3. Existing Catchment Conditions

3.1 Physical Environment

3.1.1 Hydrology

The hydrological response of a catchment is influenced by the degree and nature of development of the land surface, as well as by the soil and geological characteristics. The majority of the catchment is underlain by clay soils and sandstone contributing to low soil permeability. In contrast, the Alexandra Canal and Muddy Creek catchments are underlain by sandy soils, allowing greater soil permeability and reduced run-off from unsurfaced areas.

A very high proportion of the land surface of the Cooks River catchment is relatively impervious owing to its intensively urbanised nature. The pervious areas of the catchment are limited to the corridors of open space along the River and along Wolli Creek and Bardwell Creek, the formal parks, and residential gardens.

The concrete drainage lines, relatively low infiltration and soil storage capacity of the catchment results in a quick response to rainfall events. This is particularly significant in small frequent storm events and results in high flows and flooding in parts of the catchment. Generally the storm duration producing peak flows in the Cooks River is around two hours in a one in 100 storm (Webb 1996). Within the tributary branches in the lower catchment, the one hour storm produces peak flows in a one in 100 storm (Webb 1991).

Hydrology is greatly influenced by the urbanised nature of the catchment during the more frequent storm events. However, during major flood producing storms, there is likely to be little difference in hydrology between the urbanised Cooks River catchment and a saturated rural catchment (Public Works Department 1985).

3.1.2 Streamflow

There are no recorded streamflows along the main reach of the Cooks River and no gauging stations with rating curves for the area (Webb 1994). Limited streamflow data is available from short term sampling of the Cooks River tributaries, as shown in *Table 3.1*. The flow volumes were generally taken near the catchment outlets. *Table 3.1* is a synthesis of design peak flows and average observed flows for the Cooks River and its tributaries (determined by numerical modelling).

Table 3.1: Cooks River Streamflows

Catchment	Location	Average Daily Flow (m^3/s)	1 in 100 Year Design Peak Flow (m^3/s)
Upper Cooks River		0.10(1)	-
Cooks River	Brighton Ave, Campsie	-	400
Cup & Saucer Creek		0.07(1)	-
Wolli Creek		4.9(2)	290
Cooks River	Wolli Creek confluence	-	770
Bardwell Creek		-	80
Alexandra Canal/Sheas Creek		7.0(2)	160
Cooks River	Tempe	-	730
Bonnie Doon		-	30
Cooks River	Bonnie Doon confluence	-	820
Muddy Creek		-	150
Cooks River	Muddy Creek confluence	-	960
Cooks River	Breakwater	-	1010

Notes: (1)Sampling period from 1/1/94 to 30/6/94 (2) Sampling period from 1/1/94 to 31/12/94
References: Sydney Water Corporation (1994), Australian Water and Coastal Studies (1997), Webb (1991), Webb (1994) and Webb (1996).

Detailed investigation of flow characteristics has been undertaken for Alexandra Canal. There are a variety of water inflows to the Canal, including:

- tidal inflow estimated at 590 Ml per day;
- average run-off volume from the catchment of 28 Ml per day;
- groundwater flows to the Canal predicted to range from 9 Ml per day during dry weather to 12 ML per day during wet weather; and
- other discharges include licensed and potentially illegal discharges from individual premises (Hyder 1997).

Stormwater inflows are considered to represent around two percent (6 Ml) of the total inflows to the canal during a tidal cycle in dry weather (Hyder 1997).

3.1.3 Tidal Regime

The tidal range within Botany Bay at the mouth of the Cooks River is between 0.60 metres AHD and -0.60 metres AHD (Hyder 1997). The River is quite shallow for most of its length, and has water depths generally in the range of one to three metres (Total Environment Centre 1995).

The tidally affected portion of the Cooks River extends from the River's mouth to approximately 11 kilometres upstream near Enfield. The tidal influence on the tributaries extends up to Huntley Street on Alexandra Canal, Bestic Street on Muddy

Creek, and to Nanny Goat Hill on Wolli Creek (NSW Environment Protection Authority 1997). These tidal limits are illustrated in *Figure 5*.

Results from tidal gauging of the Cooks River on 24 January 1990 are presented in *Table 3.2*. The data show tide levels at four locations along the river:

- Kyeemagh - Endeavour Bridge 150 metres from Botany Bay;
- Tempe - Midway between the Cooks River Bridge and the Giovanni Brunetti Bridge approximately 2.3 kilometres upstream from Botany Bay;
- Undercliffe - 250 metres upstream from the Illawarra Road Bridge, approximately five kilometres upstream from Botany Bay; and
- Canterbury - Canterbury Road Bridge.

Table 3.2: Summary of Tide Level Data – 24/1/90

Location	Low Water Level (mAHD)	High Water Level (mAHD)
Kyeemagh	-0.56	0.22
Tempe	-0.53	0.23
Undercliffe	-0.52	0.23
Canterbury	-0.51	0.16

Reference: Public Works/MHL, 1991

Some general tidal data at Illawarra Road, Undercliffe are presented in *Table 3.3*. This information was not available for the other monitoring locations.

Table 3.3: Cooks River Tidal Flowrates at Illawarra Road, Undercliffe

Tidal Condition	Level at Illawarra Road (mAHD)
MHHWSS (Mean Higher High Water Spring Solstice- level above which the tide seldom rises)	1.12
Mean High Water (average of all high tides)	0.11
Indian Spring Low Water (approx. the lowest tide that will occur)	-0.78

Reference: (Soil Conservation Service 1991)

The flushing times for the mouth and lower reaches of the Cooks River and the lower reaches of Alexandra Canal are between one and five days. Botany Bay has a short flushing time of approximately one day (Hyder 1997).

There is little data available on the tidal regime of the tributaries, except for Alexandra Canal. The tidal pattern of the Canal, measured 1.8 kilometres upstream of the confluence with the Cooks River, range from 0.60 metres AHD to -0.67 metres AHD. The Canal is considered saline for its entire length and has a flushing time estimated between five and 10 days (Hyder 1997). The tidal flow rates in Alexandra Canal are shown in *Table 3.4*.

Table 3.4: Tidal Flowrates in Alexandra Canal

Tidal Condition	Average Flow for Tidal Cycle (m^3/s)	Peak Flow During Tidal Cycle (m^3/s)
Spring Tides	13.7	20.6
Neap Tides	9.9	15.0
Highest Astronomical Tide	20.7	31.0

Reference: (Hyder 1997)

3.1.4 Mainstream Flooding

Mainstream flooding occurs along sections of the Cooks River as a result of past residential and industrial development of the natural floodplain and modifications to the River channel. Flooding along the Cooks River and its tributaries can be influenced by several factors including:

- tides (particularly tidal and storm surges);
- catchment inflows (for example, stormwater, direct run-off, licensed discharges);
- flow obstructions (for example, developed floodplains, hydraulic structures, overgrown vegetation); and
- channel bathymetry.

A summary of the main areas affected by mainstream flooding and potential causes are shown in *Table 3.5*. Future developments of the natural floodplain (such as that proposed for the M5 motorway) may increase the frequency of flooding events and should be prevented where possible.

Table 3.5: Areas Affected by Mainstream Flooding

Location	Area affected	Potential Causes
Upper Cooks River	Strathfield	Overgrown vegetation along stream sections and culvert restrictions
Cooks River (Cox's Creek to Cup & Saucer Creek)	Canterbury, Campsie,	Inadequate channel size, inadequate detention and sedimentation.
Cup & Saucer Creek	Campsie, Earlwood	Industrial development ; Sewer; Culvert restrictions
Cooks River (Cup & Saucer Creek to Wolli Creek)	Earlwood, Marrickville, Dulwich Hill	Inadequate channel size and inadequate detention
Wolli Creek	Turrella, Bexley North	Overgrown stream section; Residential development; Road crossings and culvert restrictions
Bardwell Creek	Bexley, Bexley North	Bardwell Valley Golf Course; Weir; Residential development; Road crossings; Railway underbridge
Lower Cooks River (Wolli Creek to Outlet)	Tempe, North Arncliffe, Arncliffe	Sewer line; Limited overbank area
Muddy Creek	Banksia	Railway; Culvert restrictions; Road and pedestrian bridges; Development; Sewer line.

Location	Area affected	Potential Causes
Sheas Creek	Alexandria	Inadequate capacity of culverts and channels and development of the natural floodplain area.

Upper Cooks River

Significant flooding occurs along the Cooks River in Strathfield at Pemberton Street/ Ada Avenue, Hedges Avenue/Augusta Street, and Fitzgerald Avenue (Clouston 1997a). Potential causes of this flooding include the heavily overgrown vegetation along natural stream sections and culvert constrictions within the railway properties.

Flood mitigation measures proposed in the *Upper Cooks River Sydney Water Corporation No.38 Catchment Management Study, 1991* suggested increasing the culvert capacities, providing detention storage, and the restoration and enlargement of unlined channels (Water Board 1991).

Cooks River (Cox's Creek to Cup & Saucer Creek)

In a 1 in 100 year flood, three residential buildings and a number of industrial buildings would be inundated by floodwaters (Webb 1994). The main areas affected include Gordon Street, Campsie, Phillips Avenue and Charles Street, Canterbury. The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of flood awareness programs, flood hazard notification, and redevelopment or the construction of a minor levee in Gordon Street.

