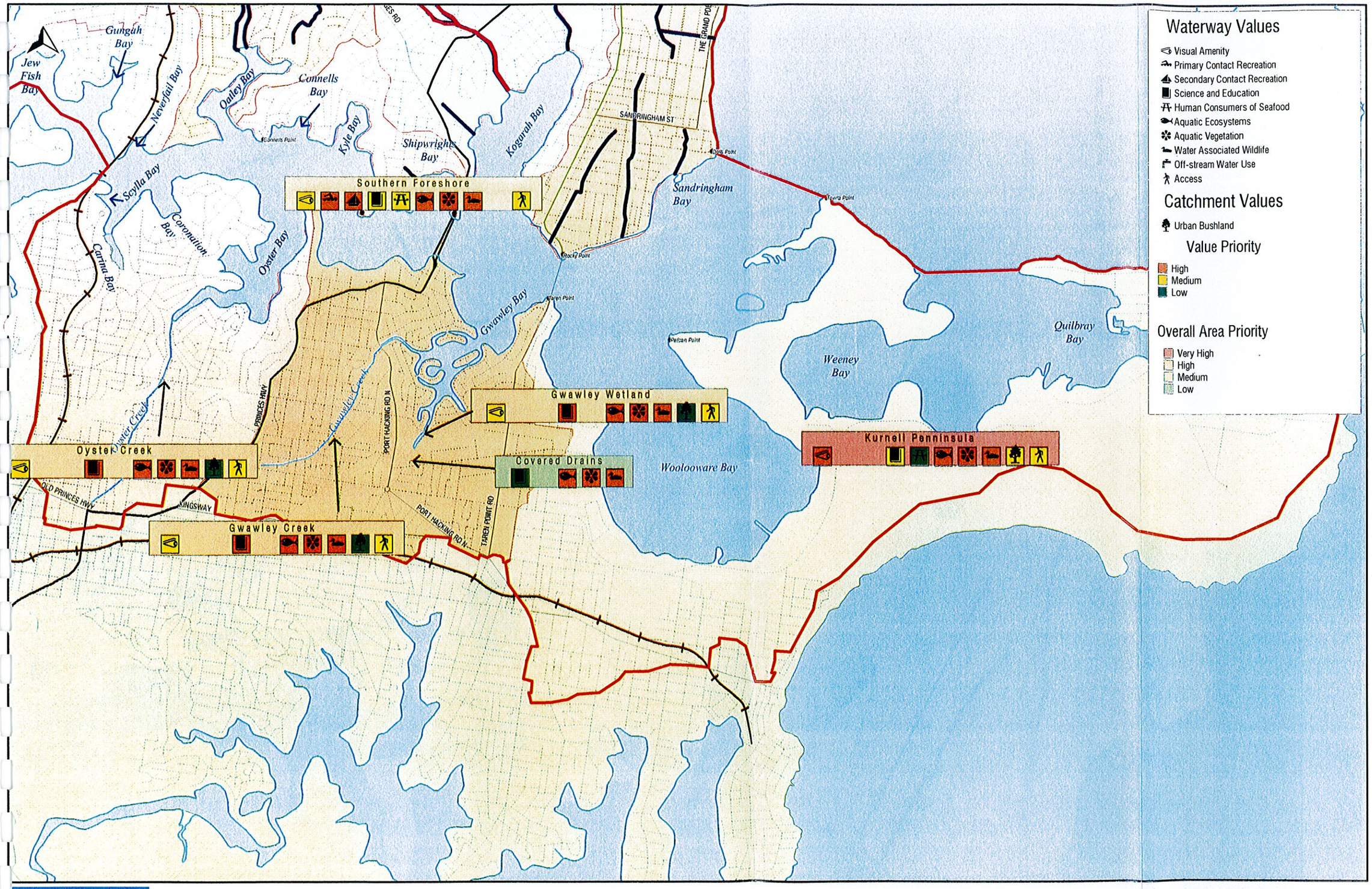

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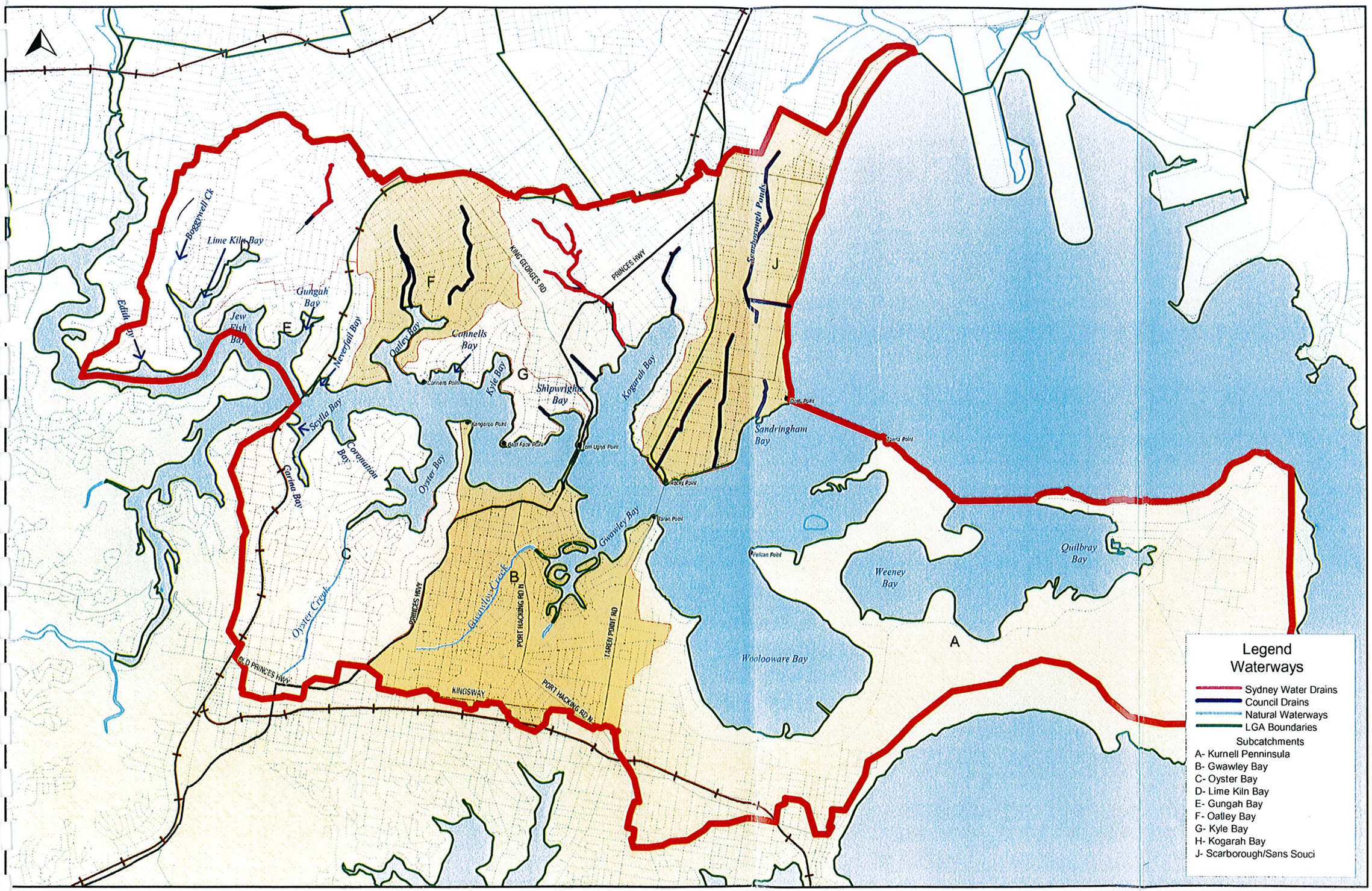
