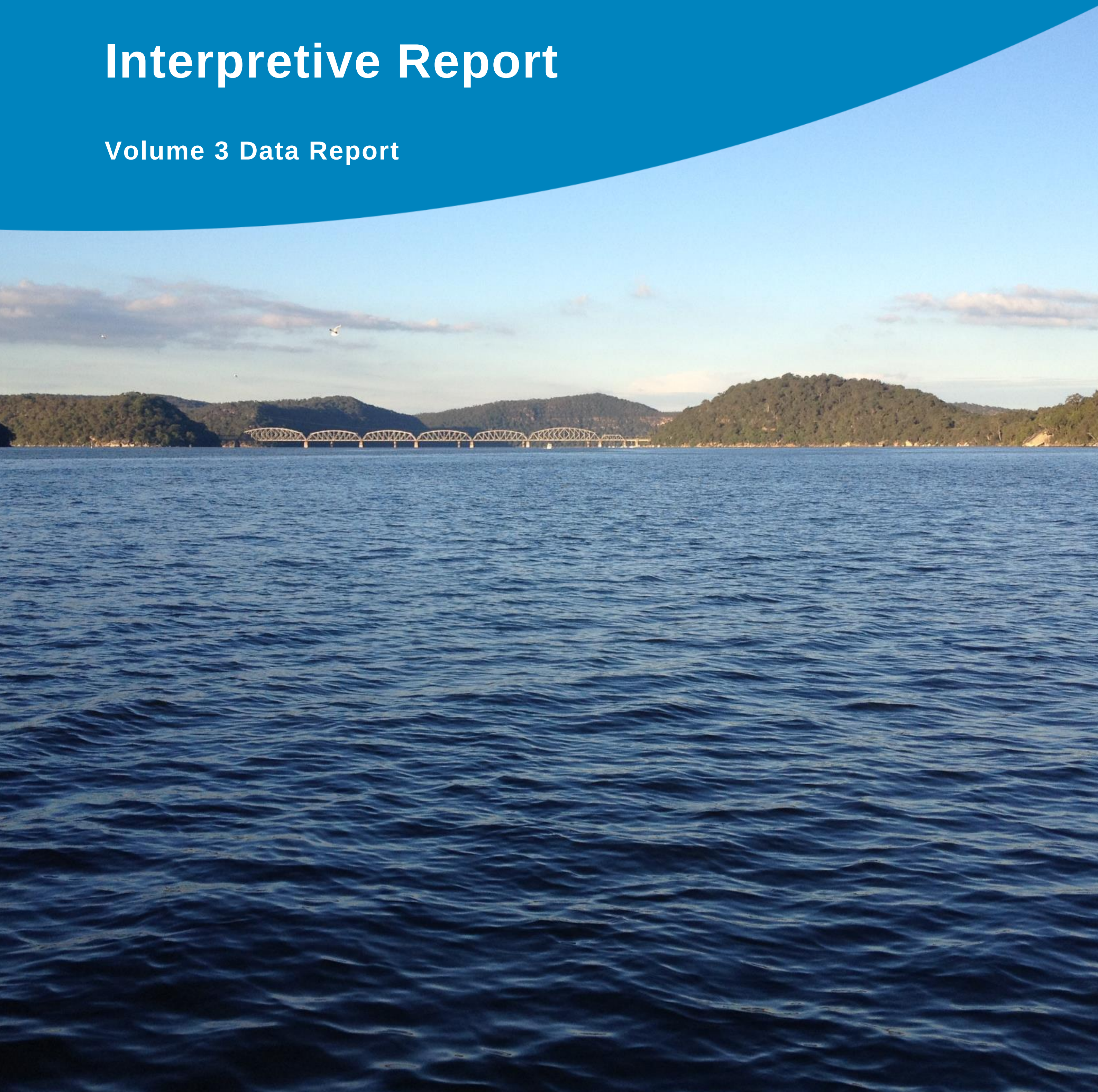
2014 Sewage Treatment System Impact Monitoring Program

Interpretive Report

Volume 3 Data Report



Foreword

This report forms Volume 3 (of four) for the 2014 Sewage Treatment System Impact Monitoring Program (STSIMP). The 2013-14 data report provides an integrated summary of monitoring data collected under the program in 2013-14 and presents generalised year to year trends and exceptions.

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1 Data report

1.1 Introduction

The STSIMP annual Data Report 2013-14 provides an integrated summary of wastewater discharge quality, quantity and load data for key pollutants with respect to regulatory limits. It also provides a summary of wastewater overflows and recycled water data. Comparison of environmental data (receiving water quality and biota) to established guidelines or protocols allow Sydney Water to determine the general status of each monitoring site as part of our environmental assessment of our wastewater operations.

This Data Report forms Volume 3 of the 2014 STSIMP Interpretive Report prepared once every three years.

The key objectives of this Data Report (2013-14) are:

- to present yearly wastewater discharge quantity and quality data with reference to Environment Protection Licence (EPL) limits
- to present the year to year changes in wastewater pollutant concentrations and loads over last ten years
- to provide yearly receiving water quality and ecosystem health statuses at various ocean and inland monitoring sites
- to present wastewater overflow and recycled water data and briefly describe the programs.

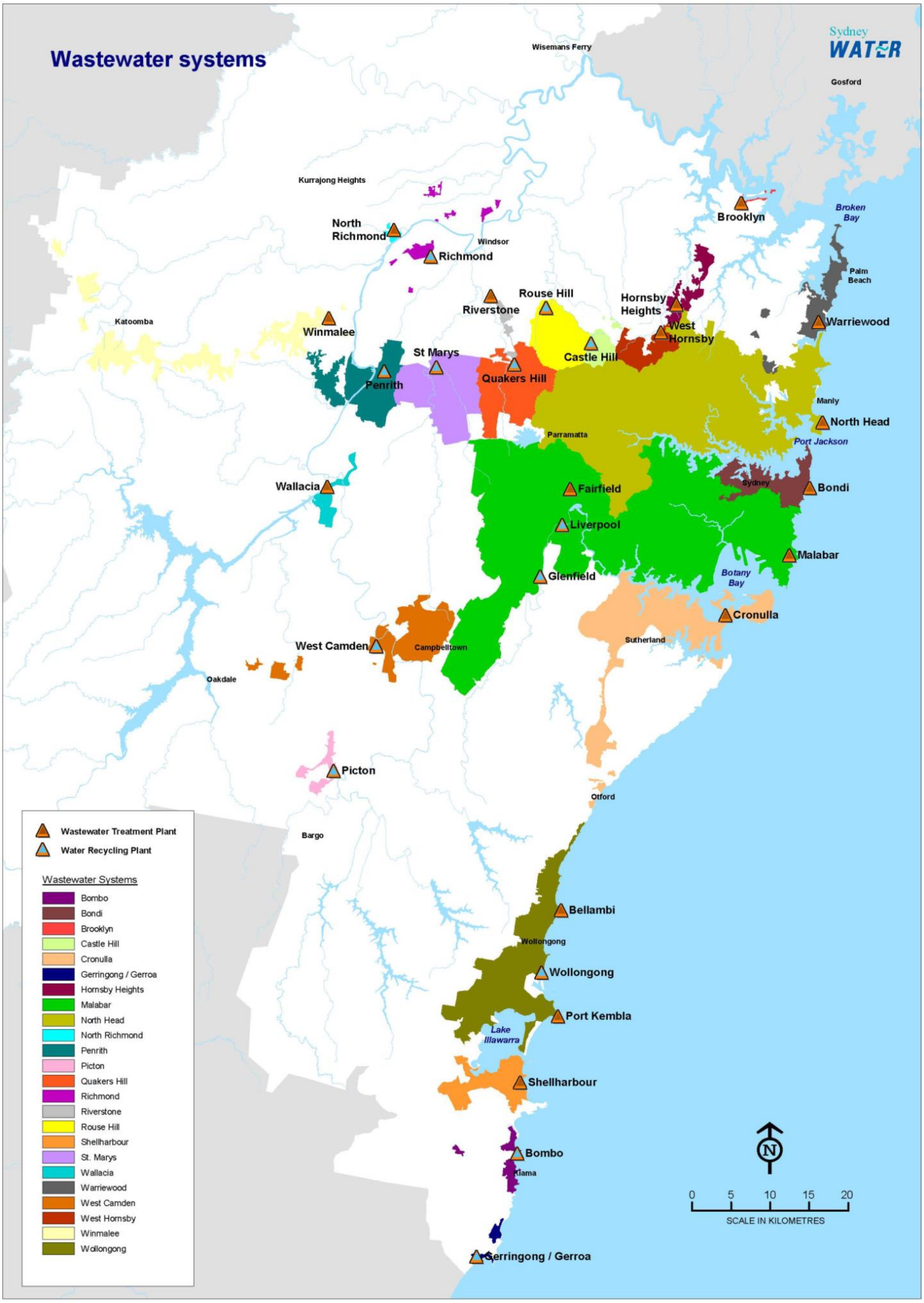
1.2 Monitoring program

The Sewage Treatment System Impact Monitoring Program (STSIMP) was developed in consultation with the Office of Environment and Heritage (OEH) and implemented from July 2008, to monitor Sydney's waterways (Sydney Water 2008). The program was endorsed by the NSW Environment Protection Authority (EPA) in 2008 with a slight amendment to one of its sub-programs in 2010 (Sydney Water 2010).

The STSIMP has been designed to quantify and evaluate the effects of our operations on the environment, as required by licences. The indicators selected are based on current knowledge of the relationship between pollutants and ecological or human health impacts. The program is consistent with national water quality guidelines (ANZECC 2000) and NSW State of the Environment reporting, as well as the objectives of previous monitoring programs undertaken by Sydney Water, NSW OEH and other agencies.

The EPLs have referenced the STSIMP to specify environmental monitoring and reporting requirements for Sydney Water's wastewater operations. There is one licence for each of the 23 wastewater systems currently operated across the greater Sydney, Blue Mountains and Illawarra region (Figure 1-1). Each EPL also directly specifies other types of monitoring requirements such as wastewater discharge quantity and quality, as well as performance standards. Sydney Water is required to prepare annual reports on monitoring from all of these programs to assess our environmental performance in relation to the EPLs issued by the EPA.

A summary of all wastewater and environmental monitoring programs including the rationale behind each program, indicators, frequency and monitoring history is provided in Table 1-1.



Note: Gerringong/Gerroa system is included for completeness. The licence is held by Veolia Water

Figure 1-1 Wastewater systems showing location of plants

Table 1-1 Details of the monitoring program

Wastewater catchment or receiving water	Sydney Water activities	Operating plants	Monitoring program and rationale	Monitoring requirements
Ocean, beaches, estuaries and lagoons	Treated wastewater discharges (near shore and offshore), partially treated wastewater discharge events and wastewater overflows	Thirteen plants: North Head Bondi Malabar Fairfield Glenfield Liverpool Warriewood Cronulla Wollongong Shellharbour Bombo Bellambi Port Kembla	Wastewater quantity, quality and toxicity: To measure plant performance, compliance limits on discharge volumes and pollutant loads	All plants: All plants*: in-situ* on line monitoring, volume of discharges (treated and partially treated), carbonaceous BOD, oil and grease, suspended solids, every six days; toxicity testing by sea urchin sperm and eggs, every month; metal and organic contaminants: every fortnight where applicable. Minor plant specific variations and other requirements as per EPL.
			Ocean reference station: To estimate the impact of ocean outfalls on water quality. Measures ocean currents and stratification, which are used as input to the deepwater ocean outfall models.	Numerical modelling: Prediction of dispersion of the wastewater plume using ocean reference centre data.
			Ocean sediment program: To measure impacts on marine benthic organisms and sediments	Benthic community and associated contaminants in sediments: Eighteen sites, surveillance once each year and assessment every third year. Two sites adjacent to each of the three deepwater ocean outfalls with five-replicate sediment grab samples per site. Two sites at each of three reference locations, with five-replicate sediment grab samples per site. With a further two sites at each of three locations at 2 km intervals from Malabar outfall to determine any gradient of impact, also with five replicates.
			Shellharbour shoreline outfall program: To estimate the impact on ecosystem health due to shoreline discharges of wastewater	Composition and abundance of intertidal biota: Three sites in the Illawarra catchments: once every year.
			Beach Suitability Grades: Estimate Beach Suitability Grades, combined	Sanitary inspection and Enterococci: Sydney ocean beaches (39 sites)

Wastewater catchment or receiving water	Sydney Water activities	Operating plants	Monitoring program and rationale	Monitoring requirements
			impact from all catchment sources	Sydney harbours (55 sites) Illawarra region (20 sites) Some sites every six days, others every six days during October to April and monthly during rest of the year. Sydney Water only monitors the Illawarra region and the Sydney lagoons, other data is provided by OEH.
			Urban rivers, estuaries and lagoons: Chlorophyll *a* Estimate trophic status, combined impact from all catchment sources	Chlorophyll *a*: Sydney lagoons (7 sites) Urban rivers and estuaries (16 sites) Monthly
			Urban rivers: Freshwater macroinvertebrates: Estimate ecosystem health status, combined impact from all catchment sources	Major rivers feeding the Sydney estuary: Ten sites, two times per year, macroinvertebrates, calculation of SIGNAL-SG biotic index.
			Sydney estuarine intertidal communities: Estimate ecosystem health status, combined impact from all catchment sources	Port Jackson, Botany Bay, Port Hacking: Twenty-six sites, once per year (spring/ summer).
Hawkesbury Nepean River and tributaries	Treated wastewater discharges, partially treated wastewater discharge events and wastewater overflows	Fifteen plants: Picton West Camden Wallacia Penrith Winmalee North Richmond Richmond St Marys Quakers Hill	Wastewater quantity, quality and toxicity: To measure plant performance, compliance limits on discharge volumes and pollutant loads	All plants: All plants: *in-situ* on line monitoring, volume of discharges (treated and partially treated), Wastewater quality: ammonia nitrogen, total nitrogen, total phosphorus, residual chlorine (for plants with disinfection systems), faecal coliforms, suspended solids and carbonaceous BOD, every six days; toxicity testing with *Ceriodaphnia dubia*, every month; metal and organic contaminants, every month. Minor plant specific variations and other requirements as per EPL.

Wastewater catchment or receiving water	Sydney Water activities	Operating plants	Monitoring program and rationale	Monitoring requirements
		Riverstone Castle Hill Rouse Hill Hornsby Heights West Hornsby Brooklyn	Hawkesbury Nepean River: Nutrients, chlorophyll *a* and algae Estimate trophic statuses, nutrient and algal dynamics, combined impact from all catchment sources	Hawkesbury Nepean River and tributaries: Eighteen sites, every three weeks; chlorophyll *a*, algal identification and counting triggered by elevated chlorophyll *a* (7 µg/L), associated nutrients and physico-chemical measurements.
			Hawkesbury Nepean River: Freshwater macroinvertebrates Estimate ecosystem health status, targeted study to assess the impact of wastewater discharges	Hawkesbury Nepean River and tributaries: Forty-two sites, twice per year; macroinvertebrates, calculation of SIGNAL-SG biotic index, upstream and downstream of plants.
All ocean and inland catchments	Wastewater overflows from distribution networks	All	Dry weather overflows: Measure wastewater overflows during dry weather	Dry weather overflow monitoring: Determine total number of overflows and volume per SCAMP and the proportion that reach receiving waters.
		All	Wet weather overflows: Estimate wastewater overflows during wet weather	Modelling: Annual runs to determine overflow frequency and volume information.
		All	Dry weather leakage program: To find and fix sewer leaks	Dry weather leakage detection program: Assessment of 211 sewer catchments for sewer leakage.