Cooks River (Cup & Saucer Creek to Wolli Creek)

In a 1 in 100 year flood, 70 residential buildings and a number of commercial buildings would be inundated by floodwaters (Webb 1994). The main areas where damage is expected to occur include Bankside Avenue to Pine Avenue, Earlwood, Illawarra Road/Wharf Street, Marrickville, Riverside Crescent, Dulwich Hill, and Lang Road, Earlwood. Other affected areas occur in Hurlstone Park, Marrickville, and Earlwood.

The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of flood awareness programs, flood hazard notification, rezoning, and the revision of development controls (Webb 1994).

Cup and Saucer Creek

Areas where property flooding is known to have occurred include Potter Avenue, Earlwood (where five properties were affected), Bexley Road, and Scahill Street, Campsie (Water Board 1992). The cause of flooding was partly attributed to several obstructions near the watercourse including a sewer aqueduct, the culvert at Bexley Road, industrial development up to the channel walls between Alfred Street and Kingsgrove Road, and many access bridges (Water Board 1992).

Wolli Creek

The main areas where flooding is a known problem occur at Henderson Street, and Bexley Road, Bexley North. Occasional flooding occurs along the drainage channel, particularly in the Kingsgrove industrial area from the Crescent to Kingsgrove Road

(Soil Conservation Service 1991). An estimated number of 11 properties are expected to be inundated above the floor level, and 22 properties affected by yard inundation during a 1 in 100 year flood. Almost all of the flood liable development lies in the Rockdale Local Government Area.

Potential for flooding also exists at the mangrove tidal flats of Wolli Creek, near the South Western Suburbs Ocean Outfall Sewer in Turrella. Flooding in the area would inundate part of the industrial land at Unwin Street (Soil Conservation Service 1991).

A number of factors cause hydraulic restrictions in the watercourse including the heavy overgrowth of vegetation along the channel, developments along the floodplain, and various road crossings (Webb 1996).

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Bardwell Creek

The main areas where flooding is known to be a problem occur at Hillcrest Avenue, Bexley, Veron Road, Bexley, and Canonbury Grove, Bexley North. The areas downstream of Pile Street and between Croydon Road and Stoney Creek Road, Bexley could also be affected by flooding. An estimated number of seven properties are expected to be inundated above the floor level, and 29 properties affected by yard inundation during a 1 in 100 year flood.

There are several features causing flow constrictions along the watercourse, these include a low level weir located some 300 metres upstream of the Wolli Creek confluence, various road crossings, and a railway underbridge. The overbank areas largely comprise cleared parkland however some area is filled to form part of Bardwell Valley Golf Course, and a few residential developments occur close to the creek.

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Lower Cooks River

In a 1 in 100 year flood three residential buildings and one commercial building at Bay Street, Tempe would be inundated by floodwaters leaving the Cooks River (Webb 1994). The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of a flood awareness program and in promoting the redevelopment of the area (Webb 1994).

Some areas near the Bonnie Doon Channel in Arncliffe can potentially flood from floodwaters leaving Wolli Creek and from the Channel itself. The main areas affected include Gertrude Street/Levey Street, Innesdale Road, and North Arncliffe between the East Hills and Illawarra railway lines. An estimated number of 101 properties are expected to be inundated above the floor level, and 172 properties affected by yard inundation during a 1 in 100 year flood (Webb 1996). Potential flow restrictions

along the Bonnie Doon channel include the sewer line, which crosses the channel downstream of Wollongong Street, and limited overbank areas.

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Muddy Creek

There are a number of potential flow obstructions along Muddy Creek. These include: road and pedestrian bridges (for example, Bridges at the Princes Highway, Bay Street and Bestic Street); railway culverts near Frys Reserve; the sewer line upstream of the Princes Highway; and properties located on the floodplain (Australian Water and Coastal Studies 1997).

During significant floods it is possible that some water overflows out of Muddy Creek to Scarborough Ponds, which is outside the Cooks River catchment (Australian Water and Coastal Studies 1997).

Sheas Creek

A main problem area for flooding occurs in the vicinity of the open watercourse between Wyndham Street and Bowden Street, Alexandria. There is no significant floodplain in the area.

3.1.5 Local Flooding

A problem faced by some areas of the catchment is the poor condition and low capacity of the existing stormwater infrastructure, much of which is over 50 years old. The infrastructure was built to cater for a lower level of development and to standards which were valid or within budgetary constraints at the time (Marrickville Council 1997). As a result, many drains now overflow on a regular basis, statistically once every two years (although it may not necessarily flood every two years) (Marrickville Council 1997).

At best, the older systems were designed for the 1 in 10 year flood event. This means that storms in excess of the system capacity will travel overland along the path of least resistance. This leads to localised flooding of roads and properties (Canterbury City Council 1997).

Local flooding usually occurs once the capacity is exceeded in limited overland flow paths and where limited downstream inlet capacity exists, resulting in rising water levels (Marrickville Council 1997).

Upper Cooks River Catchment

Areas of local flooding occur in Lakemba at Punchbowl Road/Juno Parade intersection, Wangee Road, and Hampden Road, and Punchbowl at Punchbowl Road near Cornelia Street. Flooding in these areas are generally caused by inadequate road culverts and drainage around the Punchbowl Road stormwater channel (Soil Conservation Service 1991).

Localised flooding also occurs along the Greenacre Park channel, extending upstream from the railway culvert in Chullora Workshops, Como Road, Shellcote Road and Tennyson Road, Chullora. This flooding is attributed to deficient culverts in the railway land, and inadequate street culverts and drainage network. Over 30 houses have known to flood in the area (Soil Conservation Service 1991).

Bonnie Doon Catchment

Local flooding has occurred in the upper Bonnie Doon catchment causing the inundation of four properties and ponding in roads.

Significant overland flows through the catchment have been predicted in the areas east of Dowling Street, and west of the railway line. The main areas in the upper catchment where flooding is a known problem occur at Kembla Street, Kelsey Street, and Wollongong Road (Lawson and Treloar 1997).

Muddy Creek Catchment

Within the Muddy Creek sub-catchment, flooding occurs in Hayburn Avenue and The Strand, Rockdale as a result of developed a floodway and low floor levels of properties near the trunk drainage. Frys Reserve in Rockdale also receives flooding, some areas upstream of the reserve receive minor flooding. During less frequent storm events, the road approaches and railway underpass are inundated (Soil Conservation Service 1991).

The Spring Street drain has insufficient capacity to convey storm flows from design events of frequency greater than the 1 in 5 year flood (Lawson and Treloar 1997). Local flooding occurs at seven main locations with the Spring Street sub-catchment, typically within local depressions and street intersections. The main flow restriction in the catchment is caused by the culverts at the railway underpass (Lawson and Treloar 1997).

Sheas Creek Catchment

The West Kensington area has been affected by local flooding in the past. There are some 27 houses where above floor level flooding has occurred, and a further 56 properties affected by general property flooding (Public Works Department 1985b).

Along the Sheas Creek trunk drain flooding is generally caused by inadequate capacity of the channels and culverts to cater for run-off from existing development, and from development occurring in the floodways and depressions (Soil Conservation Service 1991). Various locations such as Mount Street; Boronia Street, Redfern; Joynton Street, Zetland; and Bourke Street, Redfern have reported property inundation as a result of overland flows and pit surcharging.

3.1.6 Water Quality

Water quality is a widely used indicator for providing information on the health of an aquatic ecosystem and the local catchment. The water quality within the Cooks River is affected by all activities and management practices within the catchment. Many pollutants from catchment activities are transported by stormwater into the river system.

Monitoring of water quality within the Cooks River catchment has been undertaken over twenty years. However, this has been undertaken by many different authorities for different purposes, and the location and level of monitoring, and the range of pollutants measured have not been consistent. Consequently, it is not possible to provide comment, based on scientific sampling and analysis, on long term trends for this diverse range of catchments. There is sufficient information available to indicate that the catchment has experienced high levels of pollutants for long periods of time. While past pollution loads to the Cooks River have been significant, there is some evidence that water quality is improving, at least for some key toxicants.