Figure 4.3: Sutherland LGA Catchment & Waterway Values



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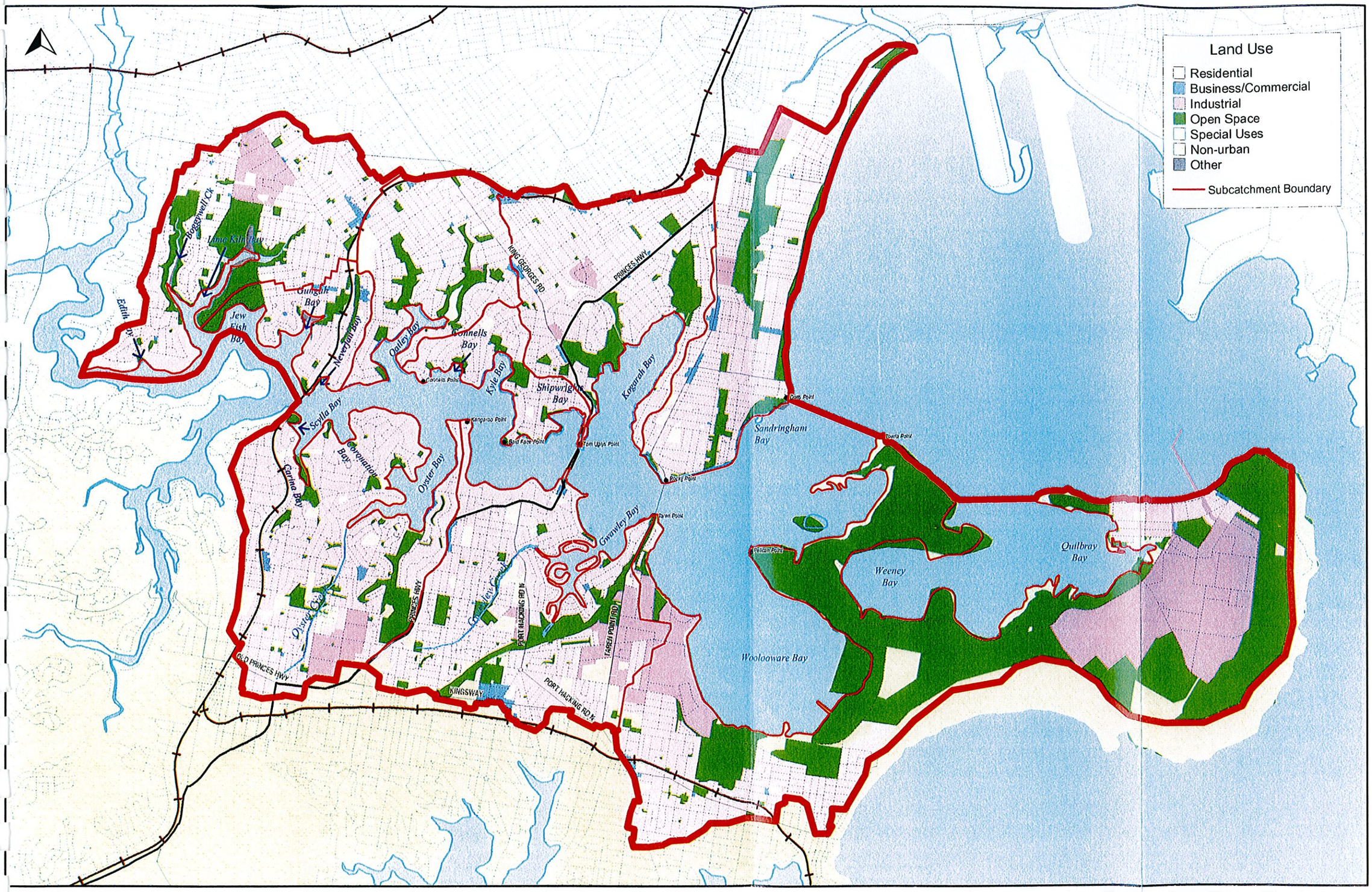