1.3 Approach and methodology

1.3.1 Data collation

In addition to presenting the various wastewater and environmental information collected by the STSIMP, this report also uses the yearly Beach Suitability Grade summaries from NSW Office of Environment and Heritage (OEH). Rainfall data is also collated from relevant stations where required.

In general, data collected between July 2013 and June 2014 was used to assess the current year's performance. However, historical data collected over the previous ten years (where available) was also used to compare 2013-2014 performance to recent years.

1.3.2 Data analysis methods

Wastewater data

Wastewater quantity and quality data sets were used to determine the performance of each plant during 2013-14. To understand how 2013-14 compared to recent years (last 10 years) in key pollutant loads under different weather categories, the data were separated into dry and wet conditions. Daily average rainfall data of one or multiple rain gauges from relevant plant catchments were used for this purpose (Appendix A, Table 6-1).

Wet weather monitoring data were defined when any of the following specific conditions were met:

- 10 mm or more rainfall fell in the previous 24 hours (until 9am on the day of sampling)
- 21 mm or more rainfall fell in the previous 72 hours (until 9am on the day of sampling)

The remaining data was categorised as dry weather.

The load of a pollutant (oil and grease, total suspended solids, nitrogen and phosphorus, as applicable) was determined following the Load Calculation Protocol, where the total wastewater discharge volume was multiplied by the flow-weighted mean concentration of the pollutant (DECC 2009a).

The report also includes a statistical summary (number of observations, mean, median etc.) of key wastewater quantity and quality data (Appendix B, Table 6-4 to Table 6-15).

Beach Suitability Grades

Beach Suitability Grades indicate the safety of the beach for recreational purposes and are not a specific indicator of Sydney Water's activities. Sydney Water assists NSW OEH's State of Beaches Monitoring Program by collecting and sharing data, (Enterococci and sanitary inspections data), from 18 Illawarra beaches. Beach Suitability Grades provide an assessment of the suitability of a swimming location for recreation over time and are based on a combination of sanitary inspections (identification and rating of potential pollution sources at a beach) and microbial assessment (based on at least 100 Enterococci measurements).

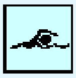
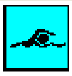
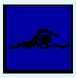
Beach Suitability Grades were determined following NHMRC (2008) guidelines using a matrix of sanitary inspection and microbial assessment data (Table 1-2). The grades for all Sydney beaches and harbour sites were supplied by the NSW OEH. The detailed method of calculating the Beach Suitability Grades can be found in the OEH website State of the Beaches Report (http://www.environment.nsw.gov.au/beach/Reportann.htm).

Table 1-2 Beach Suitability Grades

		Microbial assessment categories based on 95th percentile Enterococci, cfu/100mL			
		≤40 A	41-200 B	201-500 C	>500 D
Sanitary inspection categories	**Very low**	Very good	Very good	Follow up	Follow up
	Low	Very good	Good	Follow up	Follow up
	Moderate	Good	Good	Poor	Poor
	High	Good	Fair	Poor	Very poor
	Very high	Follow up	Fair	Poor	Very poor

The 2013-14 Beach Suitability Grades for all sites are included in Appendix C, Table 6-16 to Table 6-19.

The rating for each monitoring site is presented on page 14 'Beach Suitability Grades', page 31 'Beach Suitability Grades: Illawarra beaches' and page 38 'Beach Suitability Grades: Other estuarine and harbour sites', with three broad categories (shown below) based on the above grades.

Map colour	Beach Suitability Grades
	Very good and Good
	Fair
	Poor, Very poor and Follow up

Ratings on biota data

To fulfil the STSIMP aim of quantifying and evaluating the impact of our wastewater operations on the environment requires two types of assessment. One type is the assessment of ecological communities near wastewater discharges. The second type is the assessment of the general condition of ecological communities.

The type of biota assessed is dependent on the water type. That is fresh, estuarine or oceanic. The type of biota and the type of assessment required influenced the range of techniques used. These techniques are briefly outlined below. Greater detail of these techniques is outlined in Section 2 Testing of Shellharbour rocky intertidal assemblages, Section 4 Freshwater macroinvertebrates and Volume 4 Ocean Sediment Program report.

Freshwater biota assessed at inland plants

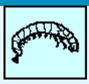
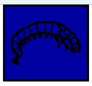
Typically, we monitor biota upstream and downstream of treated wastewater discharge pipes. This is done to determine if stream health was altered by wastewater discharges from water recycling plants or wastewater treatment plants.

Upstream and downstream (paired site) comparisons allow separation of other potential upstream catchment water quality disturbances from that of treated wastewater discharge on stream health. Upstream catchment influences include stormwater pollution. This water quality disturbance influences the health of urban and rural streams. An outline of the impact from urban and rural stormwater is presented in the next section (Freshwater biota assessed at single sites).

Paired upstream and downstream sites were located near the discharge pipe on the stream that received the discharge. In the case of the North Richmond, Penrith and West Camden plants, streams to which they discharged were not far from the Hawkesbury Nepean River. In those cases secondary paired assessment sites were placed above (upstream) and below (downstream) the junction (confluence) of the discharge stream with the Hawkesbury Nepean River.

Freshwater macroinvertebrates were monitored as a surrogate measure of stream health at site pairs for 12 plants (Castle Hill, Hornsby Heights, Quakers Hill, North Richmond, Penrith, Riverstone, Rouse Hill, St Marys, Wallacia, West Camden, West Hornsby and Winmalee). These streams were in rural or urban areas of the Hawkesbury Nepean catchment.

Assessment of stream health for each pair of sites had two possible outcomes. Either stream health at the downstream site was maintained within the range recorded for the upstream site or the downstream site differed from this range as outlined below.

Map colour	Health ratings	Criteria
	No measurable impact	SIGNAL-SG similar in upstream and downstream sites. No significant differences
	Measureable impact	SIGNAL-SG differs significantly with lower score in downstream site compared with upstream sites

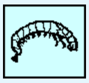
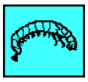
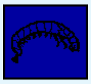
Freshwater biota assessed at single sites

Freshwater macroinvertebrate community composition has been associated with the amount of urban development. Most sensitive taxa are absent from urban sites with greater than 20% connection of hard (impervious) surfaces to streams by pipes (Walsh, 2004). The direct connection of hard (impervious) surfaces, such as roofs, gutters, roads, paths and car parks, to a stream allows small rainfall events to produce surface runoff that causes frequent disturbance to the stream through regular delivery of water and pollutants (Walsh et al. 2005a). As such, some impairment in water quality is expected when monitoring streams in urban areas.

Another potential influence on the health of urban streams is large, frequently occurring sewer overflows. Smaller and less frequent overflows had similar impacts on stream health to urban stormwater influences. As such the influence of large frequent sewer overflows cannot be ruled out as part of the degradation in stream health.

Four urban sites were monitored to assess the general condition of stream health. Three of these sites are situated in urban areas just upstream of estuarine limits of the Parramatta River, Lane Cove River and Georges River. The fourth urban site is situated about 5 km further up in the Georges River. The placement of these sites at the bottom of catchments provided information on the overall general catchment condition.

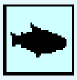
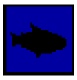
A number of reference sites around greater Sydney were monitored to define the level of natural variation of macroinvertebrate communities in streams of bushland areas without urban or rural influences on water quality. This information was, and continues to be used to calibrate the stream health SIGNAL-SG biotic index assessment tool (Chessman et al. 2007). The range of scores for natural water quality status and pollution categories is shown below.

Map colour	Health ratings	Criteria
	Natural water quality	SIGNAL-SG score > 6.5
	Mild water pollution	SIGNAL-SG score < 6.5 to 5.1
	Moderate water pollution	SIGNAL-SG score < 5.1

Shoreline outfall program intertidal biota

Monitoring of tidally inundated rocky-intertidal communities under the shoreline outfall program assesses potential ecological impact from wastewater, which discharges into the near shore ocean environment. Shellharbour was the only plant that could be measured under this program, as health and safety risks prevented sampling at four other ocean outfalls of Bombo, Cronulla, Diamond Bay and Warriewood. The structures of natural communities (without human activity impacts) from two reference (control) sites were used in assessment of the outfall site. The Shellharbour outfall site was situated about 2 km north of the two reference sites. The reference sites were situated about 400 m apart.

The PERMANOVA statistical test (Anderson et al. 2008) was used to investigate potential community structure differences between reference sites and the outfall site. The criteria used to assess the statistical test outcomes are listed below.

Map colour	Health ratings	Criteria
	No measurable impact	Any variation to below statistical test outcome
	Measurable impact	PERMANOVA indicate significant difference between both reference sites and outfall test site and there is no significant difference between reference sites

Water quality ratings

The health of rivers and estuaries was estimated by using chlorophyll *a*, an indicator of planktonic algal biomass, and other water quality variables (available for the Hawkesbury Nepean River only) such as total nitrogen, total phosphorus and cyanobacteria (blue-green algae).

Dry weather water quality data was assessed against the guideline values for water quality objectives for nutrients and cyanobacteria alert levels for recreational water. Daily average rainfall data of one or multiple rain gauges from relevant site catchments were used for this purpose (Appendix A, Table 6-2).

Wet weather monitoring data were defined when any of the following specific conditions were met:

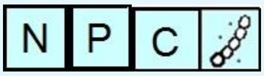
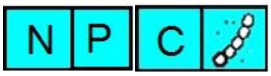
- 10 mm or more rainfall fell in the previous 24 hours (until 9am on the day of sampling)
- 21 mm or more rainfall fell in the previous 72 hours (until 9am on the day of sampling)

The remaining data was categorised as dry weather.

The summary statistics for 2013-14 dry and wet weather data are presented in Appendix G and Appendix H.

The Hawkesbury Nepean River water quality ratings for the last ten years (since 2003-04) were determined using dry weather data of four key variables: total nitrogen, total phosphorus, chlorophyll *a* and cyanobacteria. Each monitoring site was rated on the basis of percentage of time the data exceeded the site-specific guideline for each variable (Appendix A, Table 6-3). The cyanobacteria ratings were determined based on percentage of time when there were no alerts (green, amber or red).

The final water quality ratings were determined (Appendix H, Table 6-34 and Table 6-35) based on the percentage within the guideline or alert level for each site over the year as shown below:

Map colour	Water quality ratings	Within the guideline/alert values*
	Good	≥75%
	Fair	≤40% and < 75%
	Poor	< 40%

* Actual guideline to calculate this water quality ratings are in Appendix A (Table 6-3)

For lagoons and estuarine sites the only available variable was chlorophyll *a* to determine the percentage within the guideline level.

1.3.3 Useful definitions

Sewage

Sewage is a traditional term used by Sydney Water and others. To represent it more accurately, it has been replaced by 'wastewater' to include all types of used water being treated by Sydney Water's wastewater treatment facilities.

Wastewater discharges and key pollutant loads

The total volume of wastewater discharged by a plant or catchment is determined by adding together all regular discharges (fully treated) and discharges from partial treatment discharge events (also called bypasses).

Similarly, the key pollutant loads to the environment are calculated from the total volume of regular discharges and discharges from partial treatment events and the respective average concentrations of pollutants.

A partial treatment discharge event means a circumstance where wastewater has been received at the plant but is discharged from the plant without being fully treated, processed or reprocessed by any or all of the treatment processes at the plant.

Dry weather sewage overflows

The dry weather sewage overflow volumes discussed in this report, (page 55 under 'Wastewater overflows'), include discharges to property and waterways due to blockage.

Wet weather sewage overflows

The wet weather sewage overflows from sewer pipes occur in wet weather where the hydraulic capacity of the sewer is exceeded due to rainwater ingress. These overflows are controlled to discharge from designated overflow structures to waterways so that wastewater does not back up in pipes and discharge to properties or homes. The selected discharge points are chosen carefully to cause the least impact to local environment.

Recycled water

The recycled water volumes discussed in this report are the total volumes of treated wastewater supplied elsewhere for reuse and the volume of water released to the Hawkesbury Nepean River as a substitute for environmental flows from Warragamba Dam. It does not include on-site reuse of treated wastewater at plants.

Disturbance and impact

For the purpose of this report we have adopted two specific definitions from the scientific literature for ‘disturbance’ and ‘impact’. These definitions were derived from Underwood and Chapman (1995), Downes et al. (2002) and Morris and Therival (2009).

In relation to Sydney Water activities, a water quality disturbance occurs from discharge into receiving waters such as a creek, river, estuary and ocean. Disturbance can be shown by a recorded change in the chemistry of the receiving waters, such as an increased concentration of a nutrient.

A water quality disturbance does not always cause a change in the structure of an ecological community; the concentration of a contaminant may be below the threshold concentration required to trigger ecological change. In the ANZECC (2000) guidelines this is described under the wording ‘threshold concentrations’. In this way a water quality disturbance can occur without a measurable ecological impact.

Where the concentration of a chemical in the water quality disturbance exceeds a threshold concentration, an impact in a nearby ecological community structure may become measurable when compared to ecological communities at more distant (or upstream) reference locations.

1.4 Results

1.4.1 Treated wastewater discharges: Ocean plants

The treated wastewater discharged by the ocean plants in 2013-14 and the population serviced by these plants are shown in Table 1-3. The trend in wastewater inflow volume to all ocean plants and the treated wastewater discharges to the environment for the last 10 years are shown in Appendix B (Table 6-11).

Table 1-3 Ocean plants operated by Sydney Water

Plants	Treatment level	Discharge 2013-14 (ML/year)	Projected population 2013-14#	Discharge type	Discharge location
North Head	Primary	123,645	1,256,454	Deepwater	North Head Deep Ocean outfall, 3.7 km from shoreline, 65 m maximum water depth, 762 m diffuser zone
Bondi	Primary	46,009	300,138	Deepwater	Bondi Deep Ocean outfall; 2.2 km from shoreline, 63 m maximum water depth, 512 m diffuser zone
Malabar**	Primary	174,679	1,475,804	Deepwater	Malabar Deep Ocean outfall, 3.6 km from shoreline, 82 m maximum water depth, 720 m diffuser zone
Fairfield	Primary	417	0*	Discharged to Georges River	Treated wastewater discharged to Orphan School Creek (to Georges River) during wet weather.
Glenfield	Secondary and disinfection	0	158,106	Transfer to Malabar or discharged to Georges River	Treated wastewater transported to Malabar, occasionally discharged to Georges River in wet weather.
Liverpool	Secondary and disinfection	664	78,982	As above	As above.
Warriewood	Secondary and disinfection	6,477	68,331	Shoreline	Turimetta Head
Cronulla	Tertiary and disinfection	21,094	232,155	Shoreline	Potter Point
Wollongong	Tertiary and disinfection	13,616	196,270	Near shore	Ocean outfall, Coniston Beach
Bellambi***	Primary	302	0*	Near shore	Bellambi Point
Port Kembla***	Primary	496	0*	Shoreline	Red Point
Shellharbour	Secondary and disinfection	6,552	68,519	Near shore	Ocean outfall, Shellharbour Beach
Bombo	Secondary, denitrification and disinfection	1,483	14,545	Shoreline	Ocean outfall; Bombo Point

* Plants not directly servicing any households.