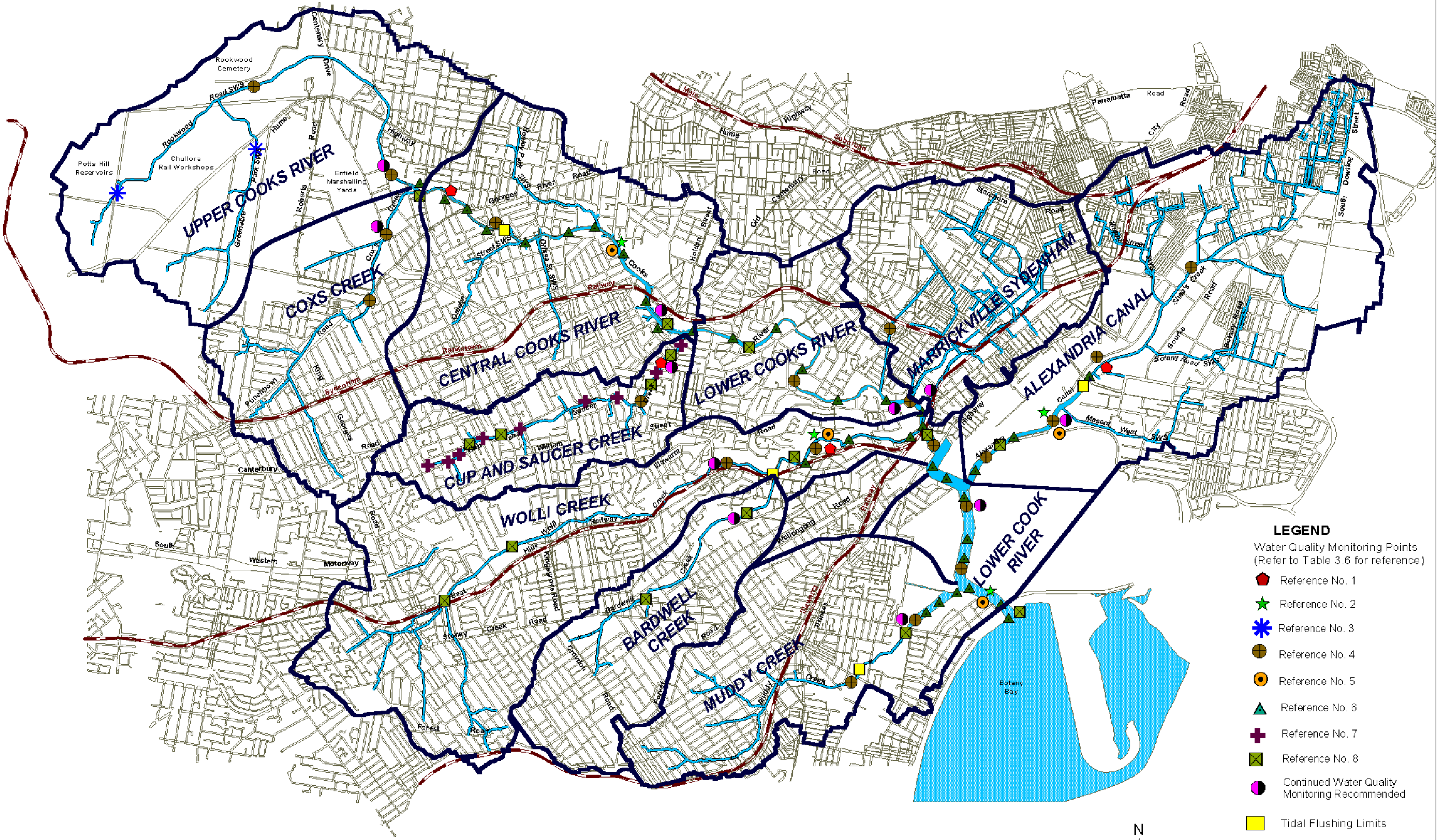
Table 3.6: Key Water Quality References

Report	Monitoring Period	No. Of Sample Sites in Cooks River Catchment	Parameters Measured	Reference
Stormwater Monitoring Project, 1994 Annual Report, Sydney Water	1994	4	Physico-chemical & bacteriological	1
Sydney Water Annual Environment Report 1997, Sydney Water	1996/97	4	Physico-chemical & bacteriological	2
State of the Catchments, 1997/98,Bankstown City Council	1997/98	2	Physico-chemical & bacteriological	3
Ecosystem Health, Report to the Committee, 1996, Cooks River Catchment Management Committee	1996	16 - 19	Physico-chemical	4
Licensing Sewerage Overflows - Environmental Impact Statement, Georges river and Southern Suburbs Geographic Area, Sydney Water	1993 onwards	4	Physico-chemical & bacteriological	5
Water Board. 1992b. *Dry and Wet Weather Intensive Water Quality Samples, Cooks River (15 January and 10 February 1992), Interpretive Report*.	1992	35	Physico-chemical & bacteriological	6
Water Board. 1992a. *Cup & Saucer Creek Stormwater Catchment Management Study*, Volume 1	1990/91	9	Physico-chemical & bacteriological	7
Scientific Services. 1991. *Water Quality in the Cooks River, February 1990 to June 1990*	1990	4	Physico-chemical & bacteriological	8

The Cooks River continues to suffer from poor water quality most of the time, although the public perception is that the water quality in parts of the river is

Figure 5

Cook River Catchment Water Quality



improving (Total Environment Centre 1995). The existing water quality in the catchment has been assessed based on review of water quality sampling at sites shown on *Figure 5*. Sydney Water have undertaken the most extensive water quality sampling within the Cooks River System with additional sampling undertaken by Councils, the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996), and the Total Environment Centre (Total Environment Centre 1995).

A summary of all the water quality for each of the key contaminants is provided in *Table 3.6*. These key water quality indicators, their sources and potential pollution problems are summarised as follows:

- Nutrients - Phosphorus and Nitrogen

  These nutrients are found in high levels in the Cooks River. Sources of the phosphorus and nitrogen found in stormwater include pets and birds, fertilisers, detergents, and sewage discharges throughout the catchment. Golf courses and suburban gardens can be major sources of these nutrients. High levels of nutrients cause excessive growth of aquatic vegetation and can result in the development of algal blooms. This is of particular concern as species such as blue green algae in high concentrations are potentially toxic. The guideline levels for protection of freshwater and marine ecosystems are listed in *Table 3.12*.

- Chlorophyll-a

  The level of algal growth in the waterways is estimated by measuring chlorophyll - a. The recommended maximum level for the protection of aquatic ecosystems is 10 micrograms per litre (ANZECC, 1992). High levels of chlorophyll-a at or approaching bloom status, are indicated by chlorophyll-a levels greater than 20 micrograms per litre. Levels of chlorophyll-a are greater than 20 micrograms per litre in most sections of the Cook River and some evidence of algal blooms has been recorded.

- Faecal Coliforms

  High levels of faecal coliforms have been found in the Cooks River and are considered a key indicator of sewage overflow and seepage into the waterways. Bacteria occur naturally in soils and are commonly found in waterways. The bacteria of concern are those associated with faecal matter and other pathogens that represent a health risk and can make bathing waters and shellfish consumption unsafe. A Recreation guideline levels of faecal coliforms safe for swimming and boating within the waterways are less than 150 and 1000 colony forming units per 100 millilitres respectively based on data from five samples per month (ANZECC, 1992). Average levels of faecal coliforms exceed 1000 colony forming units per 100 millilitres in all sub-catchments of the Cooks River *Table 3.12*. The major sources of bacteria are sewage overflows, defective sewerage systems, illegal connections to stormwater drains and animal wastes including that of domestic pets.

Table 3.12 :

- Dissolved Oxygen

  Dissolved oxygen in waterways is vital for the maintenance of beneficial aquatic organisms. Dissolved oxygen levels vary diversely, naturally with temperature and salinity, and are greatly influenced by biological activities. ANZECC (1992) recommend that for the protection of aquatic ecosystems dissolved oxygen should not fall below six milligrams per litre or 80-90 percent saturation. Overloading the river system with organic materials, sewage, and food wastes can lead to depressed levels of dissolved oxygen and may result in ecological impacts including fish kills. Dissolved oxygen levels vary greatly in the Cooks River with depleted levels occurring in the lower estuarine sections of the River.

- Toxicants

  A number of chemicals of concern may be found in elevated concentrations in urban run-off. These include organic toxicants such as pesticides and herbicides which are toxic in large doses and may accumulate in the food chain. Their over use or misuse throughout the catchment is a key source of pollution. Other toxicants include petrols, oils, and grease and carcinogenic compounds such as PAH's and PCB's.

  Heavy metals including lead, mercury, zinc and copper are also found in high levels in stormwater. These compounds are washed into the stormwater drainage system after rain and may concentrate in sediment and bioaccumulate in living organisms. Atmospheric discharges from industry and vehicle emissions (particularly lead petrol emissions) are major sources of this type of run-off contamination. There are a range of guidelines for concentration of these toxicants which are protective of aquatic ecosystems. Toxicants have been measured in the water quality and sediments of the Cooks Rivers in elevated levels. Sediments in the Alexandra Canal, in particular, have been found to include all the above heavy metals together with organochlorine compounds, high concentrations of oil and grease and PAH's. (Reference can be made to *Section 3.1.*10 for comments on specific catchments.) A number of recent fish kills which have occurred in the River have been attributed to use of pesticide within the catchment.

- Suspended Solids or Turbidity

  Suspended solids include sediments washed from building sites, soil erosion, and all particulate matter in the water column. When present in excessive amounts, suspended solids can reduce light penetration, cause sedimentation of waterways and can act as transporting mechanisms for other pollutants. Suspended solid levels in the water column are the main determinant of turbidity. Some waterways are naturally more turbid than others and the recommended guideline for turbidity is less than 10 percent change in seasonal mean (ANZECC, 1992). Results for all the Cooks River catchments indicate results well outside this guidelines.

- Water Acidity (pH)

  Many species of native flora and fauna have adapted to a narrow range of water acidity. Changes in water pH may cause native flora and fauna to die or fauna to

move out of the area affected, and may favour opportunistic pest and weed species. Any increase or reduction in acidity may mobilise toxic chemicals, including heavy metals, oxides of nitrogen and sulphur in the water body and other inert chemicals deposited in bottom sediments of waterways. The pH range considered protective of aquatic ecosystems is 6.5-9.0 in fresh waters (ANZECC, 1992). Results for all the Cooks River catchment indicate a general compliance with this guideline.

In addition to the range of water quality indicators discussed above another key pollutant of the Cooks River is litter. Much of the pollution present in the catchment could also be associated with litter from inappropriate rubbish bin use, commercial activities and roads. Surface litter can include fast food packaging, polystyrene cups, plastics, aluminium cans and paper which accumulate in waterways and can be ingested by or entangle wildlife. Litter results in a reduction of the visual amenity of a waterway and can present a risk for children playing along the foreshores.