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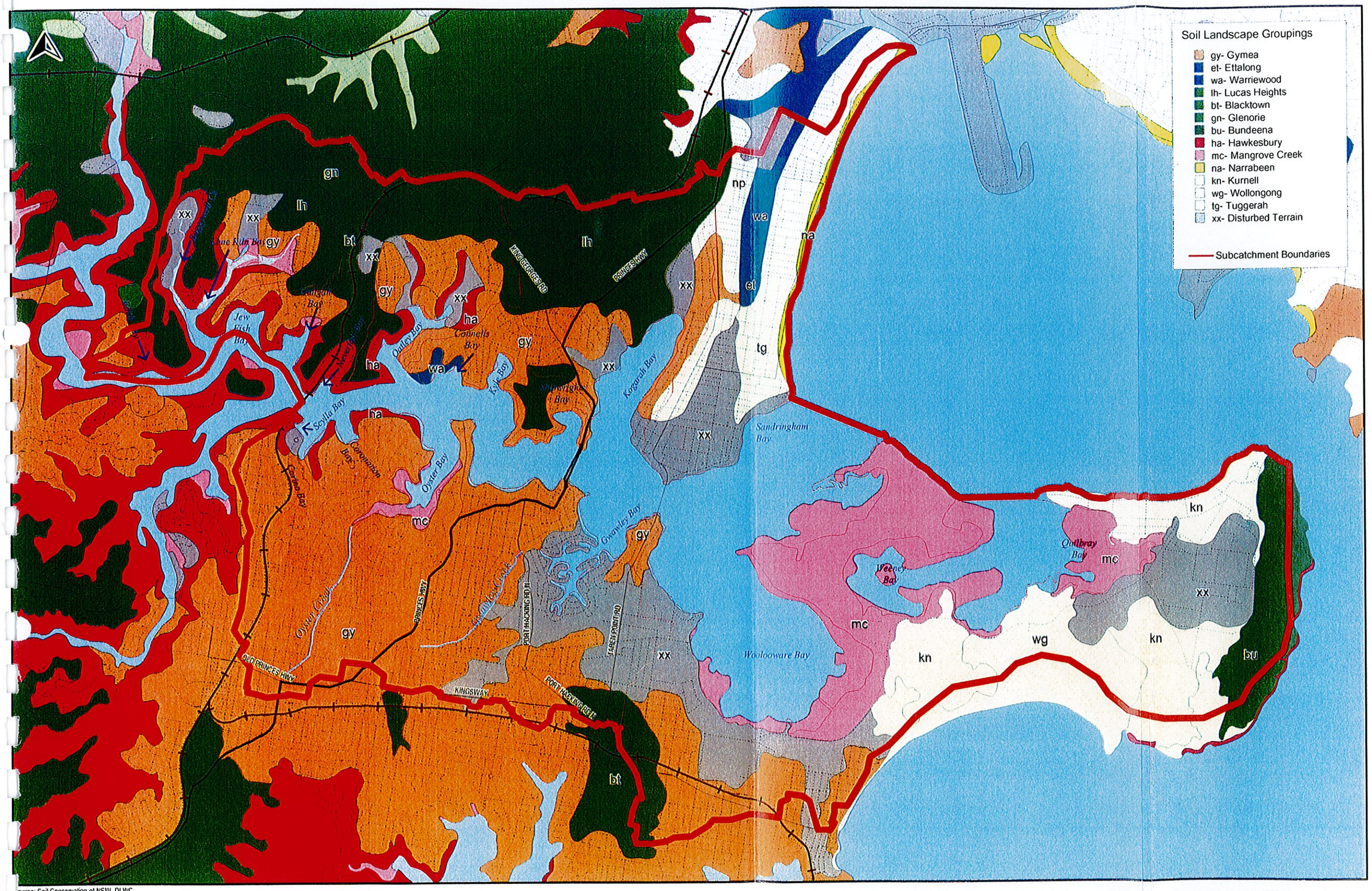

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