** Malabar discharge includes transfer from Liverpool, Glenfield and Fairfield plants.

*** Part of Wollongong system. Treated wastewater is discharged during wet weather only.

\# Projected populations are based on forecasts by the Australian Bureau of Statistics and the Department of Planning.

Wastewater volume

In 2013-14, our ocean plants received 405,127 ML of wastewater with 395,436 ML discharged into the ocean including the Georges River. The balance was the volume of treated wastewater used for different recycled water schemes including the Rosehill Camellia Recycling Water Scheme.

The ocean plant discharge includes storm flows from the Georges River plants within the Malabar system. Discharge to ocean constitutes about 90.5% of total treated wastewater discharges from all our plants. The remaining 9.5% is discharged to the Hawkesbury Nepean River from inland plants.

Rainfall over the previous ten years in ocean plant catchments is shown in Figure 1-2. After three consecutive years of above average rainfall, last year (2013-14) was typically dry with below average rainfall generally spread across the year. The increased rainfall generated stormwater runoff and can trigger discharges from wastewater transport and treatment systems as the capacity of pipes and some treatment processes are exceeded. These all contribute to pollution of waterways.

The trends in volume of wastewater inflow, treated wastewater discharges from our ocean plants along with yearly catchments rainfall is shown in Figure 1-2. A more detailed table of treated wastewater discharge volumes from our ocean plants is provided in Appendix B (Table 6-6).

Of the treated wastewater discharged to the ocean, the three major ocean plants (Malabar, North Head and Bondi) discharged 87% and the three Illawarra plants discharged 7%. The remaining 6% was discharged by the Cronulla and Warriewood plants. The Wollongong plant is the largest in the Illawarra area and receives flows from Bellambi and Port Kembla plants.

The volume of wastewater that was partially treated in wet weather (did not receive full treatment for all flows, Clause O4.1) in 2013-14 was much less than that of last year's volume (2012-13). It was about one third in comparison to previous year's volume (from 1,418 ML to 492 ML). These events occurred at North Head, Bondi, Warriewood, Wollongong, Shellharbour and Bombo systems.

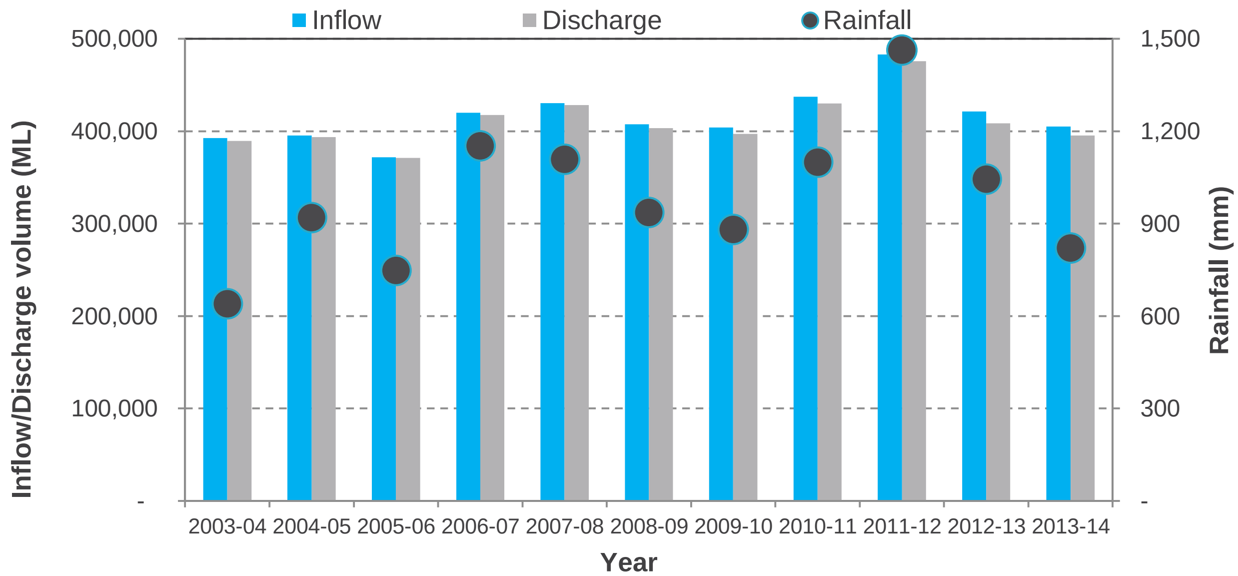


Figure 1-2 Wastewater inflows and discharge volumes for the previous ten years from all ocean plants and rainfall in the ocean catchments

Key pollutant loads

The previous ten years oil and grease and total suspended solids loads from all ocean plants (including Georges River plants) are shown in Figure 1-3 and Figure 1-4, respectively. In 2013-14, 11,621 tonnes of oil and grease and 53,903 tonnes of total suspended solids were discharged from all ocean plants. These loads were mostly discharged via the deepwater ocean outfall plants at Malabar, Bondi and North Head.

Oil and grease and total suspended solids loads discharged to the ocean were all within the limits permitted under the EPL for each plant.

The dry weather load of oil and grease load was higher during 2013-14 in comparison to 2012-13 and any other year. In contrast, suspended solids loads were slightly less during 2013-14. During 2013-14, all Sydney Water's ocean plants operated as usual without any failure on compliance. The increase in yearly dry weather oil and grease load actually reflected the higher concentration of oil and grease in influent in couple of large systems. The mean concentrations of oil and grease increased by 25% and 32% in 2013-14 in comparison to 2012-13 in Malabar and North Head system, respectively.

The wet weather loads of these key pollutants were less than last year as expected due to less rainfall, resulting in lower volumes of water being received by the plant. A summary of oil and grease loads and total suspended solids loads by each plant and weather conditions over the last ten years is included in Appendix B (Table 6-7 and Table 6-8).

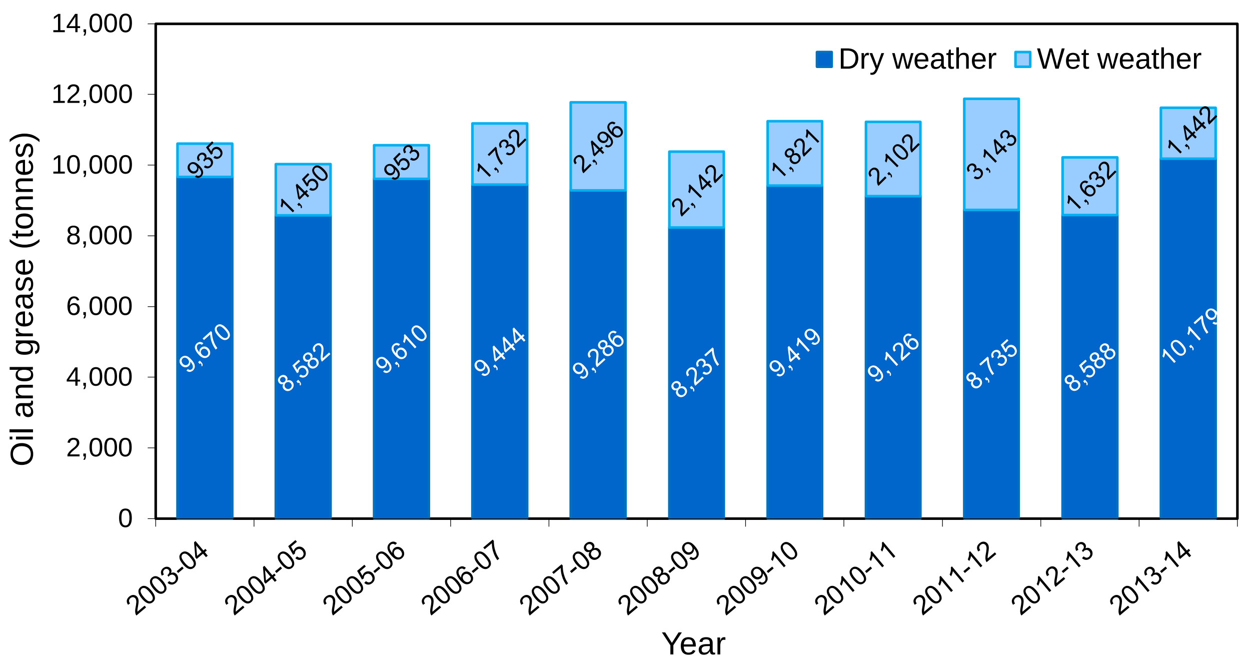


Figure 1-3 Previous ten years of oil and grease loads from all ocean plants

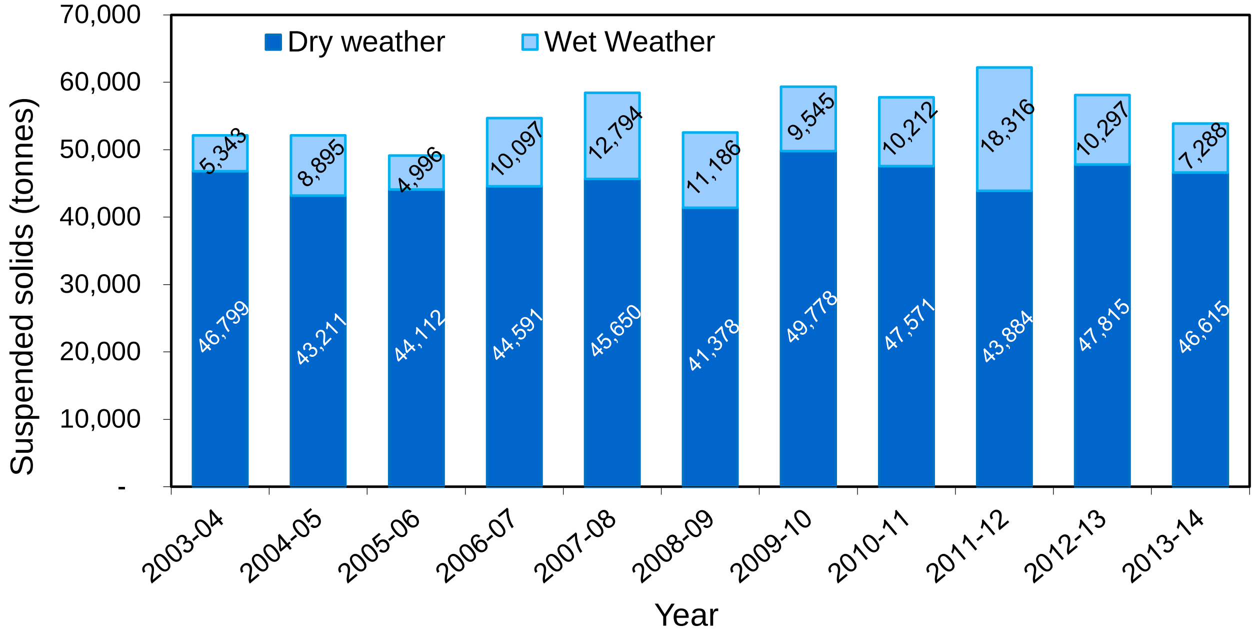


Figure 1-4 Previous ten years of total suspended solids loads from all ocean plants

Pollutant concentrations

Oil and grease and total suspended solids are the key pollutants for which there are treatment processes at the major ocean plants. Last year (2013-14) was exceptionally good with no exceedances on EPL conditions for any of the pollutants.

In 2013-14, all median and 90th percentile oil and grease and total suspended solids results for ocean plants were below the concentration limits (Table 1-4). There were also no breaches of concentration limits for metals (eg aluminium, copper or zinc), chemicals (eg diazinon, nonyl phenol ethoxylate) or other contaminants (ammonia nitrogen, BOD etc) as specified in the EPLs.

A more detailed presentation of the wastewater quality data from all ocean plants compared with EPL limits can be found on our website http://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/waterquality/epa-reports/wastewater-treatment-plants/index.htm

Historical wastewater discharge data, including oil and grease and total suspended solids concentrations monitored from 2003-04 to 2013-14 for all ocean plants are presented in Appendix B (Table 6-10).

Table 1-4 Comparison of oil and grease and total suspended solids concentrations in ocean plant discharges with EPL limits for 2013-14

Plants	Oil and grease (mg/L)				Total suspended solids (mg/L)			
	50th percentile limit	50th percentile results	90th percentile limit	90th percentile results	50th percentile limit	50th percentile results	90th percentile limit	90th percentile results
North Head	45	40	70	43	200	190	250	230
Bondi	40	38	50	39	200	110	250	130
Malabar	40	33	60	38	250	150	300	180
Fairfield	NA	<5	NA	12	NA	36	120*	67*
Glenfield	NA	-	NA	-	NA	-	100*	-
Liverpool	NA	<5	NA	6	NA	16	100*	72*
Warriewood	NA	<5	NA	<5	30	3	40**	6**
Cronulla	5	<5	8	<5	10	<2	15	5
Wollongong	NA	<5	NA	<5	30	<2	40	2
Shellharbour	NA	<5	NA	<5	30	3	40	6
Bombo	NA	<5	NA	<5	20	4	40	8

NA = Not Applicable

* Limit and results are 100%ile or maximum value

** limits and results are 80th percentile value

Toxicity

The EPL limits for wastewater toxicity were met at all seven ocean wastewater systems (Appendix B, Table 6-4). Wollongong system does not have a monitoring or reporting requirement on toxicity.

1.4.2 Treated wastewater discharges: Inland plants

The treated wastewater discharged by the inland plants in 2013-14 and the population serviced by these plants are shown in Table 1-5. The previous ten years of wastewater inflow volume to all ocean plants and the treated wastewater discharges to the environment for the last 10 years are shown in Figure 1-5.

Wastewater volume

In 2013-14, our inland plants received 63,801 ML of wastewater for treatment. From this 41,278 ML was discharged to environment and rest of it was recycled. The recycled water volume included discharges of 14,990 ML of highly treated water from St Marys Advanced Water Treatment Plant to the Hawkesbury Nepean River.

The volume of wastewater discharged decreased by about 7% in comparison to 2012-13. The reduction in treated wastewater discharge was mainly related to lower volumes of wastewater inflow to plants.

The volume of wastewater that was partially treated in wet weather (did not receive full treatment for all flows, Clause O4.1) was slightly less during 2013-14 than the previous year (2012-13).

These events only occurred at St Marys and Winmalee plants. More details on the volume of inland wastewater discharged are presented in Appendix B (Table 6-11 and Table 6-15).