3.1.7 Assessment Against Water Quality Guidelines

A water quality assessment has been undertaken for each sub-catchment of the Cooks River. Water quality indicators have been compared against guideline levels suitable for:

- Protection of Aquatic Ecosystems - Fresh Waters;
- Protection of Aquatic Ecosystems - Marine Waters;
- Primary Contact Recreation (suitable for swimming); and
- Secondary Contact Recreation (suitable for boating).

An assessment and subjective rating of available data against general guideline requirements is provided in *Tables 3 13* with a summary comparison in *Table 3.14*. The assessments in the tables are subjective indications based on the broad range of analyses available. Due to the scatter of sampling locations and inconsistent selections of analytes in the past, it is difficult to these assessments on any specific scientific / statistical data, or on a “percent of time compliant” basis. The results of this assessment are discussed for each sub-catchment below.

In the following sections the term “the Guidelines” is used to refer to the values for Protection of Aquatic Ecosystems for Fresh or Marine Waters (ANZECC, 1992). The locations of the sub-catchments discussed and the sampling sites are shown on *Figure 6*.

Upper Cooks River

This catchment represents the fresh water section of the Cooks River. The lower reach of this catchment, around the junction with Coxs Creek, was monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), with four monitoring sites in this area.

During dry weather these sites generally registered higher than guideline levels of pH, total nitrogen, ammonia and total phosphorous, with spikes of high levels of turbidity,

total nitrogen, non-filterable residue and BOD around the Georges River Road sampling point. The high pH could be due to leaching of lime from the concrete channels in this location and the high BOD could be related to an unidentified discharge/overflow event. During the wet weather sampling high turbidity, total phosphorous, total nitrogen and non-filterable residue results were noted.

If the Recreation Guidelines are applied to this stretch of the river the faecal coliforms guidelines are exceeded for both Primary and Secondary Contact recreation during dry and wet weather sampling. In this sub-catchment the high levels of turbidity, ammonia, nitrogen and BOD, together with the high range of dissolved oxygen levels (7.9 milligrams per litre to 21.2 milligrams per litre) indicate the possible existence of algae and their photosynthetic activity.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (CRCMC 1996) in 1996 included two sampling sites in this catchment at Rookwood and Strathfield. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease were also noted.

Table 3.13: Assessment of Water Quality against Guidelines

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
6	Upper Cooks River	Dry	M	M	H	M	M	L	L	H
6	Upper Cooks River	Wet	L	L	H	M	L	L	L	H
8	Upper Cooks River	Dry	L	M	H	L	H	L	L	H
8	Upper Cooks River	Wet	L	M	H	H	-	L	L	H
3	Upper Cooks River	Dry	-	-	L	M	M	L	L	H
6	Central Cooks River	Dry	L	M	H	M	H	L	L	H
6	Central Cooks River	Wet	L	M	H	H	L	L	L	H
8	Central Cooks River	Dry	L	H	H	M	H	L	L	H
8	Central Cooks River	Wet	L	M	H	M	-	L	L	H
8	Cup & Saucer Creek (Lower)	Dry	L	H	H	L	M	L	L	H
8	Cup & Saucer Creek (Lower)	Wet	L	M	H	M	-	L	L	H
8	Upper Wolli Creek	Dry	L	L	H	M	M	L	L	H
8	Bardwell Creek	Dry	L	M	H	L	L	M	L	H
8	Bardwell Creek	Wet	L	H	H	L	-	L	L	H
6	Lower Wolli Creek	Dry	L	NR	H	L	H	H	NR	M
6	Lower Wolli Creek	Wet	L	NR	H	H	L	L	NR	H
8	Lower Wolli Creek	Dry	L	NR	H	L	H	H	NR	H

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
8	Lower Wolli Creek	Wet	L	NR	H	H	-	H	NR	H
6	Lower Cooks River	Dry	L	NR	M	L	H	H	NR	M
6	Lower Cooks River	Wet	L	NR	H	H	L	L	NR	H
8	Lower Cooks River	Dry	L	NR	H	L	H	M	NR	H
8	Lower Cooks River	Wet	L	NR	H	M	-	M	NR	H
6	Alexandra Canal	Dry	L	NR	H	M	H	H	NR	H
6	Alexandra Canal	Wet	L	NR	H	M	H	L	NR	H
8	Alexandra Canal	Dry	L	NR	H	L	H	M	NR	H
8	Alexandra Canal	Wet	L	NR	H	M	-	H	NR	H
6	Muddy Creek	Dry	L	M	H	L	L	M	L	H
6	Muddy Creek	Wet	L	M	H	H	L	-	L	H
8	Muddy Creek	Dry	L	M	H	L	H	L	L	H
WATER QUALITY OBJECTIVES										
Fresh Waters:										
	Aquatic Ecosystem Protection		6.5-9	80-2500	100-750	10-100	2-10	> 6	150000	
	Primary Contact Recreation		5-9	NR	NR	NR	NR	NR		< 150
	Secondary Contact Recreation		5-9	NR	NR	NR	NR	NR		< 1000
Marine Waters:										
	Aquatic Ecosystem Protection		< 0.2pH Unit Change	NR	10-100	5-15	2-10	> 6	NR	NR
Ratings			L = 6.5 - 9	L = < 80	L = < 100	L = < 100	L = < 10	L = > 6	L = < 150000	L = < 150

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
			M = 5-10	M = 80-2500	M = 100-750	M = 100-200	M = 10-20	M = 5-6	M = 150000-250000	M = 150-1000
			H = < 5 > 10	H = > 2500	H = > 750	H = > 200	H = > 20	H = < 5	H = > 250000	H = > 1000

Table 3.14: Summary of Water Quality Against Guidelines

Ref. No.	Sub-Catchment	Weather	Aquatic Ecosystem Health (Freshwater)	Aquatic Ecosystem Health (Marine Waters)	Primary Contact Recreation	Secondary Contact Recreation	Parameter Exceeded
6	Upper Cooks River	Dry	H	NA	H	H	Nitrogen, F. Coliforms
6	Upper Cooks River	Wet	H	NA	H	H	
8	Upper Cooks River	Dry	H	NA	H	H	
8	Upper Cooks River	Wet	H	NA	H	H	
3	Upper Cooks River	Dry					
6	Central Cooks River	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Central Cooks River	Wet	NA	H	H	H	Chlorophyll-a (Dryweather)
8	Central Cooks River	Dry	NA	H	H	H	
8	Central Cooks River	Wet	NA	H	H	H	
7	Cup & Saucer Creek	Dry	NA	H	H	H	Nitrogen, Phosphorus, F Coliforms
8	Cup & Saucer Creek (Lower)	Dry	NA	H	H	H	Nitrogen, F Coliforms
8	Cup & Saucer Creek (Lower)	Wet	NA	H	H	H	
8	Upper Wolli Creek	Dry	M	NA	H	H	F.Coliforms, Nitrogen
8	Bardwell Creek	Dry	M	NA	H	H	Ammonia, Nitrogen, F Coliforms
8	Bardwell Creek	Wet	M	NA	H	H	Ammonia, Nitrogen, F Coliforms
6	Lower Wolli Creek	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Lower Wolli Creek	Wet	NA	H	H	H	Phosphorus (Wetweather)
8	Lower Wolli Creek	Dry	NA	H	H	H	Chlorophyll-a (Dryweather)
8	Lower Wolli Creek	Wet	NA	H	H	H	DO

Ref. No.	Sub-Catchment	Weather	Aquatic Ecosystem Health (Freshwater)	Aquatic Ecosystem Health (Marine Waters)	Primary Contact Recreation	Secondary Contact Recreation	Parameter Exceeded
6	Lower Cooks River	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Lower Cooks River	Wet	NA	H	H	H	Phosphorus (Wetweather)
8	Lower Cooks River	Dry	NA	H	H	H	DO
8	Lower Cooks River	Wet	NA	H	H	H	Chlorophyll-a (Dryweather)
6	Alexandra Canal	Dry	NA	H	H	H	Nitrogen
6	Alexandra Canal	Wet	NA	H	H	H	Chlorophyll-a
8	Alexandra Canal	Dry	NA	H	H	H	F. Coliforms
8	Alexandra Canal	Wet	NA	H	H	H	
6	Muddy Creek	Dry	NA	M	H	H	F.Coliforms
6	Muddy Creek	Wet	NA	M	H	H	Nitrogen
8	Muddy Creek	Dry	NA	M	H	H	Phosphorus

L = Levels within guidelines

M = Low level of exceedance of guidelines

H = High level of exceedance of guidelines

NA = Not Applicable

Further monitoring was reported by Bankstown City Council (Bankstown City Council 1998) at two sites in the catchment (Rookwood Road and Como Road) in 1997 and 1998. The results indicate that water quality is generally in compliance with the guidelines, with the exception of a high proportion of sampling dates which exhibited high pH and several occasions when high levels of faecal coliforms and conductivity were measured. Toxic metals and other pollutants noted in the Ecosystem Health Report were not measured.

Coxs Creek

Only one monitoring point has been identified for this catchment in the Ecosystem Health Report to the Cooks River Catchment Management Committee (CRCMC 1996) in 1996. The site is in the lower reaches of the Creek and the results indicate poor to very poor compliance with unspecified guidelines for toxic substances such as copper, cadmium, lead, mercury and zinc; and for pesticides (chlordane, dieldrin and DDT). The unspecified guideline requirements were also exceeded for PCB's and high levels of oil and grease were noted.