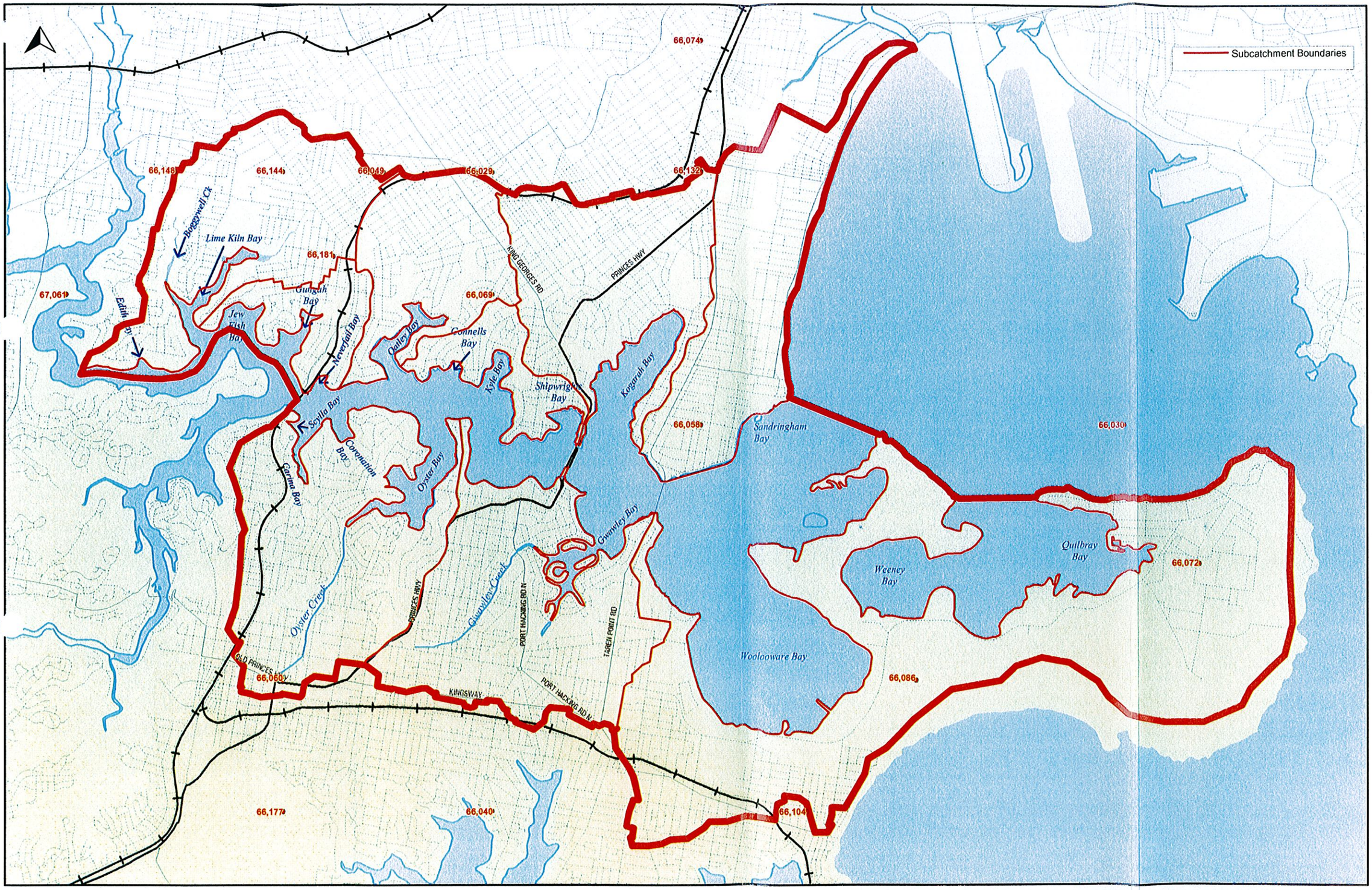

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Legend

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