Table 1-5 Inland plants operated by Sydney Water

Plants	Treatment level	Discharge 2013-14 (ML/year)	Projected population 2013-14#	Discharge location
Picton	Tertiary and disinfection	134	10,807	Reused for onsite agricultural irrigation; wet-weather overflows to Stonequarry Creek
West Camden	Tertiary and disinfection	3,921	67,380	Matahil Creek to the Hawkesbury Nepean River
Wallacia	Tertiary and disinfection	213	4,287	Warragamba River to the Hawkesbury Nepean River
Penrith	Tertiary and disinfection	1,843	103,679	Boundary Creek to the Hawkesbury Nepean River
Winmalee	Tertiary and disinfection	6,373	60,217	Unnamed creek to the Hawkesbury Nepean River
North Richmond	Tertiary and disinfection	305	4,417	Redbank Creek to the Hawkesbury River
Richmond	Tertiary and disinfection	481	15,178	Reused for irrigation at the University of Western Sydney Richmond campus and Richmond Golf Club; excess overflows to Rickabys Creek
St Marys	Tertiary and disinfection	5,486	153,390	Unnamed creek to South Creek
Quakers Hill	Tertiary and disinfection	8,827	155,292	Breakfast Creek to Eastern Creek
Riverstone	Tertiary and disinfection	561	8,225	Eastern Creek to South Creek
Castle Hill	Tertiary and disinfection	2,068	29,241	Cattai Creek
Rouse Hill	Tertiary and disinfection	4,590	89,755	Second Ponds Creek to Cattai Creek; also reused for local recycling scheme
Hornsby Heights	Tertiary and disinfection	1,917	29,497	Calna Creek to Berowra Creek
West Hornsby	Tertiary and disinfection	4,471	56,368	Waitara Creek to Berowra Creek
Brooklyn	Tertiary and disinfection	88	1,436	Hawkesbury River at 14 m depth on the second pylon of the old road bridge adjacent to Kangaroo Point

Projected populations are based on forecasts by the Australian Bureau of Statistics and the Department of Planning

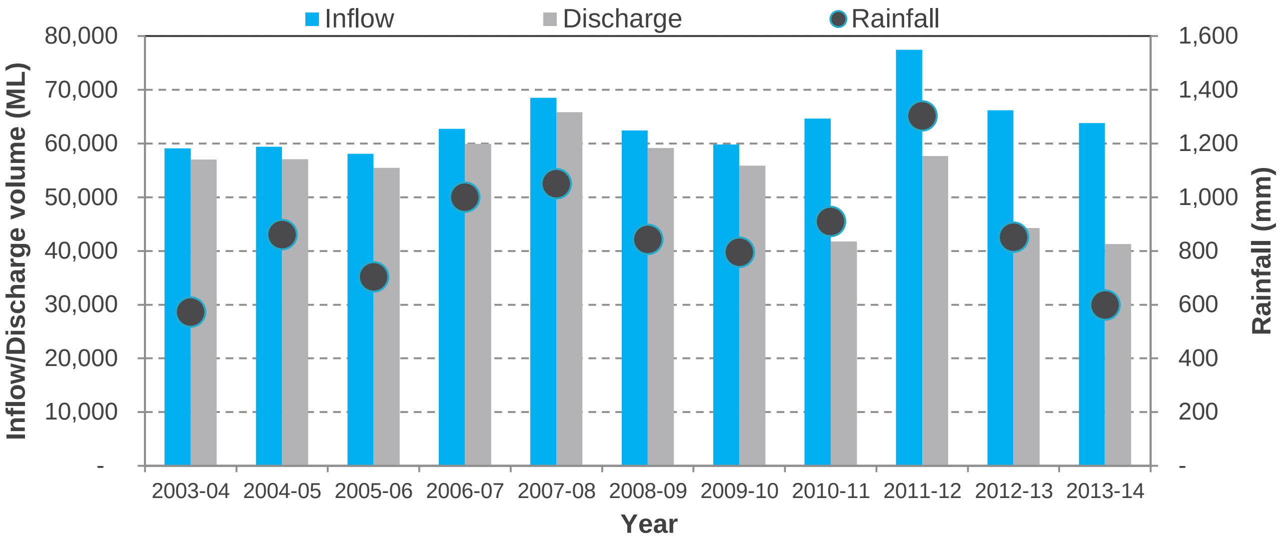


Figure 1-5 Previous ten years of wastewater inflow and discharge volumes from all inland plants and rainfall in the inland catchments

Key pollutant loads

The trends in total nitrogen and total phosphorus loads from inland plants are shown in Figure 1-6 and Figure 1-7, respectively. During 2013-14, 229 tonnes of nitrogen and 6.6 tonnes of phosphorus were discharged into streams and rivers from the inland plants. All loads were within the EPL limits. Quakers Hill, Riverstone and St Marys plants are operated to meet a shared limit for total nitrogen of 222 tonnes/year and total phosphorus of 2.3 tonnes/year. These plants performed within this shared limit.

All nutrient and other pollutant loads from inland plants complied with EPL load limits. The overall nitrogen load from all inland plants decreased 10% from 253 tonnes last year (2012-13) to 229 tonnes in 2013-14. Total phosphorus loads also decreased 43% from 11.4 tonnes in 2012-13 to 6.5 tonnes in 2013-14.

A summary of total nitrogen and total phosphorus loads by each plant and weather conditions over last ten years is included in Appendix B (Table 6-12 and Table 6-13).

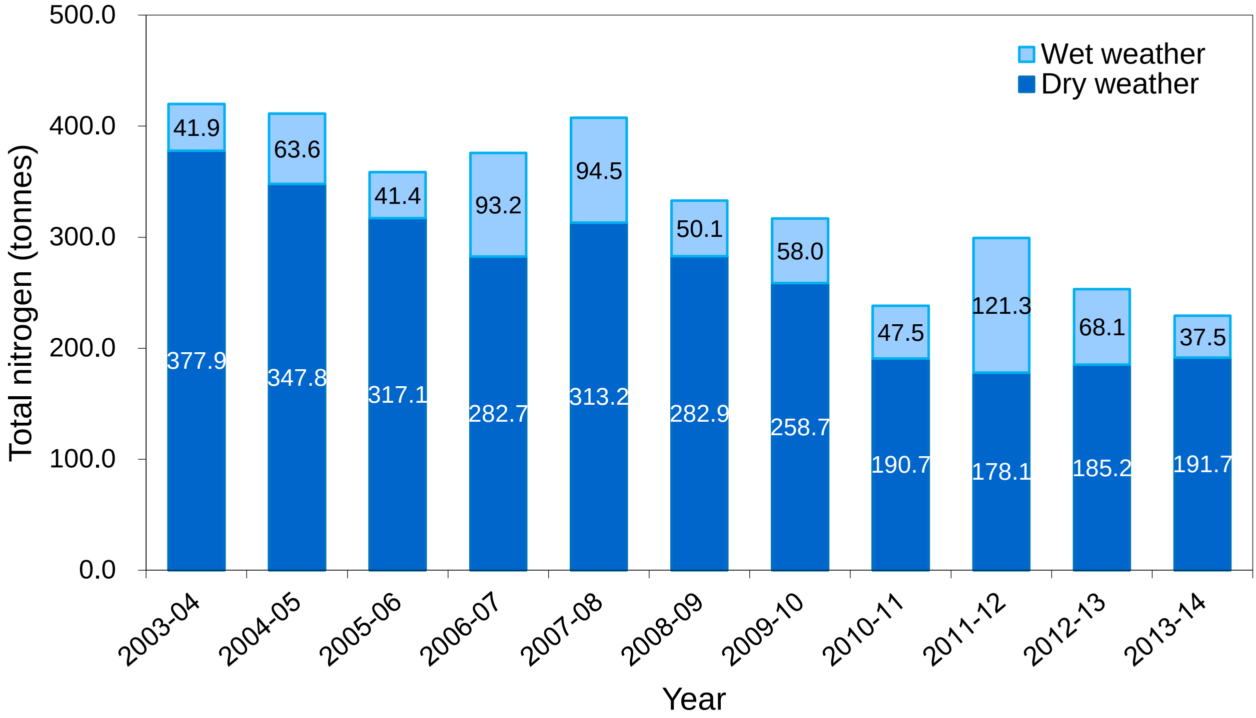


Figure 1-6 Previous ten years of total nitrogen loads from all inland plants

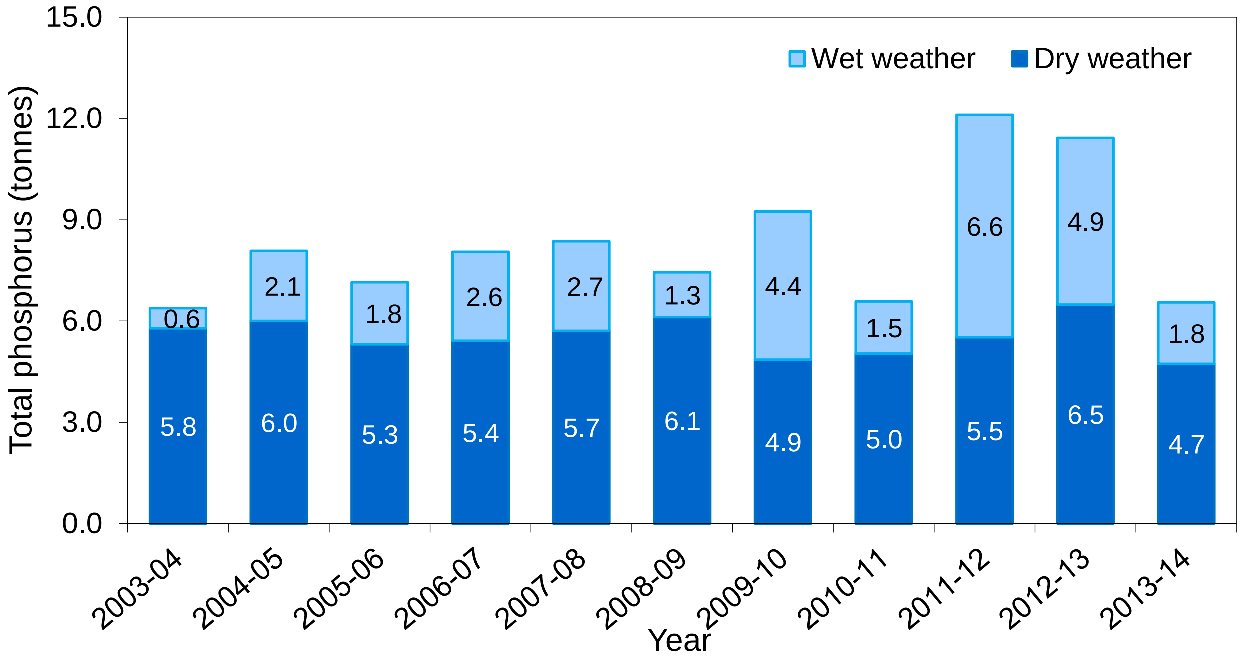


Figure 1-7 Previous ten years of total phosphorus loads from all inland plants

Pollutant concentrations

EPLs set various conditions for the operation of a plant and specify allowable levels of various contaminants in treated wastewater that is discharged.

The EPL concentration limits for total nitrogen and total phosphorus for each inland plant and performance for 2013-14 are presented in Table 1-6. The EPL limits for total nitrogen and total phosphorus were met at all inland plants. Last year (2013-14) was an exceptionally good year with no breaches of concentration limits for any pollutants as specified in the EPLs. All plants complied with concentration limits for metals (eg aluminium, zinc), chemicals (eg cyanide, diazinon), other contaminants (eg ammonia nitrogen, BOD) and bacteria (faecal coliforms) according to each EPL.

A more detailed presentation of the wastewater quality data from all inland plants compared with EPL limits can be found on the our website http://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/waterquality/epa-reports/wastewater-treatment-plants/index.htm

A statistical summary of key wastewater quantity and quality data including number of observations, mean and median is provided in Appendix B (Table 6-15).

Toxicity

The EPL limits for wastewater toxicity were met at all 14 inland plants (Appendix B, Table 6-5). Picton does not have EPL monitoring and reporting requirements on toxicity.

Table 1-6 Total nitrogen and total phosphorus concentrations in inland wastewater discharges during 2013-14 and EPL limits

Plants	Total nitrogen (mg/L)				Total phosphorus (mg/L)			
	50th percentile limit	50th percentile results	90th percentile limit	90th percentile results	50th percentile limit	50th percentile results	90th percentile limit	90th percentile results
Picton	6	3.29	10	3.43	0.2	0.02	0.4	0.03
West Camden	20	4.19	25	5.45	0.3	0.06	1	0.14
Wallacia	7.5	4.64	10	6.35	0.15	0.02	0.3	0.07
Penrith	10	3.28	15	4.52	0.2	0.07	0.4	0.13
Winmalee	10	6.2	15	7.85	2	0.44	3	0.58
North Richmond	10	5.2	15	6.07	2	0.08	5	0.12
Richmond	10	6.46	15	7.54	0.3	0.02	1	0.03
St Marys	NA	4.07	45*	6.53*	NA	0.03	5*	0.88*
Quakers Hill	NA	4.85	45*	7.15*	NA	0.06	5*	0.24*
Riverstone	NA	6.9	45*	12.4*	NA	0.03	5*	0.47*
Castle Hill	20	12.4	25	14.7	0.3	0.12	1	0.24
Rouse Hill	10	6.65	15	8.3	0.2	0.02	0.4	0.04
Hornsby Heights	10	4.31	15	9.11	0.3	0.07	1	0.27
West Hornsby	10	4.13	15	6.58	0.3	0.07	1	0.35
Brooklyn	20	3.72	30	5.55	3**	0.08	4.5	1.32

NA Not applicable
* Limit and results are 100%ile or maximum value
** Commissioning EPL limits

1.4.3 Ocean environment

Ocean receiving water

Water quality in the ocean near the deepwater outfalls was assessed using wastewater chemical concentration data and dilution factors from hydrodynamic modelling of wastewater plume dispersion. The models were calibrated and validated using both laboratory and field data. The Ocean Reference Station (ORS) provides the input data to run the models. The ORS is a oceanographic mooring that collects data on current speed and direction and stratification of the water column, all of which affect the movement and dilution of the wastewater plumes. Design criteria of the deepwater ocean outfalls was that at the boundary of the initial dilution zone the dilution exceeds 40:1 at least 98% of the time. This was met in 2013-14 with dilutions achieved of 72:1 at North Head, 89:1 at Bondi and 56:1 at Malabar.

Modelled results of 2013-14 indicate diluted wastewater chemical concentrations in the ocean near all three deepwater outfalls were below the ANZECC (2000) guidelines for the protection of 95% of marine species (Appendix F) with the exception of copper at North Head and Malabar. Modelled concentrations for copper were just over the guideline value at these two plants based on dilutions that were exceeded 98% of the time. Further context of these results is provided in Volume 4 Ocean Sediment Program report.

Shoreline outfall data

As outlined on page17 under 'Ratings on biota data', only the Shellharbour outfall site and two reference sites could be monitored under this sub-program. A detailed monitoring method and results for this program are provided in Section 2 Testing of Shellharbour rocky intertidal assemblages.

Variability in taxonomic composition of photo quadrat samples taken at the outfall site was comparable with photo quadrat samples taken from at least one control site through the study period. No fundamental shift in community structure was detected at the outfall site. In fact, samples taken at the outfall site were similar to those taken at control-site1. Statistical analysis indicated there was no measurable impact from wastewater discharges at the Shellharbour outfall at Barrack Point (Section 2).