Central Cooks River

This catchment represents the upper reaches of the tidal section of the river referred to as "not frequently used" in the Proposed Interim Environmental Objectives for NSW

Waters. It was extensively monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), with seven monitoring sites in this area. During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. The concentrations of chlorophyll-a, generally for the total catchment, increased with distance from the highest being recorded in this sub-catchment. NFR levels are also high and levels of total phosphorous and filterable phosphorous are high indicating that the Guideline for PO_4-P will be exceeded. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, total nitrogen and non-filterable residue results were noted. The levels of faecal coliforms also exceed the guidelines for both Primary and Secondary Contact Recreation during dry and wet weather sampling.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) included one sampling site in this catchment in 1996. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site in this catchment at Brighton Avenue with data from 1993 to 1997. The results indicate compliance with the Guidelines with the exception of filterable phosphorous, oxidised nitrogen, ammonia and chlorophyll-a in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with Secondary Contact Recreation Guidelines but not Primary Contact. However, wet weather results do not comply either guideline.

The Brighton Avenue site is also referenced in the Licensing Sewerage Overflows, Environmental Impact Statement for the Georges River and Southern Suburbs Geographic Area (Sydney Water Corporation 1998). This document also notes the failure of samples from this site to comply with guidelines for chlorophyll-a and with guidelines (SPCC,1990) for phosphorous and nitrogen.

Cup and Saucer Creek

This catchment was extensively monitored in 1990 and 1991 for the Cup and Saucer Creek Catchment Management Study (Water Board 1992a). From these results it can be seen that both the upper reaches (drain) and the lower reaches (part drain / part creek) of this catchment fail to comply with most of the required parameters in the Guidelines. Total phosphorous, total Kjeldahl nitrogen, zinc, iron, copper, chromium, lead and nickel exceed Guideline values throughout the catchment but are generally noticeably worse for the upper reach (drain) around the Kingsgrove Road and Trafalgar Street sampling sites. This is believed to be due to industrial activities in the area. Both NFR and BOD results are also high in this area. Toxic organics were found in the form of polycyclic aromatic hydrocarbons (PAH) and organochlorines (OC) in the lower reaches at Fore Street and Berna Street. Litter and sediment were also recorded as significant pollutants requiring the trash rack to be cleaned once per week.

In addition, in 1990 a further study was undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) which included two monitoring sites in the lower reaches of Cup and Saucer Creek. These results indicated high levels of turbidity even during dry weather sampling indicating pollution sources other than rainwater.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 included one sampling site in this catchment at the upstream end of the lower reach. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT). High levels of oil and grease were also noted.

Upper Wolli Creek

This catchment was included in the study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) in 1990 with two monitoring sites in the upper reaches of the Upper Wolli Creek catchment. The results from this monitoring indicated high levels of pH, total phosphorous and faecal coliforms.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment close to the junction with Bardwell Creek. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, lead and zinc; and also with the pesticide chlordane. High levels of oil and grease were also noted.

Bardwell Creek

The study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) in 1990 included two monitoring sites on Bardwell Creek. The results from this monitoring indicated high levels of turbidity during dry weather sampling and very high levels of total nitrogen, ammonia, colour and faecal streptococci at the downstream site indicating a possible point source of pollution between the two sites.

Lower Wolli Creek

This catchment was monitored at three sites in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b). During dry weather these sites generally did not comply with guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR levels were also high and levels of total phosphorous and filterable phosphorous were high indicating that the guideline for PO_4-P would be exceeded. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, ammonia and total nitrogen were observed. During dry weather sampling the levels of faecal coliforms were found to exceed the Primary Contact Recreation Guidelines at one site but comply with those for Secondary Contact at all sites. During wet weather sampling both Primary and Secondary Contact Guidelines were exceeded.

The Water Quality in the Cooks River Catchment Report (Water Board 1992b) in 1990 included one site at the upstream end of this catchment. The results from this site indicated a low level of dissolved oxygen at four milligrams per litre as the only concern, which was also noted in the 1992 Report above.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site on this part of Wolli Creek downstream of the Bardwell Creek junction with data from 1993 to 1997. The results indicate general compliance with the Guidelines with the exception of dissolved oxygen (which appears to be decreasing over the last four years), filterable phosphorous, oxidised nitrogen and ammonia in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with both Primary and Secondary Contact Recreation Guidelines for most samples. However, wet weather results only comply with the Secondary Contact Guideline.

One site at Henderson Street was included in the Stormwater Monitoring Project, 1994 Annual Report (Sydney Water Corporation 1994) which noted that this site had the highest wet weather event mean concentration for total uncombined ammonia of all sites monitored in the Sydney catchments.

Marrickville/Sydenham Drainage System

No monitoring results have been identified specifically for this catchment. The Marrickville Council State of the Environment Report, 1997 (Marrickville Council 1997) refers only to regional data for the Cooks River and Alexandra Canal plus some sampling undertaken by local schools for the same areas. The report does however acknowledge that the condition of waterways in this area require significant Council policies and programs to improve the generally unsatisfactory conditions.

Lower Cooks River

This catchment was extensively monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), at fifteen sites spread evenly along this length of river. During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR levels were also found to be high and levels of total phosphorous and filterable phosphorous were higher than the guideline level. In general, the concentration of nitrogen, ammonia, phosphorous and chlorophyll-a for tis sub-catchment, as for the total catchment, tend to increase with distance upstream from the mouth of the River. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, total nitrogen and non-filterable residue results were noted. During dry weather the levels of faecal coliforms exceed the Primary Contact Recreation Guidelines except for the first one kilometre at the river

mouth. The remainder were found to comply with the requirements for Secondary Contact Recreation. During wet weather the levels of faecal coliforms exceed both the Primary and Secondary Contact Recreation Guidelines.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, chromium, cadmium, lead, mercury and zinc; and also with pesticides (chlordane and DDT) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site on this part of the Cooks River downstream of the Muddy Creek junction with data from 1993 to 1997. The results indicate compliance with the Guidelines with the exception of filterable phosphorous, oxidised nitrogen and ammonia in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with both Primary and Secondary Contact Recreation Guidelines. However, wet weather results do not comply with either Recreation Guideline.

One site adjacent to Muddy Creek is also referenced in the Licensing Sewerage Overflows, Environmental Impact Statement for the Georges River and Southern Suburbs Geographic Area (Sydney Water Corporation 1998). This 1998 document also notes the failure of samples from this site to comply with guidelines for chlorophyll-a and with Guidelines (SPCC,1990) for phosphorous and nitrogen.

Sheas Creek

Very little monitoring has been identified in this upper reach of the creek as most previous work appears to have concentrated on the Alexandra Canal, which is the downstream section of this waterway. However, an extensive monitoring program of four sites in the catchment was undertaken in the Sheas Creek Stormwater Channel Water Quality Report (Simms, 1992). This study indicated that the samples taken did not comply with Guidelines for cadmium, copper, lead and zinc. In addition high levels of total phosphorous and nitrogen were found indicating that filterable phosphorous and oxidised nitrogen Guidelines are also likely to be exceeded. Suspended solids results were also high and average faecal coliform figures exceeded Secondary Contact Recreation requirements. Dry weather faecal coliform levels complied with Secondary Contact Guidelines only.

One site at Maddox Street was included in the Stormwater Monitoring Project, 1994 Annual Report (Sydney Water Corporation, 1994) which noted that Sheas Creek had the highest rainfall in the Sydney catchments monitored and the highest unit area exports for all pollutants. The high export (and run-off ratio) has been attributed to the extensive industrial use of groundwater in the catchment.

Alexandra Canal

This canal is the extension of Sheas Creek to the Cooks River. It was monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks

River Report (Water Board, 1992b), at three sites in the lower half of the canal. During dry weather these sites generally did not comply with guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR and total phosphorous levels are also high. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, oxidised and total nitrogen and non-filterable residue results were noted. During dry and wet weather the levels of faecal coliforms exceed the Primary and Secondary Contact Recreation Guidelines.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee, 1996) in 1996 also included a number of sampling sites in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, chromium, cadmium, lead, mercury and zinc; and also with pesticides (chlordane and DDT mostly) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

Taking all parameters into account, this waterway is considered to have the poorest water quality in the Cooks River catchment.

Muddy Creek

The most extensive monitoring of this catchment was undertaken at three sites in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board, 1992b). During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3) and ammonia. Levels of total phosphorous and filterable phosphorous are high indicating that the Guideline for PO_4-P will be exceeded.

During the wet weather sampling high levels of turbidity, filterable and total phosphorous, ammonia and total nitrogen results were noted. During dry weather sampling the levels of faecal coliforms generally exceeded the Primary Contact Recreation Guidelines but complied with those for Secondary Contact. During wet weather sampling both Primary and Secondary Contact Guidelines are exceeded. Dry weather faecal coliforms results are considered to be impacted by an unidentified overflow/discharge event.

This catchment was included in the study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services, 1991) in 1990 with one monitoring site in the creek catchment. The results from this monitoring indicated high levels of total nitrogen and ammonia, and faecal coliforms above Secondary Contact Recreation Guidelines.

Water Quality Hotspots

As detailed above, much of the catchment has extensive water pollution issues in terms of nutrients, eutrophication, metals, and faecal coliforms. However, the following areas are of significant concern for these and other factors:

- Georges River Road area of the Upper Cooks River Sub-Catchment (high BOD, possible unidentified discharge/overflow);

- Kingsgrove Road area of the Cup and Saucer Creek Sub-Catchment (high metal concentrations, possible industrial discharge);
- Sheas Creek Sub-Catchment (highest unit area export figures for pollutants for total Sydney Water catchment); and
- Alexandra Canal Sub-Catchment (poor performance on all parameters, particularly on copper, mercury, lead, zinc, oil and grease).