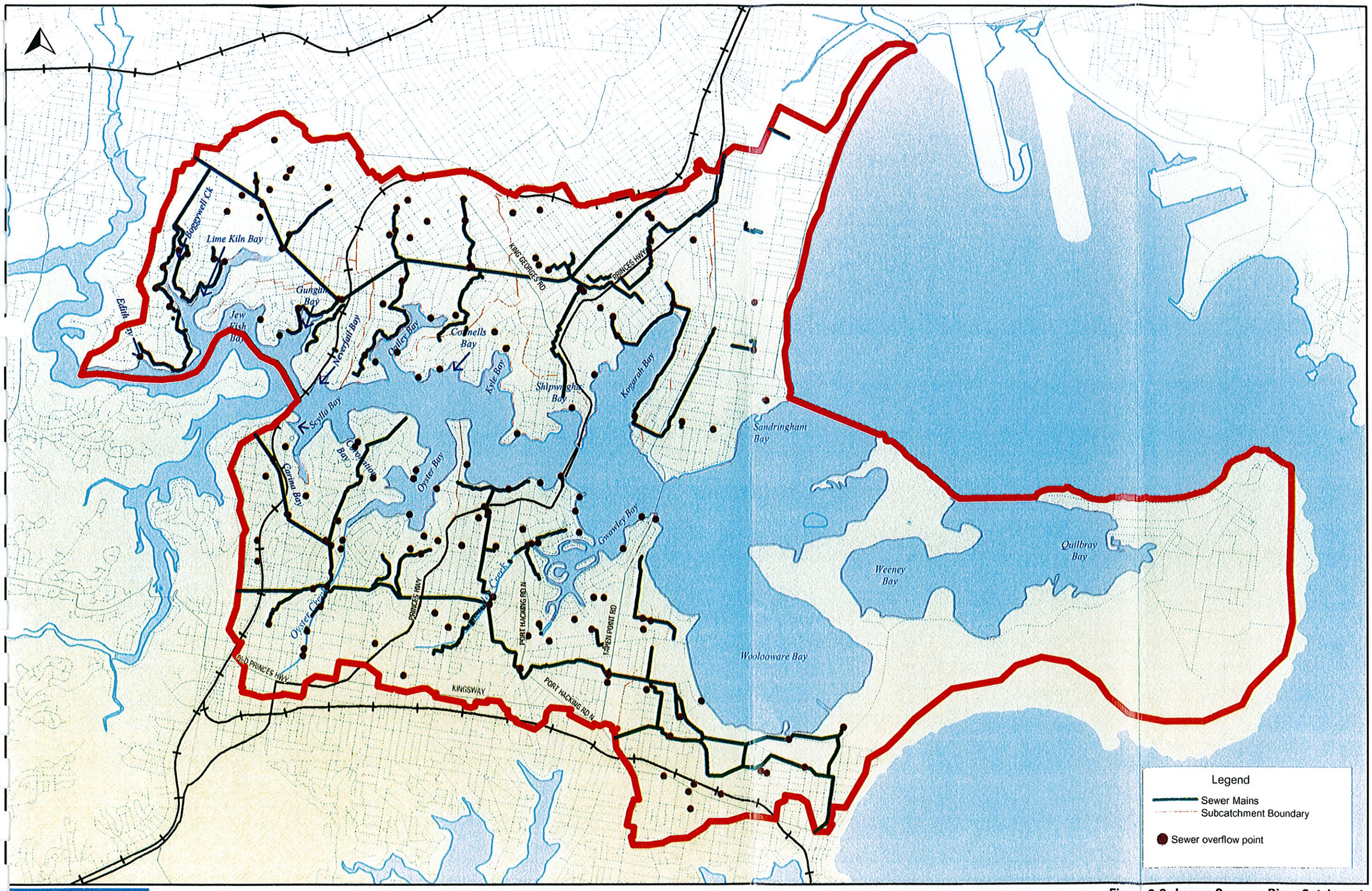

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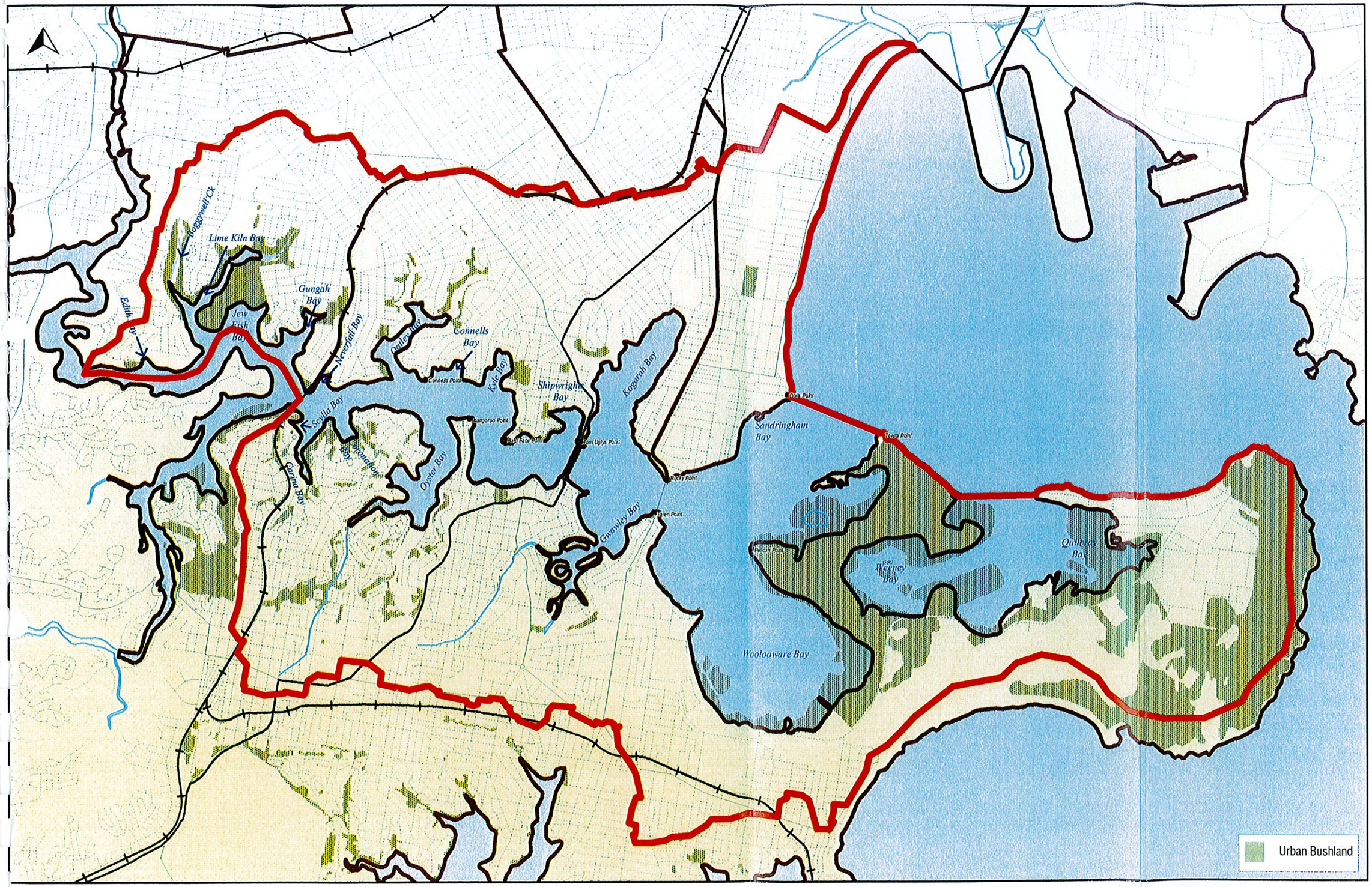