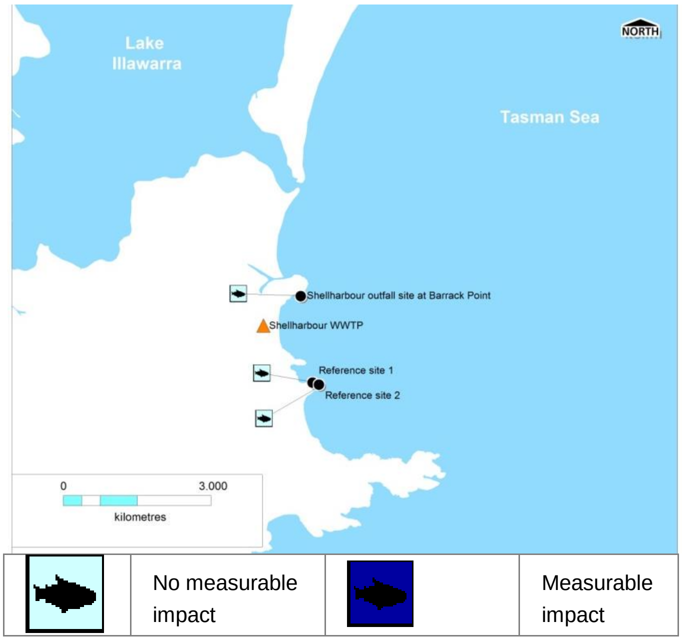


Figure 1-8 Shellharbour ecosystem health ratings

Marine benthic and sediment quality

Regular monitoring of offshore marine sediments began before Sydney's deepwater ocean outfalls were commissioned in the early 1990s. An ongoing monitoring program, the Ocean Sediment Program (OSP), became a sub program of the STSIMP. The OSP assesses how the deepwater ocean outfalls of Malabar, Bondi and North Head plants perform over the longer term. This program includes monitoring the characteristics of ocean sediment and benthic macrofaunal communities. This program is conducted on a three-year cycle, the first year is an assessment year, and the second and third years are surveillance years. Under the current cycle 2013-14 is an assessment year.

In the assessment year, we collect sediment samples from nine locations and identify and count the benthic macrofauna (small animals that live on the ocean floor). We test the sediment samples to determine concentrations of metals, organic compounds, nutrients and sediment grain size.

In 2013-14, and in all years since 1999, no accumulation of fine sediments was identified near the deepwater ocean outfall locations, and the total organic carbon (TOC) trigger level was not reached at the Malabar deepwater ocean outfall location.

Results from the most recent assessment year, 2013-14, indicated that the deepwater ocean outfalls had no measureable impact on ecosystem health based upon the morphological benthic invertebrate indicator. The statistical assessment of the 2013-14 assessment year data is presented in Volume 4, Ocean Sediment Program technical analysis report.

Beach Suitability Grades: Sydney beaches

The calculated Beach Suitability Grades data for 39 Sydney Beaches were provided by the NSW Office of Environment and Heritage (OEH, http://www.environment.nsw.gov.au/beach/ar1314/index.htm).

Last year (2013-14) was characteristically a dry year with the lowest total rainfall recorded in Sydney's catchment in the last seven years. This might have helped produce better Beach Suitability Grades during 2013-14 (Figure 1-9 and Appendix C, Table 6-16). The grade improved at one third of the sites in comparison to 2012-13 results (Appendix C, Table 6-19). At 12 sites, it improved from 'Good' to 'Very good'. The Narrabeen Lagoon at Birdwood Park improved to 'Good' from 'Poor' grade for the last few years.

The only site where the Beach Suitability Grade deteriorated was Maroubra Beach where the status changed to 'Good' this year, from 'Very good' a year ago.

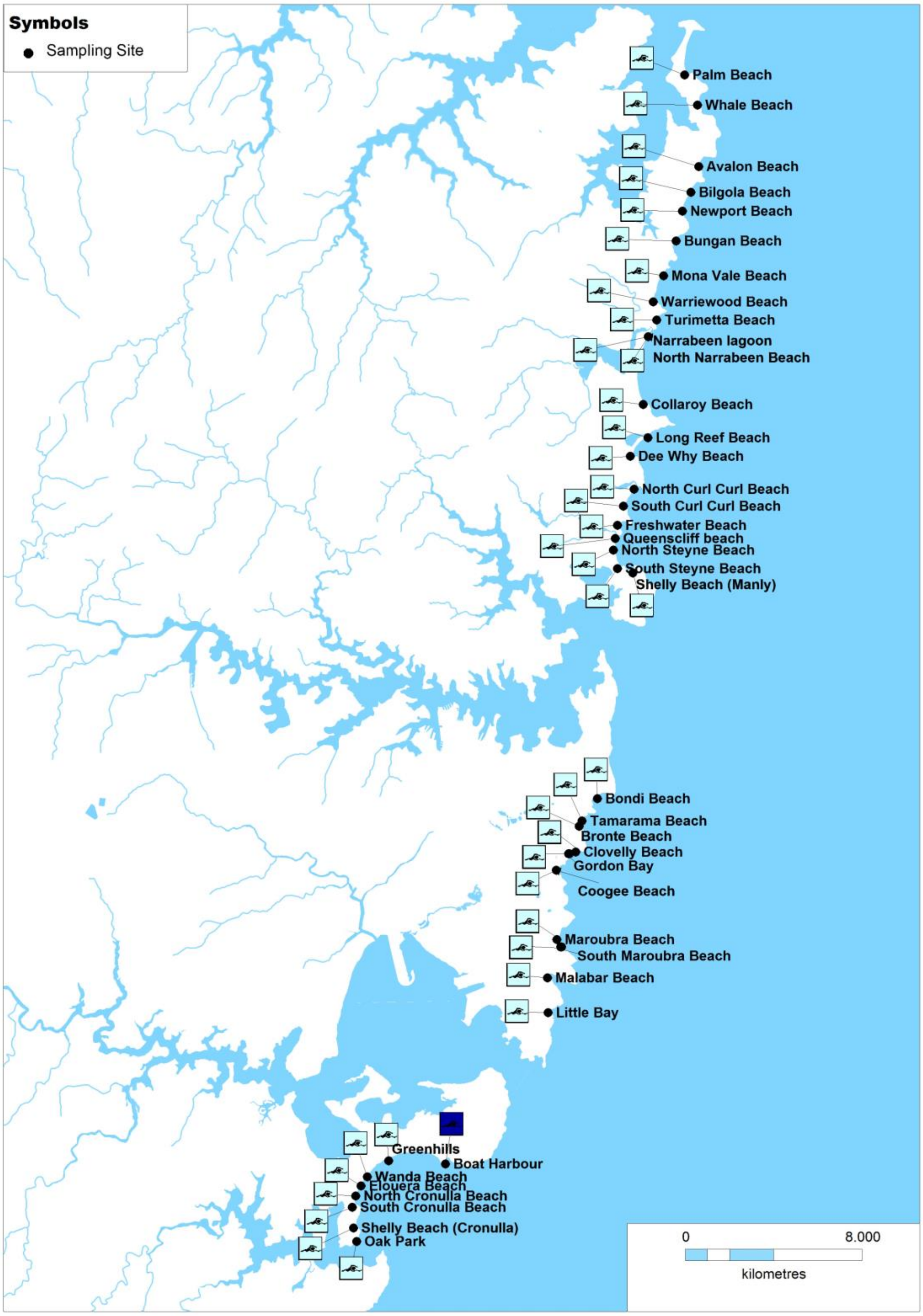
Among the 39 sites monitored, the only poor performing site was Boat Harbour with potential source of contamination from on-site sewage management systems. This Beach Suitability Grade was 'Poor' at this site, similar to 2012-13 outcomes. The Malabar Beach maintained its 'Good' status as it was benefited from a recent stormwater diversion project.

Beach Suitability Grades: Illawarra beaches

Sydney Water monitors 18 beaches in the Illawarra region and provides the data to OEH. Stanwell Park and Coledale Beaches are monitored by the OEH. The Beach Suitability Grades of Illawarra beaches during 2013-14 as calculated by OEH are shown in Figure 1-10. Nineteen of the 20 beaches were graded as 'Good' or 'Very good'. As usual, the only 'Poor' grade was for the Entrance Lagoon Beach (Figure 1-10, Appendix C Table 6-17).

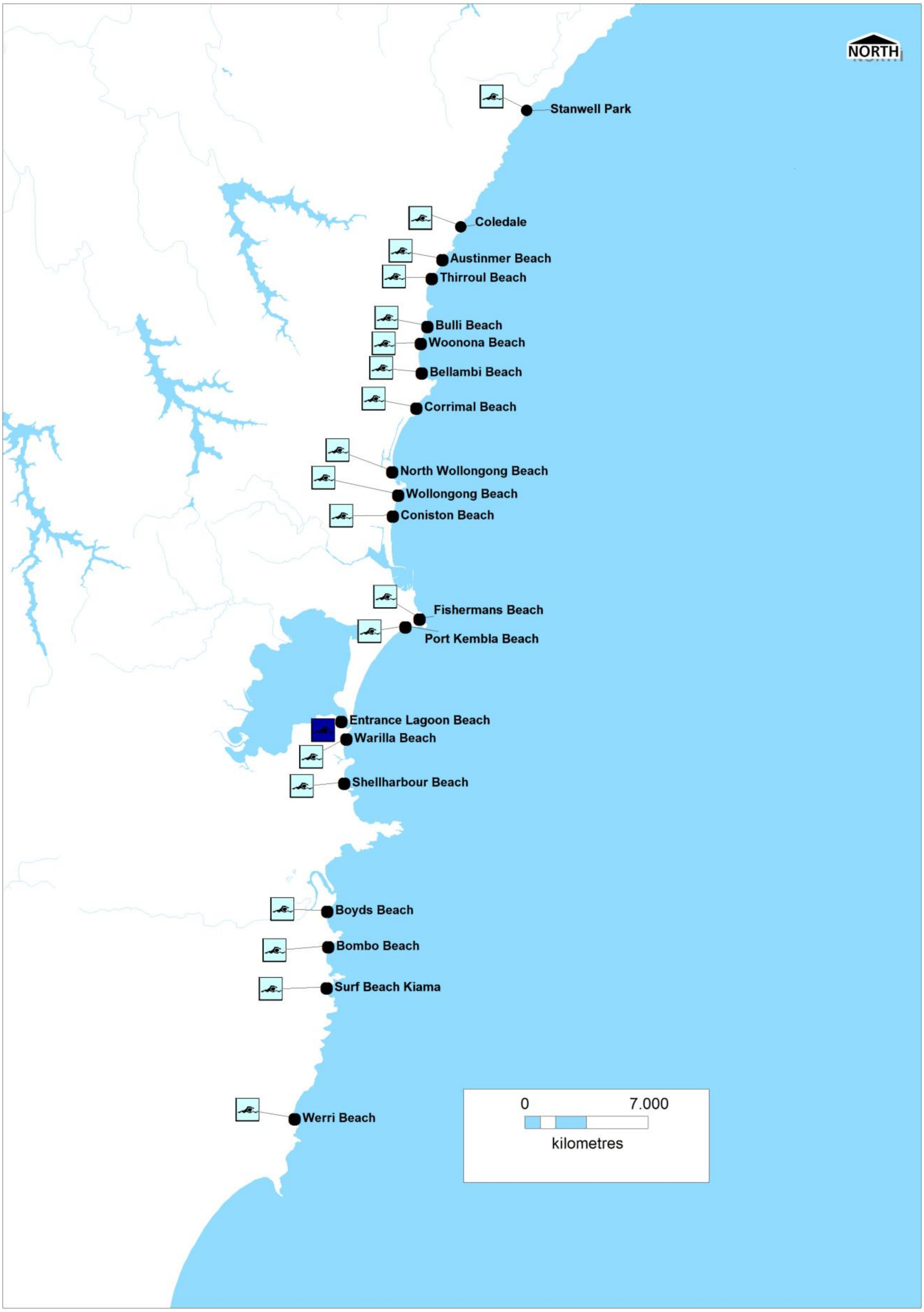
Thirroul beach was the only site where the Beach Suitability Grade deteriorated to 'Good' from a 'Very good' a year ago.

The swimming site at the Entrance Lagoon Beach at the mouth of Lake Illawarra is on the southern shore of the entrance to Lake Illawarra and is partly enclosed by a rock break wall that allows for tidal flushing. The microbial water quality is susceptible to pollution, particularly after rainfall and occasionally during dry weather conditions, with several potential sources of contamination including outflow from Lake Illawarra, stormwater and birds.



	Very good and Good		Fair		Poor, Very poor and Follow up

Figure 1-9 Beach Suitability Grades of Sydney beaches 2013-14



	Very good and Good		Fair		Poor, Very poor and Follow up

Figure 1-10 Beach Suitability Grades of Illawarra beaches 2013-14

1.4.4 Coastal environment

In addition to measuring the direct impacts from point source discharges, Sydney Water also monitors the general condition of receiving water environments. This includes coastal rivers and estuaries where wastewater overflows can contribute to an impact in combination with water quality disturbance from stormwater. Stormwater quality disturbance occurs from the direct connection of hard surfaces, such as roofs, gutters, roads, paths and car parks, to a stream. This direct connection allows small rainfall events to produce surface runoff that causes frequent disturbance to the stream through regular delivery of pollutants (Walsh et al. 2005a).

The condition of receiving waters is assessed by chlorophyll *a*, and biota communities in fresh and salt water. This section excludes the Hawkesbury Nepean River and Berowra Creek estuaries which are detailed in Section 1.4.5.

Chlorophyll *a*: Urban rivers and estuary

Sixteen sites were monitored throughout Port Jackson, Botany Bay/Georges River and Port Hacking for chlorophyll *a*. The summary statistics for 2013-14 chlorophyll *a* data by dry and wet weather categories are presented in Appendix G (Table 6-29). The summary of calculated water quality ratings, per and comparison to previous year is presented in Appendix G (Table 6-30). The ratings deteriorated at two Botany Bay sites and at Lane Cove River from ‘Good’ to ‘Fair’. The water quality ratings improved at one uppermost Georges River site from ‘Poor’ to ‘Good’.