3.1.8 Sewer System

The nature and significance of discharges from the sewer system within the Cooks River Catchment was recently investigated by Sydney Water Corporation for the Sewer Overflow Licensing project (SWC, 1998). This study identified that the sewer system in the catchment is one of the oldest in Sydney and in poor condition, with leakage occurring from both privately owned and SWC owned pipes. Sandy soils and groundwater movement allow mitigation of discharged sewerage into the waterways.

Leaky pipes or connection of stormwater pipes to the sewer system can also allow rainwater to enter the system in wet weather, thus overloading it. If this occurs, or there are blockages or pump station failures, sewage can overflow at:

- *designed overflow points* – designated overflows are generally located at watercourses so that the overflowing sewage can be diluted, and the health risks reduced. Major overflows are considered to make up about 85 percent of total load;
- *non-designed overflow points* – the location of these are not always known or recorded, although SWC field staff are often aware of them;
- pumping stations which have provision for overflows; and
- "unintended overflows:, for example via access chamber covers. "Frequent surcharge locations" are recorded, but other locations are not always known or recorded.

The estimated significance of the pollution loads as a result of sewer system discharge are discussed in *Section 6.1*.

3.1.9 Groundwater Quality

The Botany Sands Aquifer in the lower Cooks River area is an important underground water resource from which water is pumped for use by industry, golf courses, and residents. The aquifer flows into Botany Bay and tributaries, including Alexandra Canal. There is significant contamination of parts of the aquifer as a result of past industry in the area (South Sydney Council, 1997). The large numbers of disused tip sites within the catchment are likely to be a significant source of contaminated leachate into the groundwater.

Water pumped from the aquifer is often later discharged to surface water and may contain chemical contaminants. In addition, the Alexandra Canal acts as a sump, with groundwater flowing to the ocean via the Canal. As a result, contamination of

the groundwater supply may be exacerbating the contamination of the waterways and sediments of the Cooks River. The Department of Land and Water Conservation is currently preparing a Groundwater Management Plan for the Botany Sands Aquifer.

3.1.10 Soil Erosion and Sedimentation

Soil Erosion

Wind erosion is the dominant agent of soil erosion in the eastern part of the catchment, particularly in the South Sydney and Botany Local Government Areas, where there are loose sandy soils. Sheet erosion presents a greater hazard to the north-west of the catchment, where the nature of the soils is more clayey. Water is the major agent of erosion inland, particularly in the Local Government Areas of Bankstown, Burwood and Strathfield (Soil Conservation Service 1991).

Existing erosion is confined to current development sites, rubbish tips and storage areas which present the greatest source of sediment. The long term point sources of sediment include the railway establishments at Chullora and Enfield which are proposed for redevelopment, Rookwood Cemetery and Jubilee Park (Rendell, undated). Areas where there are current erosion problems are identified in *Table 3.15*.

Table 3.15: Significant Erosion Sites Within the Cooks River Catchment

Location	Problem
Stormwater drain Eastern Boundary of Rookwood Cemetery	■ unprotected and eroding stormwater channel; and ■ lack or erosion & sediment controls on development immediately up stream of drain.
Chullora Railway Workshops	■ large areas of unvegetated material that is subject to water and wind erosion and is in close proximity to the river.
Enfield Marshalling Yards	■ as above.
Cooks River Goods Yard Sydenham	■ large areas used for container handling and storage; ■ Constant usage by heavy vehicles on exposed unprotected soil in close proximity to Alexandra Canal.
Wolli & Bardwell Creek	■ bank erosion occurs following even minor storm events.
Waste Transfer Station Alexandria and neighbouring tip sites.	■ large stockpiles of soil material with little, and in areas, no vegetation.
Eveleigh Railway Workshops	■ large areas unvegetated.
Cox's Creek Reserve	■ bank erosion occurs following even minor storm events.
Freshwater Park	■ bank erosion occurs following even minor storm events.

Reference: (Rendell, undated)

The Cooks River Catchment is almost completely urbanised, as a result the current sediment yield is considered to be relatively minimal. The estimate of current sediment yields from the catchment under present development conditions is assessed at 2.5 tonnes per hectare per year. Approximately 90-95 percent of this sediment will reach the tidal sections of the river, and as much as 80 percent of this sediment will

be carried in suspension (Rendell, undated). Greater rates of sediment erosion are expected during construction of major developments or roadworks in the catchment (Rendell, undated).

There are various structural sediment controls within the Cooks River Catchment as shown in *Table 3.16*. SSROC has recently prepared sediment control guidelines for construction activities throughout the catchment. However, at present soil conservation control measures are not uniformly specified throughout the catchment in conditions of development consent (Rendell, undated).

Table 3.16: Structural Sediment Controls

Authority	Sediment Control	Location
Rockdale Council	Silt Trap [56]	End of Spring St drain
Rockdale Council	Silt Trap [56]	Muddy Creek
South Sydney Council	Gully Pit Traps	Along roads in 80 percent of Council area

Sedimentation

Sediment particle size and hydraulic conditions will influence the amount of sediment that remains in the estuary. The coarser fraction is likely to be deposited in the upper tidal reaches and redistributed during very large events with outflow tidal conditions. The fine fraction will be progressively deposited. It is probable that a significant proportion will be totally removed from the estuary (Rendell, undated).

The main areas where heavy siltation have been noted are generally in the lower sections of Cooks River, particularly near the Boat Harbour and Marrickville Golf Course (Clouston 1997a). There is little information available on the sedimentation regime of the Cooks River tributaries. Alexandra Canal typically has little sediment transport, apart from high flow conditions during storm events (Hyder 1997).

Dredging occurs in some concrete line sections of the river where sediment accumulates and flooding is a problem, such as at Fifth Avenue, Campsie. The source of the sediments has been attributed to catchment erosion and channel bank erosion. In addition, some minor stream bank erosion occurs due to attrition from overland flow and fretting wave action (Total Environment Centre 1995).

Acid Sulfate Soils

Acid sulfate soils are the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid (ASSMAC, 1998). Maps produced by the Soil Conservation Service of NSW and DLWC, indicate that acid sulfate soil conditions existing in bottom sediments of all the tidally influenced areas of the Cooks River. The areas immediately south of the lower Cooks River are also considered to support acid sulphate soils , 1-3 metres below ground surface. Any removal of surface water, or lowering of the watertable, that protects potentially acid sulphate soils, will result in their aeration and the exposure of iron sulfides to oxygen. Acid sulphate soils present severe environmental risk if disturbed by activities such as dredging, excavation, or clearing. The potential for acid sulphate soils needs to be considered for all stormwater management activities that involve exposure of bottom sediments to oxygen.

3.1.11 Sediment Quality

Contaminated sediments pose a major problem for environmental management of the Cooks River catchment. Past land use and pollutant management practices in the catchment have resulted in high levels of contamination of sediments within the channel and in surrounding lands. Profiles of sediment quality in the channel close to the mouth of the Cooks River indicate that contamination levels are higher beneath the more recently deposited surface layers. Elevated levels of chemicals have been recorded in sediments up to nine metres below the surface (Hyder 1997). Whilst sediments are immobilised they do not pose a significant threat to water quality. However, if the surface layers are dredged or moved via naturally transportation, contaminants may be released into the water column.

The major ongoing sources for contamination of channel sediments are most likely to include:

- road run-off;
- urban run-off;
- atmospheric fallout;
- general litter;
- construction run-off;
- stormwater run-off from industrial areas; and
- waste material discharged from past and current industrial and commercial premises.

The rates of natural biodegradation of chemical contaminants are slow, due to low oxygen availability in the sediments. This is particularly the case for chemicals with more complex structures such as polychlorinated biphenyls and organochlorine pesticides which have been identified in Alexandra Canal (Hyder 1997). Locations of major industrial areas, likely to result in past contamination of sediments in the waterways include:

- the Rockdale section of Muddy Creek;
- the Turrella section of Wolli Creek;
- the Kingsgrove section of Wolli Creek;
- the Belmore section of Cup and Saucer Creek; and
- the Enfield Marshalling Yards and Chullora Railway Workshops.

Sites where major roads cross the waterways, or where road drainage outlets discharge to waterways are potential contamination sources as a result of stormwater run-off from roads exposed to heavy motor vehicle usage. Major road crossings include:

- Marsh Street;
- General Holmes Drive;

- Canal Road;
- Bayview Avenue;
- Bexley Road;
- Bardwell Road;
- Canterbury Road;
- Brighton Avenue; and
- Illawarra Road.

During the past twenty years, contamination from industry has decreased dramatically and pollutant management practices have reduced non-point source pollution. As such, the waterways have shown a gradual improvement in sediment quality.

3.2 Biological Environment

3.2.1 Aquatic Flora and Fauna

The aquatic systems of the Cooks River have been significantly modified and polluted since European settlement. The tidal sections of the Cooks River were described in the 1800's as being surrounded by saltwater swamps and mudflats bordered by mangroves and saltmarshes.

The following changes to this original ecosystem have resulted in a River system that has little value as aquatic habitat:

- concrete lining of the river bed along most sections of the river system;
- filling in of intertidal zone and mudflats and removal of mangrove forests;
- sealing of bank habitats with steep constructed river walls;
- clearing of riparian and floodplain vegetation;
- diversion of creeklines and piping of natural drainage lines;
- changes in flow regimes particularly wet weather flow velocities; and
- point and non-point pollution discharges.