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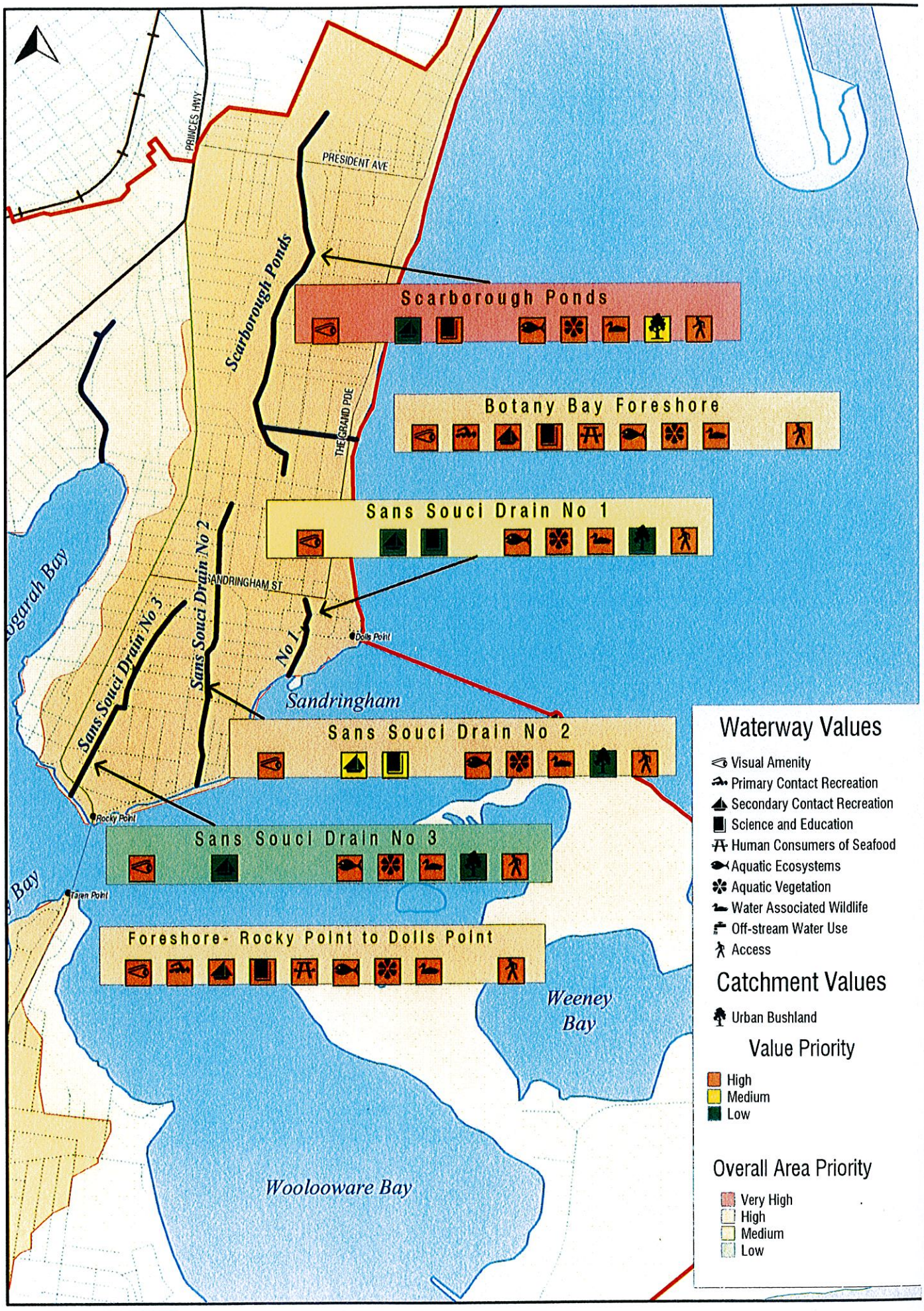

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