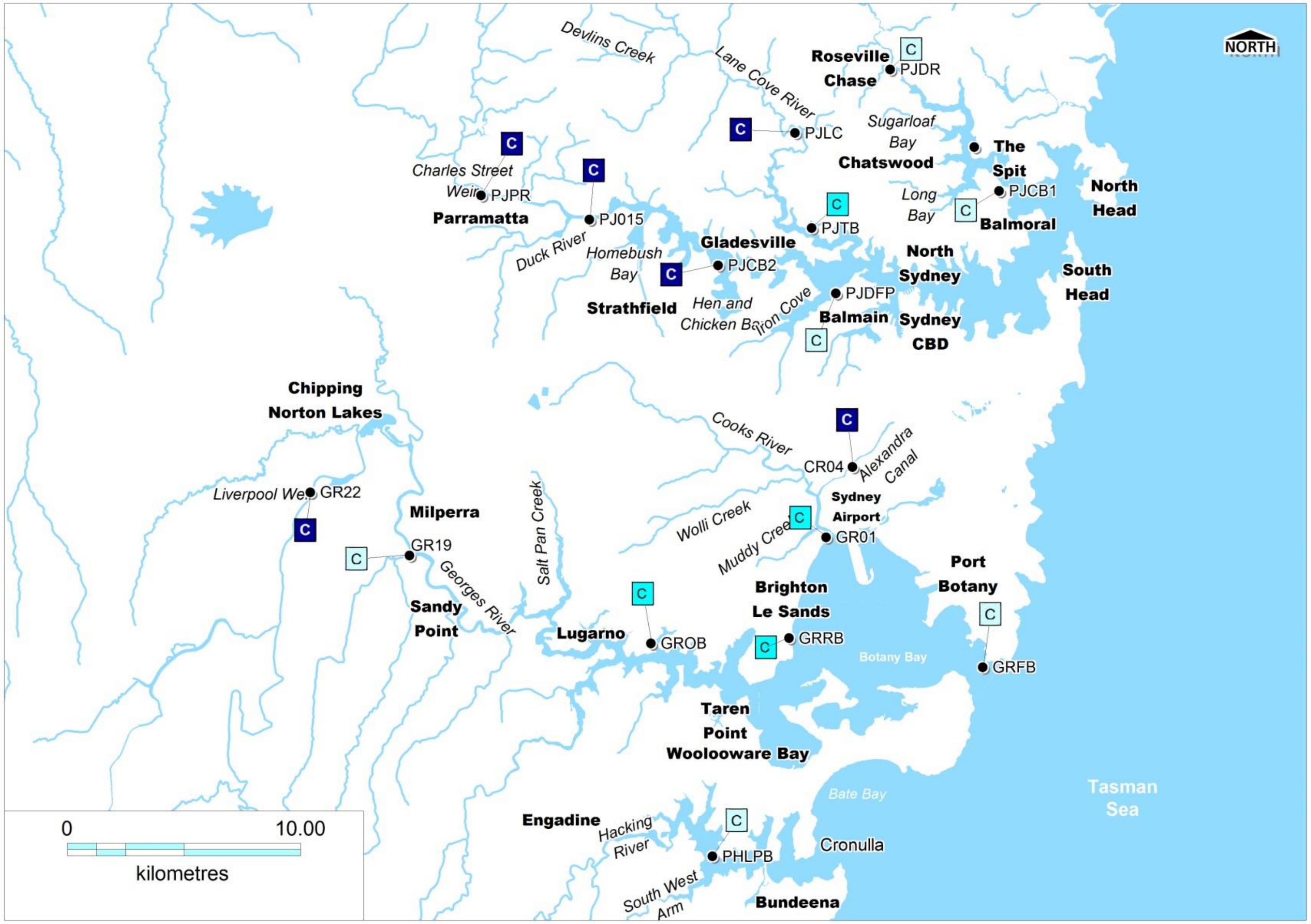
Only six out of 16 sites were rated as ‘Good’, the remaining as ‘Fair’ or ‘Poor’. In general, the upstream river sites were more polluted than the sites closer to the mouth of each estuary (Figure 1-11). Upstream freshwater reaches of the rivers were more prone to develop algal blooms as they are not flushed by low nutrient marine water.

In Sydney Harbour, the outer harbour area is well flushed by low-nutrient sea water and this is reflected by low chlorophyll *a* levels (maximum of 4.5 µg/L at Chinamans Beach). Chlorophyll *a* levels increase with distance from the mouth of the estuary, with the inner harbour attaining the highest levels (maximum of 13.0 µg/L at Cabarita Beach).

The freshwater reaches of the Lane Cove River and the Parramatta River have consistently high concentrations of chlorophyll *a*. In 2013-14, the maximum chlorophyll *a* at the uppermost weir sites of these rivers was 43.6 µg/L and 47.1 µg/L, respectively. However, these levels were much lower than the last year’s maxima for these sites.

Botany Bay and the Georges River have a similar pattern to Sydney Harbour, with the well-flushed outer harbour site having the better water quality rating (Frenchmans Bay). As usual, the upstream Cooks River sites had higher chlorophyll *a* (maximum of 45.5 µg/L at Alexandria Canal).

Port Hacking is a well flushed estuary and this is reflected in consistently low concentrations of chlorophyll *a* (maximum of 4.1 µg/L at Lilli Pilli Baths).



C	Good	C	Fair	C	Poor

Figure 1-11 Water quality ratings as determined by chlorophyll *a* at urban rivers and estuarine monitoring sites

Chlorophyll *a*: Lagoons

Seven lagoons sites were monitored for chlorophyll *a*. Data were assessed to determine the water quality status of the sites. The status in coastal lagoons varied widely depending on whether the lagoon was open or closed to marine water flushing (Figure 1-12). The summary statistics of 2013-14 chlorophyll *a* data by dry and wet weather categories are presented in Appendix G (Table 6-31). The summary of percentage samples within the guideline values and the calculated water quality ratings is presented in Appendix G (Table 6-32).

Four sites, the Narrabeen Lagoon, Curl Curl Lagoon, mouth of Manly Lagoon and upper Manly Lagoon, were rated 'Poor'. The Dee Why Lagoon improved to 'Fair' from 'Poor' in 2012-13 (Appendix G Table 6-32). There was an algal bloom at Curl Curl Lagoon with chlorophyll *a* reaching 192 µg/L on 11 February 2014. This lagoon was consistently closed to marine waters at the time of sampling events and prior to the algal bloom incident. This prevented flushing and lowered the water velocity. Given the warm conditions and sufficient nutrients from catchment sources, ideal conditions were present for algal growth.

The remaining two sites, East Narrabeen Lagoon and Wattamolla Lagoon (a reference/ control site) were rated 'Good'. The maximum chlorophyll *a* concentrations at these sites were 8.2 µg/L and 2.3 µg/L, respectively.

C	Good	C	Fair	C	Poor

Figure 1-12 Water quality ratings as determined by chlorophyll *a* at lagoons

Beach Suitability Grades: Other estuarine and harbour sites

Beach Suitability Grades for 55 other estuarine and harbour sites are presented in Appendix C Table 6-18. These sites were monitored and assessed by NSW OEH, further details can be found at http://www.environment.nsw.gov.au/beach/ar1314/index.htm.

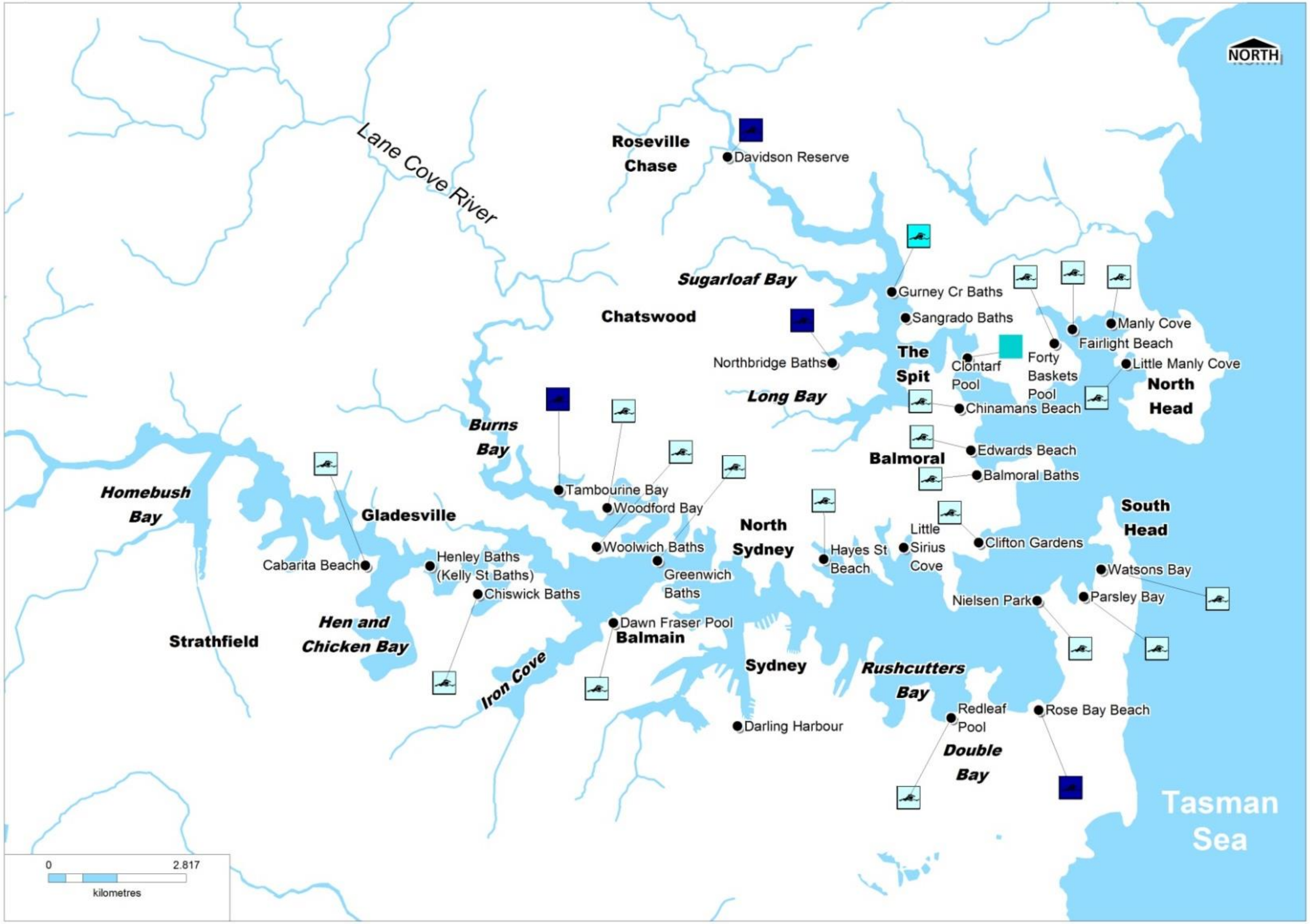
The Beach Suitability Grades at eight out of ten Pittwater sites were rated as 'Good' and one site rated 'Very good' during 2013-14 (Figure 1-13). The grade deteriorated at Bayview Baths site from 'Good' to 'Poor' this year and improved at The Basin site from 'Good' to 'Very good'.

The majority of Sydney Harbour sites (17 out of 25) were graded as 'Good' and two sites rated as 'Very good' in 2013-14. Two sites were rated as 'Fair' and the remaining four sites were rated as 'Poor'. No site was rated as 'Very poor' within Sydney Harbour (Figure 1-14, Appendix C Table 6-18). The grade improved at three sites and deteriorated at one site compared to last year (Appendix C Table 6-19).

The 2013-14 Beach Suitability Grades for the monitoring sites at Botany Bay, lower Georges River and Port Hacking are shown in Figure 1-15. In these catchments, 16 out of 20 sites were rated as 'Good', two sites were rated as 'Very good'. Gymea Bay Baths was rated as 'Poor' and Foreshore Beach was rated as 'Very poor' (Figure 1-15). Foreshore Beach is susceptible to pollution from wet weather sewage overflows which discharge into Mill Pond Creek. The Beach Suitability Grades improved at five out of 20 sites in comparison to last year's results.

	Very good and Good		Fair		Poor, Very poor and Follow up

Figure 1-13 Beach Suitability Grades for Pittwater



	Very good and Good		Fair		Poor, Very poor and Follow up

Figure 1-14 Beach Suitability Grades for Sydney Harbour

	Very good and Good		Fair		Poor, Very poor and Follow up

Figure 1-15 Beach Suitability Grades for Botany Bay and Port Hacking

Freshwater macroinvertebrates: Urban rivers

Eight sites monitored using macroinvertebrate indicators to assess the general condition of stream health in urban areas (Figure 1-18). Among these four are control or reference sites located upstream of any likely impact from urban areas. Three out of four impact sites are situated in urban areas just upstream of estuarine limits of the Parramatta River (PJPR), Lane Cove River (PJLC) and Georges River (GR22). The fourth urban site is situated about 5 km further up in the Georges River (GR23).

Figure 1-16 and Figure 1-17 indicate that the range of stream health in urban areas for 2013-14 was similar to that recorded from 1995 to June 2013. A level of mild to moderate impairment was measured in these urbanised streams. Stream health of reference sites was typical of natural water quality. The general condition of stream health at urban and reference sites is summarised in Figure 1-18.

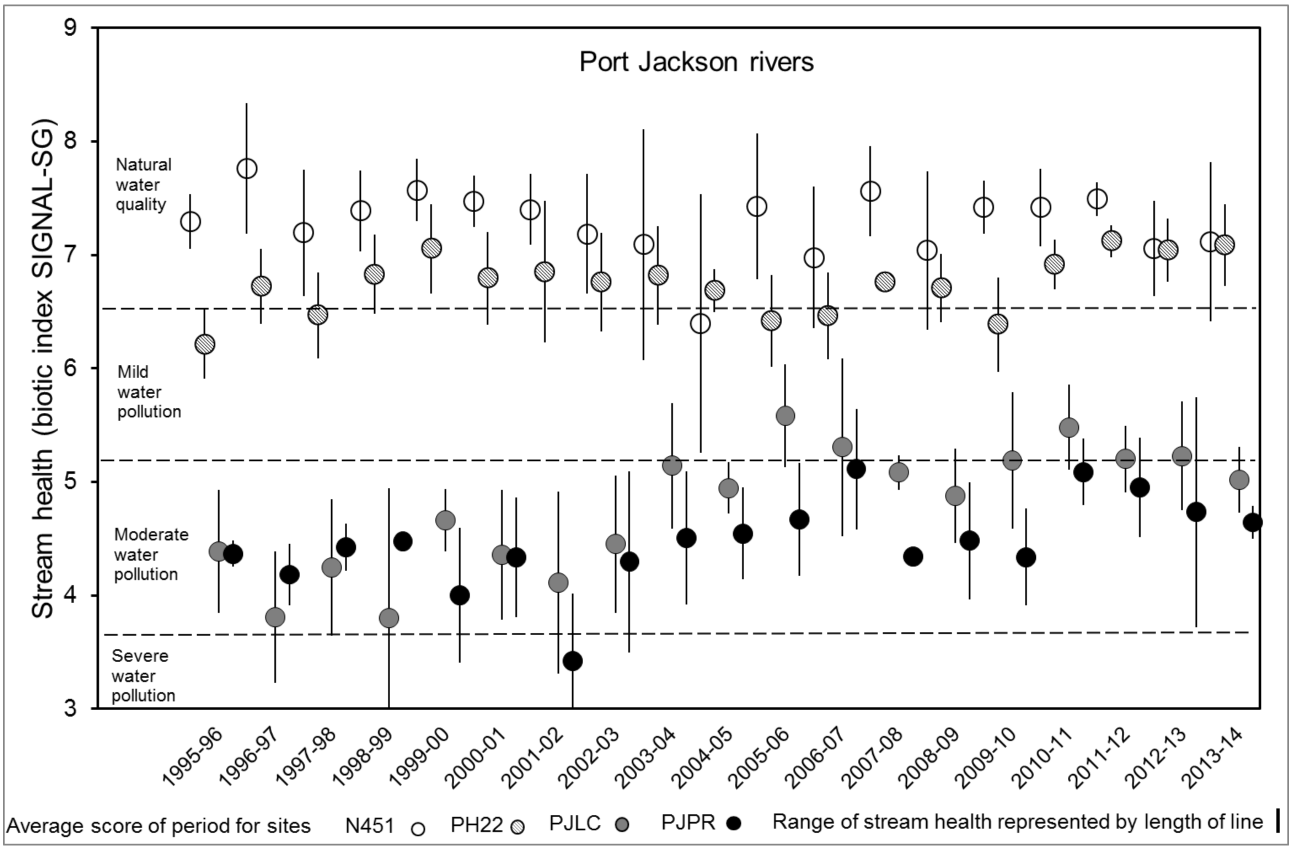


Figure 1-16 Stream health of Lane Cove (PJLC) and Parramatta (PJPR) rivers in comparison to reference site (N451, Lynch's Creek, tributary of Hawkesbury Nepean River; PH22 at McKell Avenue, Hacking River)