Studies of fish and macroinvertebrate communities within the Cooks River indicate a limited diversity of aquatic species. Species recorded are dominated by polychaetes and molluscs known to be tolerant to highly contaminated river systems. Fish species found in the river include mullet, eel and galaxies and gobies (Sydney Water, 1998). The limited diversity of aquatic fauna is characteristic of a polluted waterway.

The species diversity is greatest within the tidally influenced sections of the River and rapidly declines with distance upstream (Total Environment Centre, 1976). Aquatic fauna surveys (Total Environment Centre, 1976) indicate that the mouth of the river

and its lower reaches have a much greater species diversity than habitats further upstream (Total Environment Centre, 1976).

Prior to European settlement, the fish and shellfish caught in the Cooks River supported local aboriginal communities (Total Environment Centre, 1995). Today, all forms of commercial fishing are banned in the Cooks River due to toxicants which accumulate within the fish and represent a health risk to consumers. A technical report by the Central Sydney Area Health Service (1997) concluded that the taking of fish, shellfish and crustaceans from the Cooks River should be banned for both recreational and commercial operators. Currently, under the *Fisheries Management Act, 1994* it is still permissible for recreational fishers to catch fish by the use of rod or handline (Central Sydney Area Health Unit, 1997).

The poor water quality of the Cooks River has often resulted in acute toxic effects on fish within the River. During summer, 1997, the release of the pesticide, chloropyrifos into the drainage system of the Cooks River resulting in an acute toxic spike that killed thousands of fish and over 100 birds. This event followed the fish kill that occurred during October, 1991 where thousands of fish were found dead. This time, whilst a pollutant was not specifically identified, the waters displayed very low dissolved oxygen levels.

3.2.2 Wetlands

- The Cooks River catchment contains a number of wetlands that are considered to be regionally significant owing to their limited distribution and their fragmented status. These wetlands offer locally valuable habitat for native fauna including birds, mammals, fish, reptiles, amphibians, insects and other invertebrates. The major wetlands within the Cooks River Catchment are described below and their locations illustrated in Figure 7.

Rockdale Wetlands

The Rockdale Wetlands consists of three wetland systems contained within three distinct catchments including: Cooks River, Botany Bay and Georges River. The Rockdale Wetlands corridor is connected to Botany Bay by a 700 metre underground channel which allows tidal exchange and a modified access route for fish and invertebrates. The Rockdale Wetlands system has been recognised regionally for its scenic, ecological, recreational and heritage significance (Rockdale City Council, 1995). It also acts as a floodway during major rainfall events.

- The Cooks River component is tidal and runs from the confluence of the Cooks River and Muddy Creek down to Bestic Street. The Cooks River component includes the Cooks River headwater, Kyeemagh Canal boat harbour, Muddy Creek Canal, Eve street ponds and the Landing Light Wetland (located to the South of Barton Park).

The wetlands system offers significant habitat for native Australian wetland birds and a refuge and temporary feeding ground for a number of migratory birds. The threatened bird species and species protected by the Australia Migratory Birds Agreements (CAMBA and JAMBA) which occur in these wetlands are listed in *Table 3.17*. In addition, the wetlands are utilised by a number of terrestrial fauna species including

bandicoots, common Brushtail possums, water rats, small skinks and various species of frogs. A number of introduced species including: black rat, house mouse, cats, dogs, and rabbits.

Weed growth in the wetlands include the following species; water hyacinth, umbrella sedge, Indian canna, lantana, Ludwigia, honeysuckle, bramble and kikuyu (Rockdale City Council, 1995). These species are out-competing native species and effecting the water quality of the wetlands.

Table 3.17: Significant Bird Species recorded in Rockdale Wetlands

Common Name	Scientific Name
Birds listed on the China-Australia Migratory Bird Agreement (CAMBA,1986)	
Caspian Tern	*Hydropogne tschegrava*
Curlew Sandpiper	*Calidris ferruginea*
Great Egret	*Egretta alba*
Greenshank	*Tringa nebularia*
Latham's Snipe	*Capella hardwickii*
Lesser Golden Plover	*Pluvialis dominica*
Little Tern	*Sterna albifrons*
Red-necked Stint	*Calidris ruficollis*
Sharp-tailed Sandpiper	*Calidris acuminata*
White-winged Tern	*Chlidonias leucoptera*
Birds listed on the Japan-Australia Migratory Bird Agreement (JAMBA, 1974)	
Common Tern	*Sterna hirundo*
Curlew Sandpiper	*Calidris ferruginea*
Greenshank	*Tringa nebularia*
Little Tern	*Sterna albifrons*
Pectoral Sandpiper	*Calidris melanotos*
Red-necked Stint	*Calidris ruficollis*
Sharp-tailed Sandpiper	*Calidris acuminata*
White-winged Tern	*Chlidonias leucoptera*
Threatened Species Conservation Act, 1995	
Vulnerable	
Comb-crested Jacana	*Irediparra gallinacea*
Endangered	
Little Tern Endangered	*Sterna albifrons*

Eve Street Wetlands

The Eve Street Wetlands are a remnant of the larger Barton Park wetland system which once stretched from Eve Street to the Cooks River. Much of the original wetland was lost by landfill operations to create playing fields and parkland. In 1993, Sydney Water in association with the local community, began restoration works on a section now known as the Eve Street Wetlands in Arncliffe. This wetland now provides important refuge and feeding grounds for migratory birds and is considered of regional ecological value (Rockdale City Council, 1995). The ecological values of the

Eve Street wetlands, as a component of the Rockdale wetlands, are recognised by its listing on the Commonwealth Directory of Important Wetlands.

Wolli Creek Wetlands

A number of wetlands providing both estuarine and fresh aquatic habitats occur within Wolli Creek and its tributary, Bardwell Creek as illustrated in Figure 6. Turrella weir marks the division between estuarine and freshwater conditions (Manidis Roberts, 1994). The estuarine wetlands of Wolli Creek cover an area of 1.5 hectares and support three major herbland communities:

- Austral Seablite (*Suaeda australis*) and Common Reed;
- Beaded Glasswort (*Sarcocornia quinqueflora*) and Common Reed; and
- Beaded Glasswort and Streaky Arrow-Grass (*Triglochin striata*).

Mangrove forests dominated by the Grey Mangrove (*Avicennia marina*) occur along 2.5 kilometres of foreshore in Wolli Creek (Figure 7). The freshwater wetlands above Turrella weir are generally in poor condition, with condition and species diversity improving with distance upstream. The predominant freshwater wetland species include Common Reed, Tall Spikerush (*Eleocharis sphacelata*) and Cumbungi (*Typha* sp.) (Manidis Roberts, 1994).

The Wolli Creek wetlands provide habitat for more that 160 bird species which are either permanent residents or migratory visitors to the area. The estuarine wetlands have been identified by the Ecology Lab (1995) as providing critical nursery habitat for a number of commercially important fish and prawns.

Other Cooks River Wetlands

A waterhole adjacent to the Cooks River off Dibble Avenue, Dulwich Hill, has formed in what was formerly the Toyer Brothers brick pit. The waterhole has been used for many years as a haven for several wetland bird species (Total Environment Centre, 1995).

Mangroves

Mangroves have been re-established along sections of the Cooks River and Muddy Creek, particularly in the vicinity of Steel and Kendrick Parks. Mangroves have been planted by Marrickville Council around Fatima Island. Although there are no large areas of remnant indigenous vegetation in the Marrickville Council area, a number of trees along the Cooks River including mangroves, and fig and palm trees, have been recorded as significant in the Marrickville Heritage Study (Marrickville Council, 1994: Total Environment Centre, 1995).

The success of natural re-colonisation of mangroves in Wolli Creek has been well documented. The original low closed forest mangroves of Wolli Creek were considered non-existent following the construction of the Tempe Dam in 1840 which deprived the mangroves of tidal salt water essential for their survival. In 1970, six years after the Dam was removed the first evidence of a re-colonising mangrove

community occurred. The area of mangrove has increased rapidly over the last twenty years and is likely to continue to expand its range (Brown *et al*., 1988a). At present around 0.024 square kilometres of mangroves now cover Wolli Creek's tidal plain adjacent to Bayview avenue, Turrella. A study of macro invertebrate fauna of the Wolli Creek conducted by Brown *et. al*. (1988b), found the number of arthropod species to be far greater than that reported ten years earlier in 1978.

From 1994 to 1996 a restoration and rehabilitation program was carried out along the western shoreline of Muddy Creek. This involved the planting of grey mangrove seedlings to regenerate the shoreline ecosystems and to support the mature mangroves growing naturally along the eastern shoreline (Kinhill Engineers, 1993).

Wetlands are vulnerable to the impacts of poor stormwater quality with major threats presented by:

- disposal of litter and other solid wastes;
- discharge of residential and industrial effluent, stormwater and run-off leading to pollution;
- oil and chemical spills;
- increasing suspended solids;
- reclamation and modification of land for commercial, residential and infrastructure developments; and
- construction of harbours and engineering structures such as channelisation of river and creek channels (Manidis Roberts, 1994).

3.2.3 Riparian and Foreshore Flora and Fauna

The native flora and fauna of the Cooks River valley survive in small remnants of the original vegetation which occur primarily in open space and parkland areas along the River foreshores. The remaining bushland and foreshore vegetation remnants are considered of high ecological value and important for conservation of biodiversity within the region (Total Environment Centre, 1995b). The remnant bushland areas of the Cooks River are illustrated in *Figure 7* and described below.