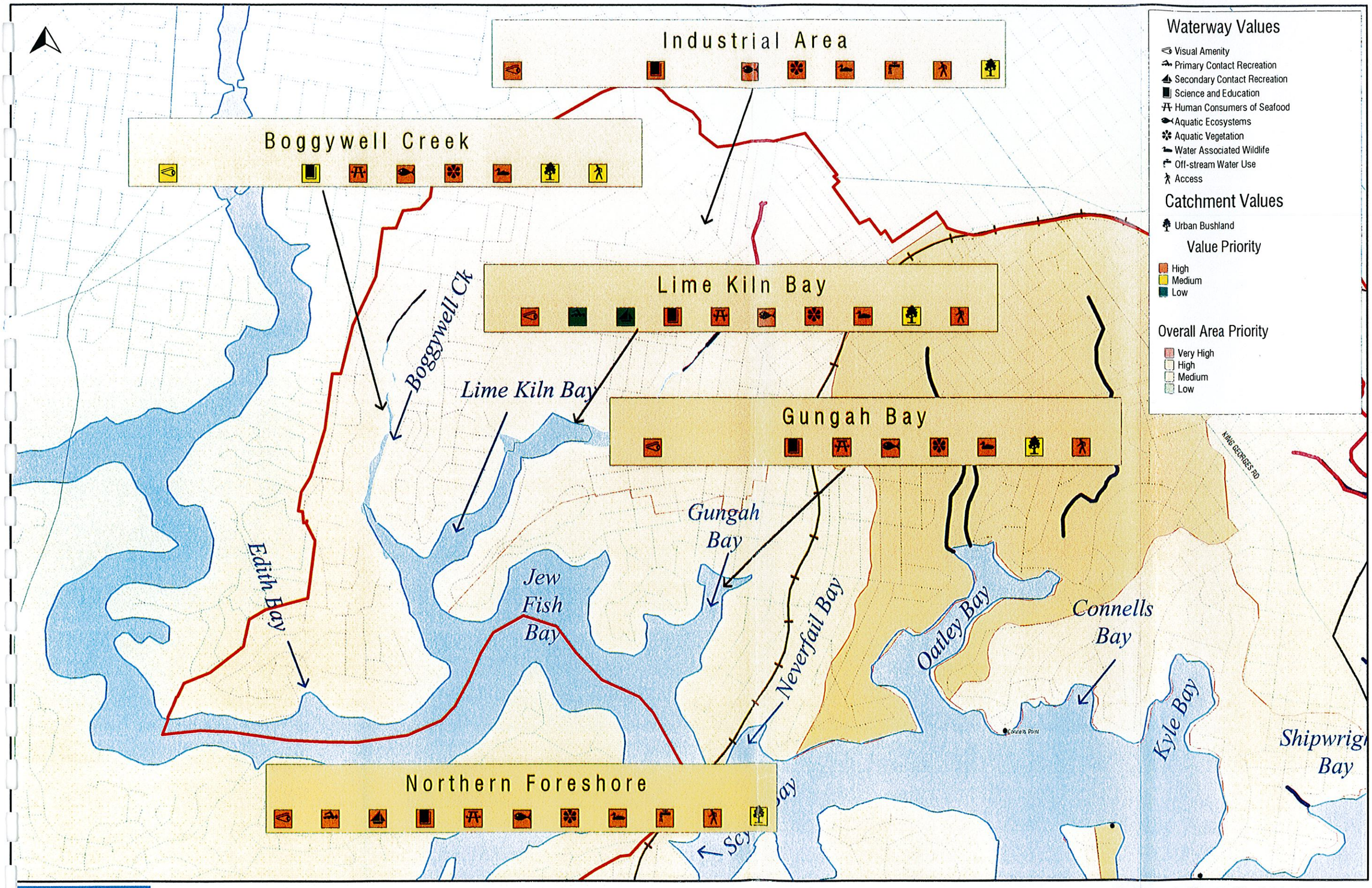
Figure 4.1: Rockdale LGA Catchment & Waterway Values



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