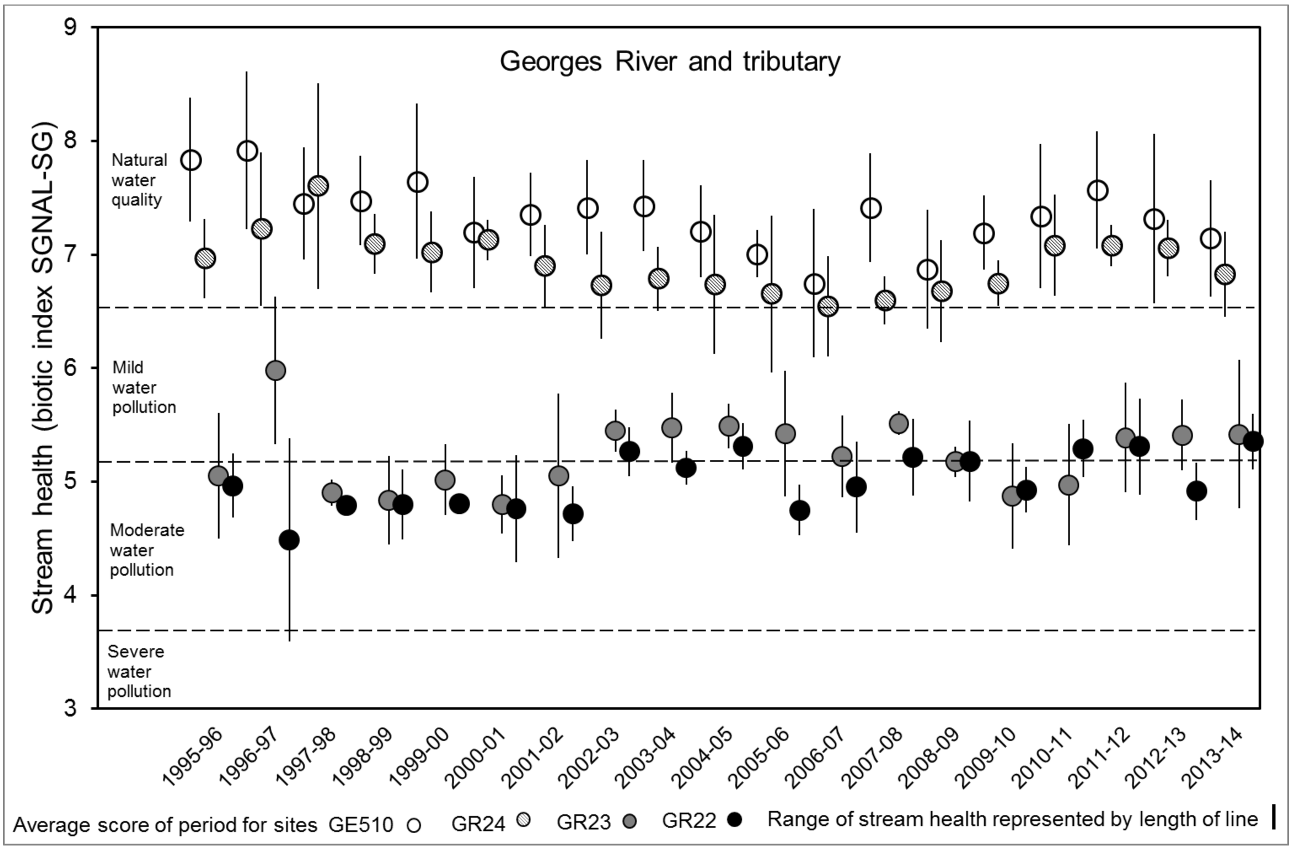


Figure 1-17 Stream health of Georges River sites Liverpool (GR22), Cambridge Causeway (GR23), Ingleburn Reserve (GR24) and O'Hares Creek tributary (GE510)

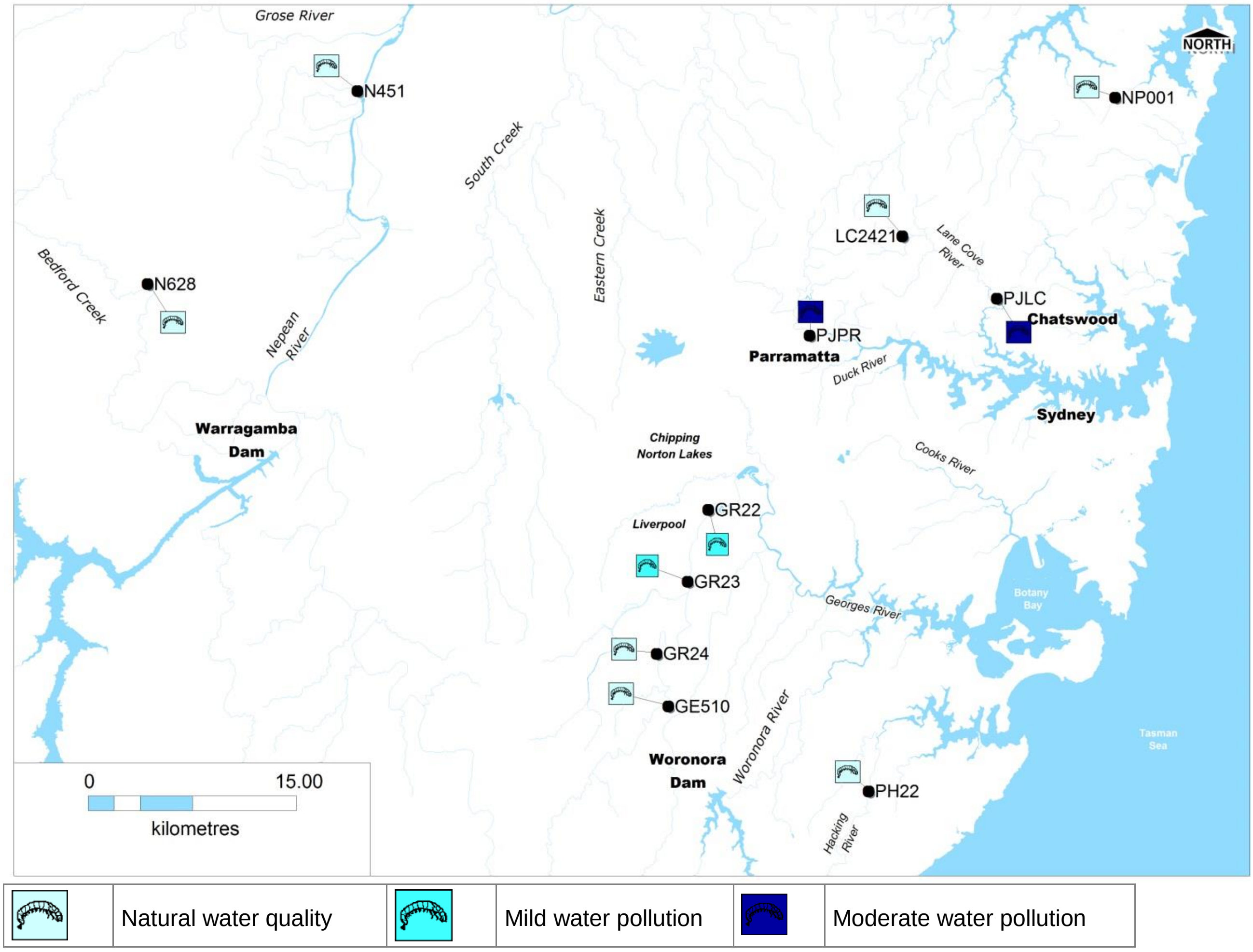


Figure 1-18 Water quality indicator ratings: four sites monitored for ambient condition based on macroinvertebrate indicator

Sydney estuarine intertidal communities

As detailed in Section 3 the statistical test based on the ANOSIM technique run in past years was not repeated in 2014. As such, a grading of estuarine test and urban control sites against reference sites has not been performed. Multivariate analysis of these data was performed and is outlined in Section 3.

In general, community structure of outer estuarine test and urban control sites was more similar to reference sites situated near national parks. Test and urban control sites of the inner estuaries generally had differing community structures to those at reference sites based upon morphological surveys of the intertidal rock platform indicator (Section 3).

1.4.5 Hawkesbury Nepean River

Freshwater macroinvertebrates

Macroinvertebrates were monitored in the Hawkesbury Nepean River, and South, Cattai and Berowra creeks to determine if stream health was altered downstream of wastewater discharges.

Visual inspection of stream health plots based on SIGNAL-SG indicated that the water quality status of all upstream sites was mildly to moderately impaired. Water quality status of upstream sites of Boundary, Breakfast, Eastern and Cattai creeks were occasionally severely impaired (Figure 1-19, Figure 1-22, Figure 1-23). These results suggest stormwater pollutants have been impacting stream health in the upper catchments since at least from the mid 1990's (when monitoring commenced). Expanded versions of these summary ecological control charts are presented in Section 4 with one plot for each plant.

Comparison of upstream and downstream site pairs showed that there was no measurable impact on macroinvertebrate communities recorded for 13 of 16 plant assessments (Figure 1-25). In the main stream of the Hawkesbury Nepean River, no plant discharged wastewater that resulted in a measurable impact downstream compared to upstream of the inflow or tributary conveying the inflow (Figure 1-19 and Figure 1-20). The three cases where localised reductions in stream health occurred were downstream of the West Camden, Winmalee and Hornsby Heights plants (Figure 1-19, Figure 1-20, Figure 1-24, respectively). These localised impacts, apparent in SIGNAL-SG plots, were confirmed with two tailed t-tests (Section 4 Table 4-2) and further statistical analysis presented in Section 4. For Winmalee, data was available for two downstream sites. Only the site directly downstream had a measurable impact, while stream health of the site 3 km downstream of Winmalee was similar to that of the Hawkesbury Nepean River. Additional statistical analysis of upstream and downstream sites for Hornsby Heights, West Camden, and Winmalee plants is presented in Section 4.

In 2013-14, a wide range of stream health was recorded in Boundary Creek below the Penrith plant where the St Marys Advanced Water Treatment Plant discharges high quality recycled water (Figure 1-19). While the range of stream health was broad, no impact was recorded in Boundary Creek or in the Hawkesbury Nepean River from recycled water discharges. This trend was also apparent in 2012-13.