Cooks River Plain Scrub Forest Remnants

A remnant of the original clay-soil bushland which was once widespread throughout the Cooks River catchment remains along Freshwater Creek within the Chullora Railway Yards. This remnant vegetation, known as the Cooks River Clay Plain Scrub Forest, is classified as an endangered ecological community and protected by the *NSW Threatened Species Conservation Act, 1995*. The Bankstown Bushland Society have been enhancing the value of this three hectare remnant through a bush regeneration program. The site is owned by the National Rail and is part of a recent proposal for redevelopment.

A site at the end of Third Avenue, Campsie, also supports an isolated small remnant of Cooks River Clay Plain Scrub Forest. The site occupies about 0.5 hectares between the Cooks River and its junction with a small stormwater canal (Total Environment

Centre, 1995b). The vegetation has patches of scrub, native grassland and mature trees. This remnant is relatively undisturbed as the natural Wianamatta Shale soils are largely unmodified and, due to the topography of the site, have not been impacted by high nutrient run-off. The remnant vegetation at this site has scientific and natural heritage significance (Total Environment Centre, 1995b).

A third remnant of this endangered ecological community, known as Freshwater Park, is located along the foreshores of the Cooks River at Hedges Avenue, close to Strathfield High School.

Cox's Creek Reserve, at Sylvans Street, Greenacre, is a significant remnant of the Cooks River Clay Plain Scrub Forest covering an area of 1.65 hectares. The remnant is managed by Strathfield Council and bush regeneration works have been undertaken with the assistance of volunteers since 1996. The site supports a well preserved example of Melaleuca Scrub and provides habitat for the threatened Green and Golden Bell Frog, *Litoria aurea.* The reserve is dissected by two earth bank stormwater channels which are known to erode in high rainfall events.

Wolli Creek Remnants

The Wolli Creek valley supports a diversity of natural environments including mangroves, heaths, eucalypt forests, wetlands and a pocket of coachwood-watergum rainforest (Total Environment Centre 1995b). The condition of vegetation throughout the valley varies with both healthy bushland remnants and significantly degraded areas. In recent years efforts by local Councils, residents groups, and the National Trust have assisted with the protection and enhancement of this area. The number of bird species found in the area has increased over the last twenty years with current estimates of over 160 bird species (Total Environment Centre 1995b). Water birds include migratory bird species that have travelled from Japan and Siberia and are protected through international treaties (Total Environment Centre, 1995b).

Foreshore vegetation along Wolli Creek extends from Bexley Road, Earlwood, through to Waterworth Park, Undercliffe, and includes the popular Girrahween Park. Vegetation along Bardwell Creek extends from Preddys Road, Bexley to its confluence with Wolli Creek near Edith Street, Bardwell Park. Small remnants of bushland survive along Wolli and Bardwell Creeks.

The upper Bardwell Creek valley supports patches of open woodland of Sydney Red Gum (*Angophora costata*) and Sydney Peppermint (Eucalyptus piperita) with a diverse shrubby understorey supporting 80 different species (Benson and Howell, 1990). Remnant woodland vegetation can be seen along Wolli Creek at Girrahween Park and Nanny goat Hill at Earlwood. Shrubby heath can be seen at Highcliffe Road, Undercliffe (Benson and Howell, 1990; Total Environment Centre, 1995b).

Shrubland vegetation occurs between Bexley Road and the Bardwell Valley Golf Course with the predominant species being Tick Bush (*Kunzea ambigua*), Black She-Oak (*Casuarina littoralis*), NSW Coral Heath (*Epacris pulchella*), Fuchsia Heath (*Epacris longiflora*), Coral Heath (*Epacris microphylla*), *Astroloma pinifolium* and *Styphelia tubiflora*. This vegetation is found on a quarry site where bared rock has allowed the heath species, which are now rare in this part of Sydney, to prosper.

A rare remnant of Sydney Blue Gum (*Eucalyptus saligna*) open forest occurs along a small tributary within Stotts Reserve at Bexley North. Sydney Redgum - Sydney Peppermint (*Angophora costata - Eucalyptus piperita*) woodland association also occurs in within this area (Benson and Howell, 1990; Total Environment Centre, 1995b).

National Parks and Wildlife Service identified a diversity of vegetation types along Wolli Creek following a detailed study in 1988. The vegetation communities observed following a field survey and review of existing literature are identified in *Table 3.18*. Whilst a diversity of vegetation types were recorded, the extent of each community was limited (Total Environment Centre, 1995b).

Table 3.18: Vegetation Survey of Wolli Creek

Location Along Wolli Creek	Vegetation Structural Type	Dominant Species of Vegetation Associations Common Name (Scientific Name)
Bexley North, on north side of Wolli Creek	Low Closed Forest	Coachwood-Water Gum (*Ceratopetalum apetalum - Tristaniopsis laurina*)
Tidally influenced parts of the lower Wolli Creek	Low Closed Forest	Grey Mangrove - River Mangrove (*Avicennia marina - Aegiceras corniculatum*)
Sheltered hills and gullies	Forest	Blackbutt-Sydney Peppermint - Sydney Red Gum (*E. Pilularis - E piperita - Angophora costata*)
Freshwater wetland, lower Wolli Creek	Low Forest	Paperbark species (*Melaleuca spp*.)
South facing hillsides	Open Forest	Sydney Red Gum - Red Bloodwood - Sydney Peppermint *Angophora costata - Eucalyptus gummifera - e. Piperita*)
South facing hillsides	Low Open Forest	Sydney Red Gum - Turpentine – Bangalay (*A. Costata - Syncarpia glomulifera - E. botryoides*)
Ridges, plateaux and dry exposed hillsides	Forest	Red Bloodwood – Blakely (*E. Gummifera - E. sclerophylla*)
Rocky outcrops	Scrub	Tick Bush (*Kunzea ambigua*)
Moist sites along lower Wolli Creek	Grassland	Common Reed (*Phragmites australis*)
Saltmarsh areas, lower Wolli Creek	Sedgeland	Sea Rush (*Juncus krausii*)
Saltmarsh areas, lower Wolli Creek	Herbland	Austral Seablite - Common Reed (*Suaeda australia - Phragmites australis*)
		Samphire - Common Reed (*Sarcocornia quinqueflora - Phragmites australis*)
		Samphire – Street Arrow-grass (*S. Quinqueflora - Triglochin striata*)

(Source: Total Environment Centre, 1995b)

At Marrickville the Cooks River follows a narrow valley with steep Hawkesbury Sandstone slopes. Prior to European settlement, Blackbutt (*Eucalyptus pilularis*) forest with a typically sclerophyllous understorey of shrubs predominated in this area.

There are still some remaining Blackbutts in Marrickville Golf Course. Swamp Oak (*Casuarina glauca*) forest was also common along the River, with mature trees occurring in Marrickville Golf Course, as well as many younger plantings (Benson and Howell, 1990; Total Environment Centre, 1995b).

Weeds

One of the major impacts on the riparian vegetation of the Cooks River Catchment is the spread of exotic species. Weeds are encouraged by poor water quality which provides sediment deposits on which they may establish and high nutrient concentrations. The major weed species within the catchment include (Bankstown City Council, 1997):

- Noxious Weeds - terrestrial noxious weeds which are prevalent in Bankstown are Blackberry, Castor Oil, Green Cestrum, and Lantana, which are spread across Bankstown. The remaining terrestrial noxious weeds include Pampas Grass, Prickly Pear, Pellitory of the Wall and Rhus Tree which are limited in area, on private and Council land. There are however serious infestations of Pampas Grass on State Government Land at Chullora and Yagoona (Bankstown City Council 1997); and
- Other Weeds - The major environmental weeds impacting on bushland areas have been identified as Asparagus Fern, African Love Grass, African Olive, buffalo Grass, Bridal Creeper, Canna Lily, Cape Ivy, Carpet Grass, Cobblers Peg, Couch, Crofton Weed, Fennel, Honeysuckle, *Juncus acutus*, Kalanchloe, Kikuyu, Madiera Vine, Morning Glory, Moth Vine, Ochna, Paddys Lucerne, Pigeon Grass, Purple Top, Small-leaved privet, Turkey Rhubarb, Wandering Jew.

These weeds typically outcompete native species, and degrade the ecological values of wetlands, remnant bushland and riparian zones.

Terrestrial Fauna

Terrestrial fauna species in the Cooks River catchment are considered to be typical of most Sydney urban catchments. Pressures on native fauna and their habitats as a result of land clearing, intense development, recreation use, introduced fauna, pollution, draining and filling of wetlands, and fluctuating fire regimes have greatly reduced species diversity (Clouston, 1997a).

Terrestrial fauna species that use the Cooks River catchment as habitat include a variety of birds (such as Superb Fairy-wrens and New Holland Honeyeaters), Grey-headed Flying-Fox, Common Brushtail Possums, the Bush Rat, bats, lizards (such as the Common Blue Tongue) and frogs (such as the Striped Marsh Frog, the Common Foglet and the Green and Golden Bell Frog).

The Green and Golden Bell Frog is a species of state significance being listed as 'endangered' pursuant to the *Threatened Species Conservation Act (1995)*. The Green and Golden Bell Frog has been found at the Enfield Marshalling Yards, Coxs Creek Reserve, Brickpits on Punchbowl Road, Eve Street Wetlands, and the Rockdale Wetlands.