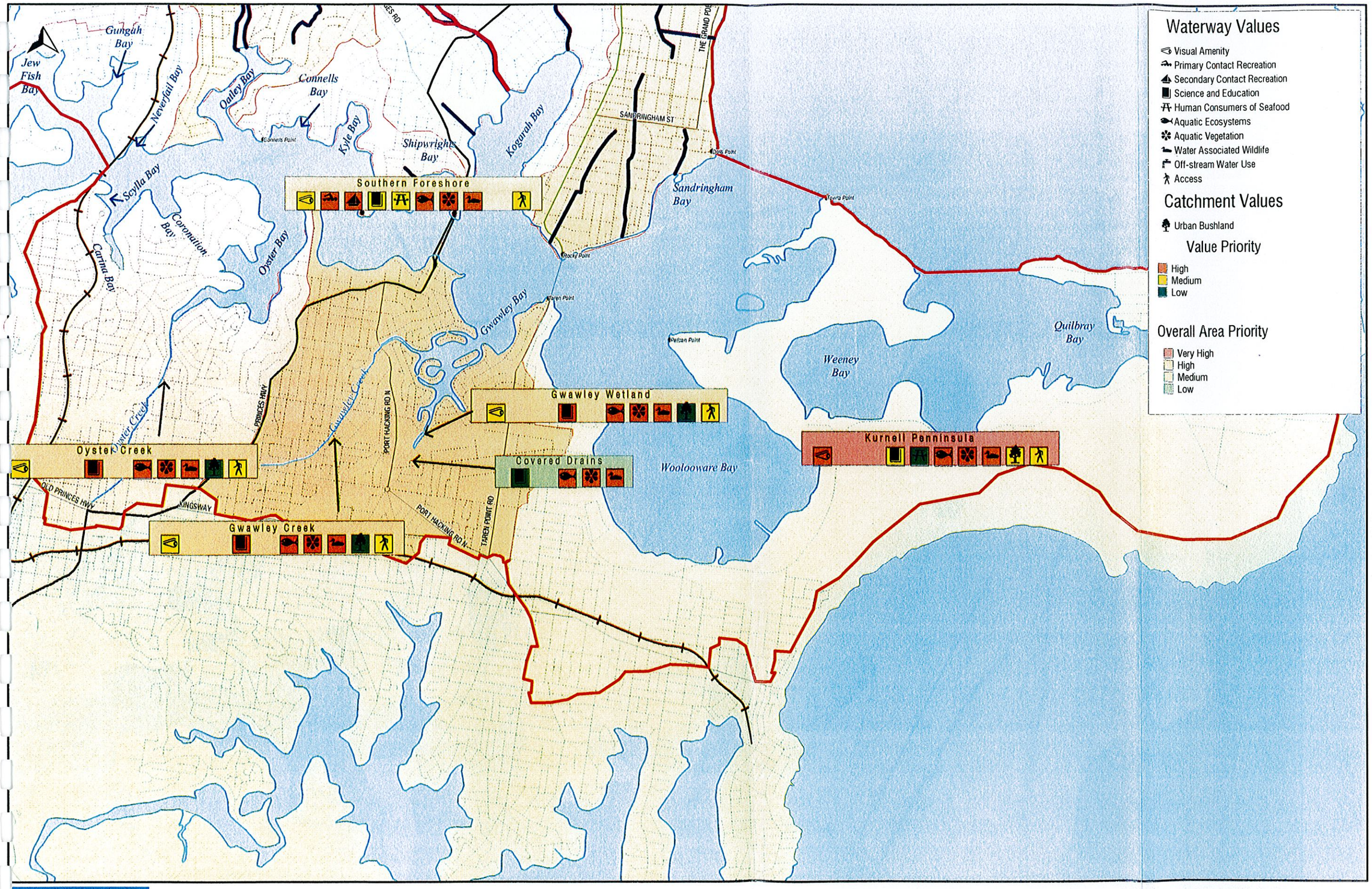

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Figure 4.3: Sutherland LGA Catchment & Waterway Values