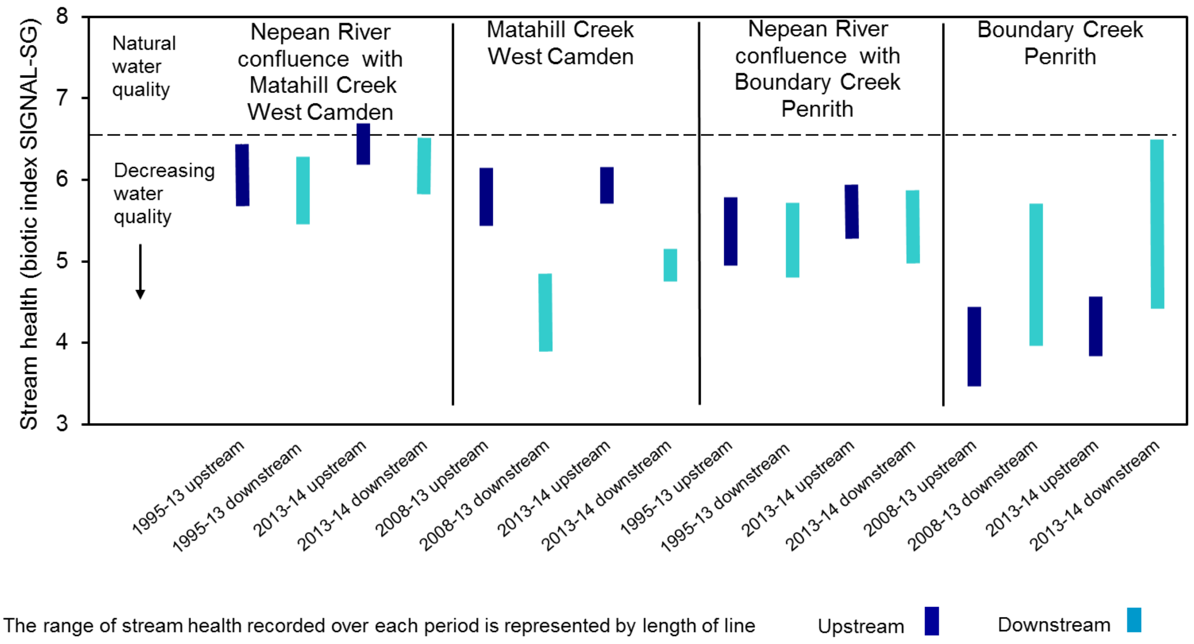


Figure 1-19 Stream health in the upper Hawkesbury Nepean River catchment

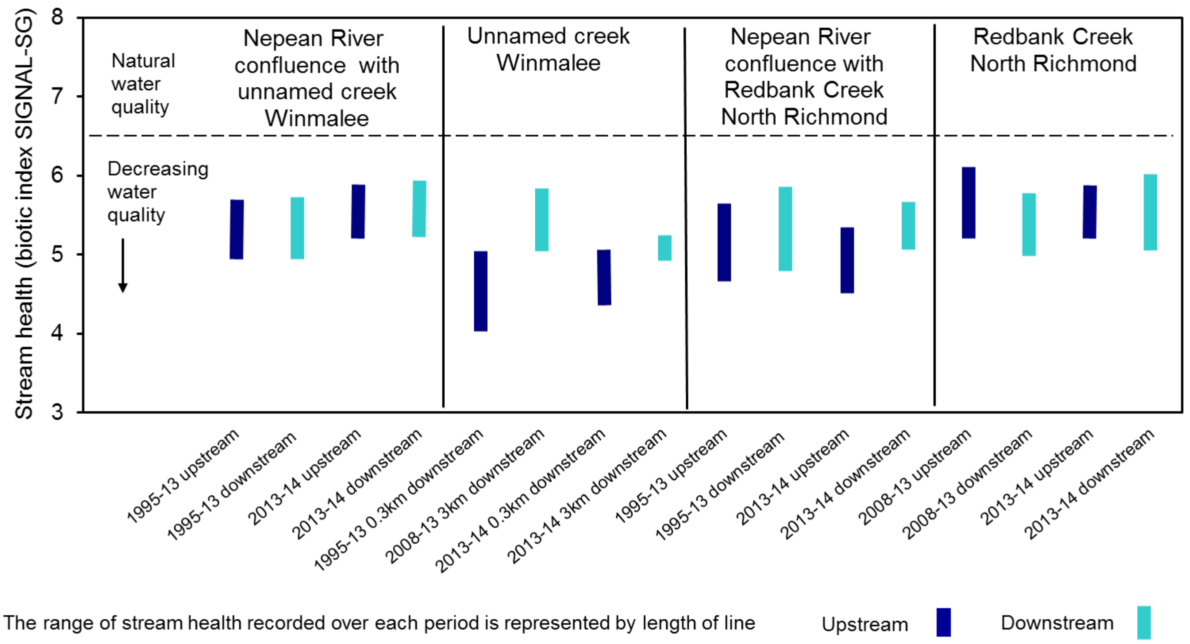


Figure 1-20 Stream health in the lower Hawkesbury Nepean River catchment

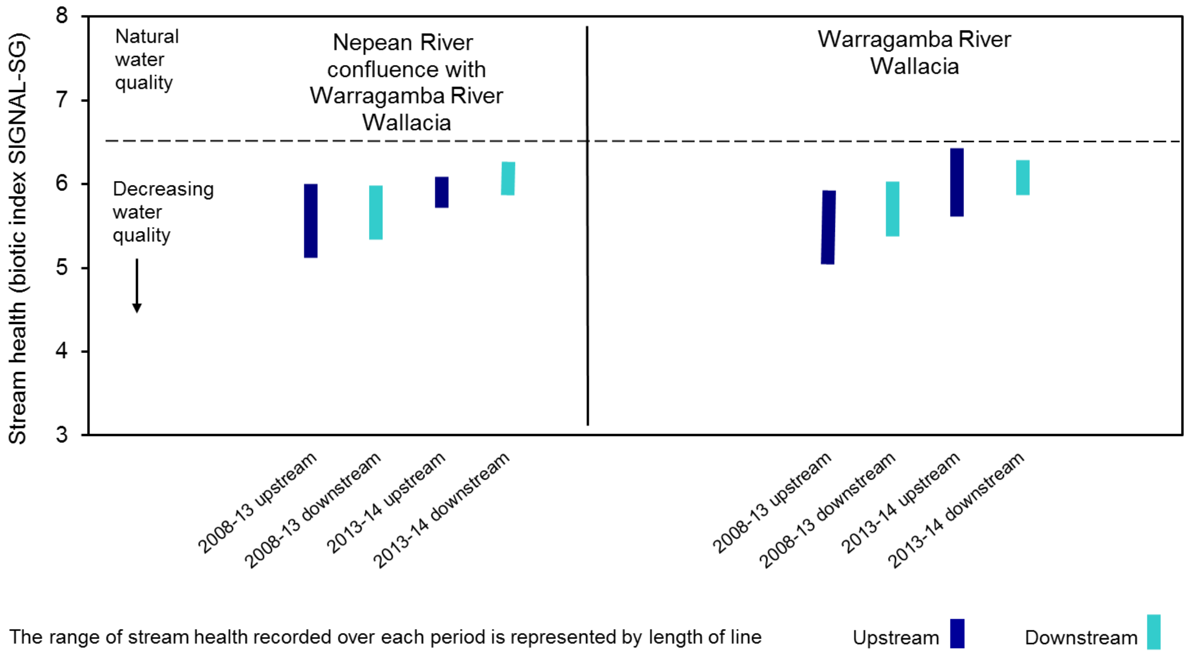


Figure 1-21 Stream health in the Warragamba River catchment below the dam

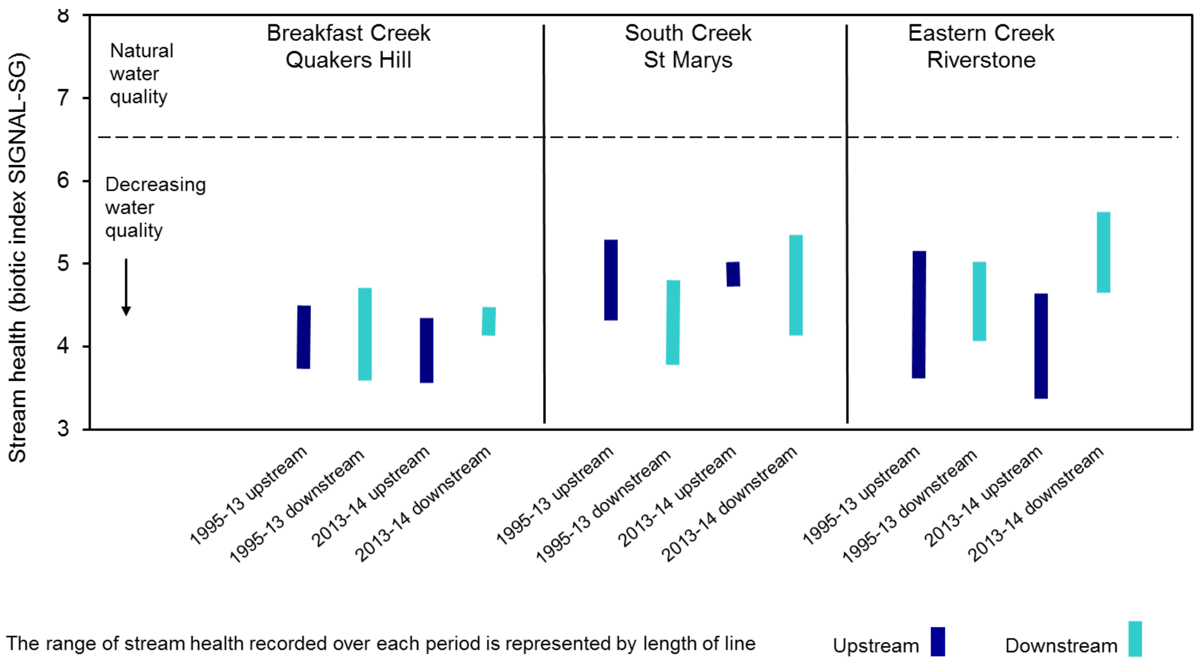


Figure 1-22 Stream health in the South Creek catchment

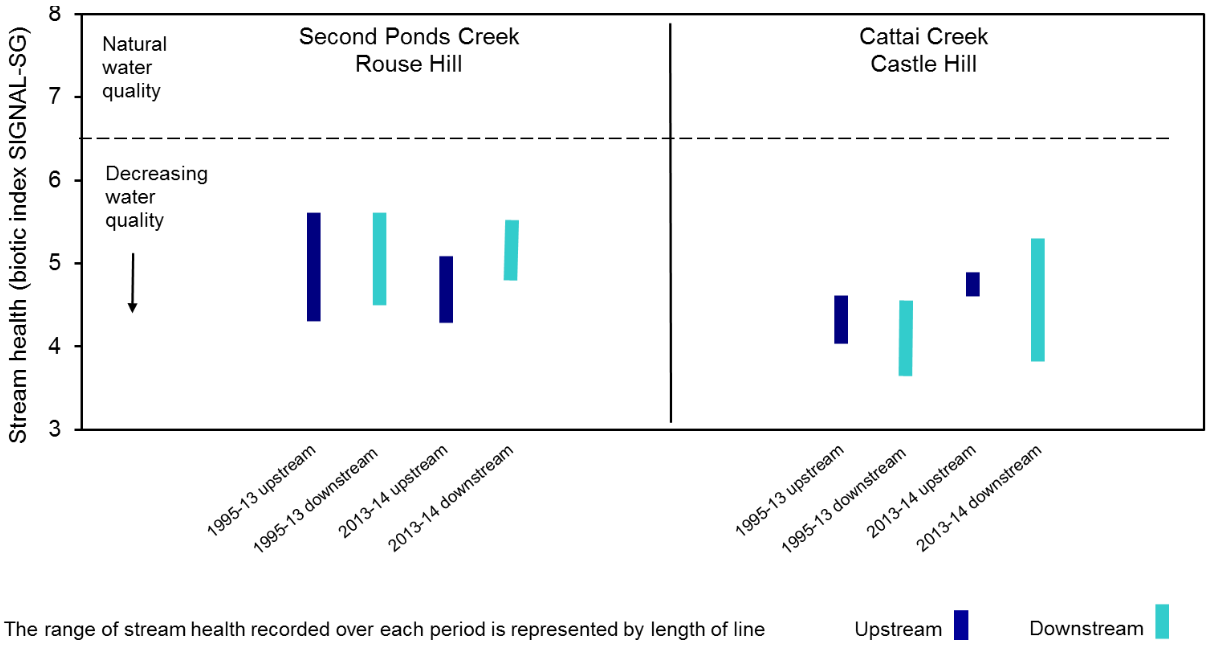


Figure 1-23 Stream health in the Cattai Creek catchment

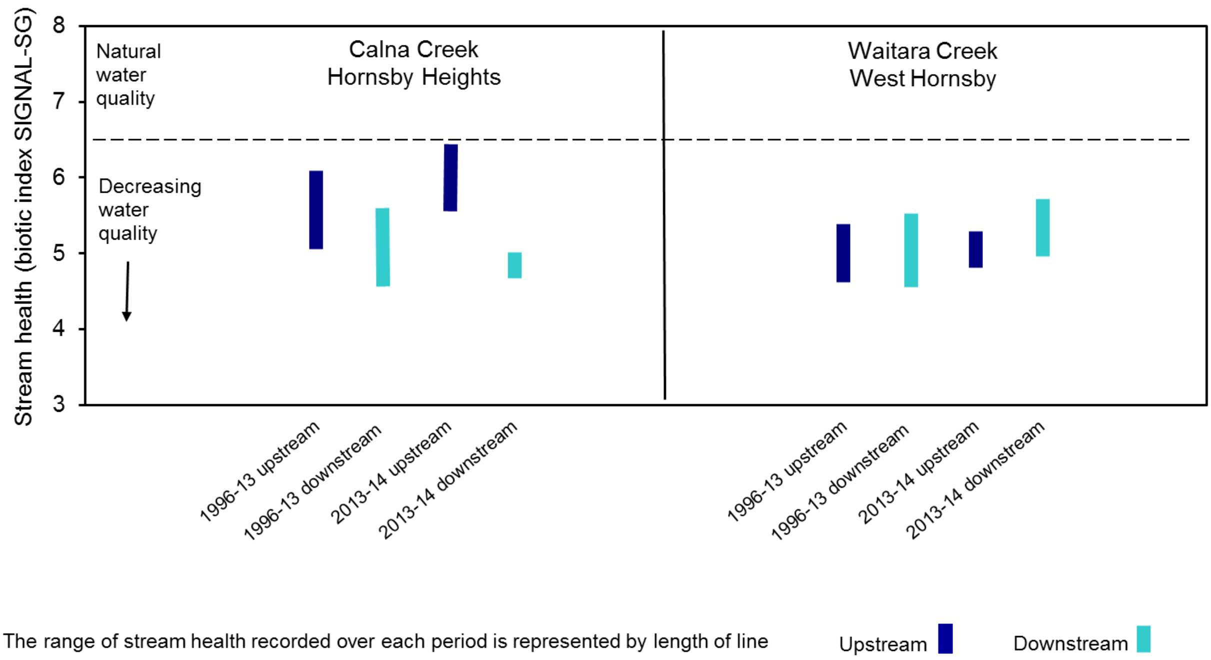


Figure 1-24 Stream health in the Berowra Creek catchment

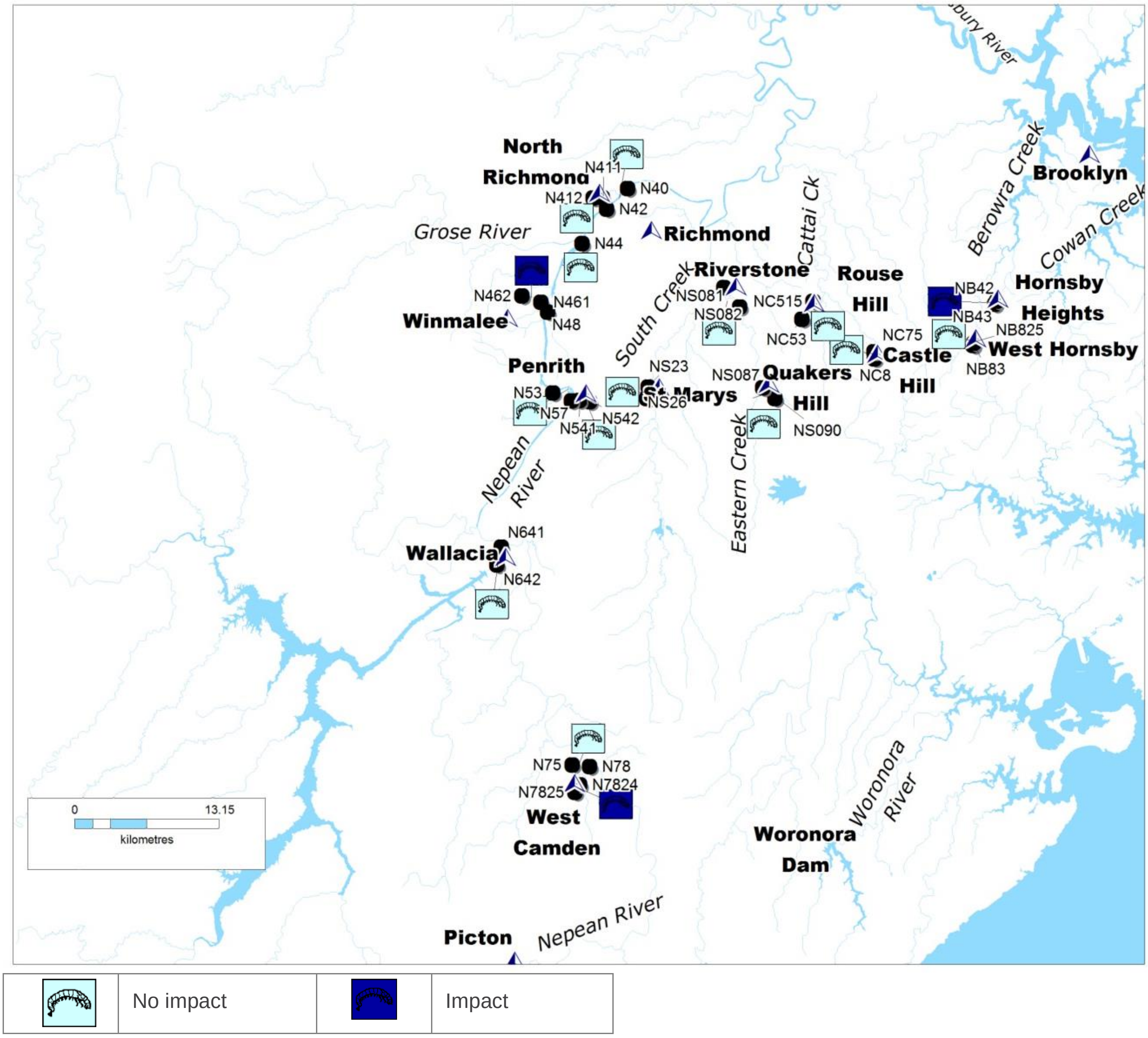


Figure 1-25 Water quality indicator ratings: stream health status at Hawkesbury Nepean River monitoring sites based on macroinvertebrate indicator

Water quality

The receiving water quality was assessed via monitoring key water quality variables at 13 sites along the Hawkesbury Nepean River from the upstream freshwater reaches of the Hawkesbury Nepean River at Maldon to downstream Hawkesbury River at Leets Vale. Another five sites were monitored at four major tributaries, South Creek, Cattai Creek, Colo River and Berowra Creek.

The key aim of this program is to measure the change in water quality in the river over time and find any relationship with Sydney Water activities in the catchment. Several water quality variables were monitored at three weekly intervals (temperature, dissolved oxygen, pH, conductivity, turbidity, ammonia nitrogen, oxidised nitrogen, total nitrogen, filterable total phosphorus, total phosphorus and chlorophyll *a*). Algal abundance was determined during elevated chlorophyll *a* concentrations (whenever the chlorophyll *a* level exceeded 7 µg/L).

The Hawkesbury Nepean River water quality data and the summary statistics for 2013-14 in dry and wet weather conditions are presented in Appendix H (Table 6-33). The summary of calculated water quality ratings based on dry weather data and percentage samples within the guideline values or alert levels to four key variables is presented in Appendix H (Table 6-34 and Table 6-35).

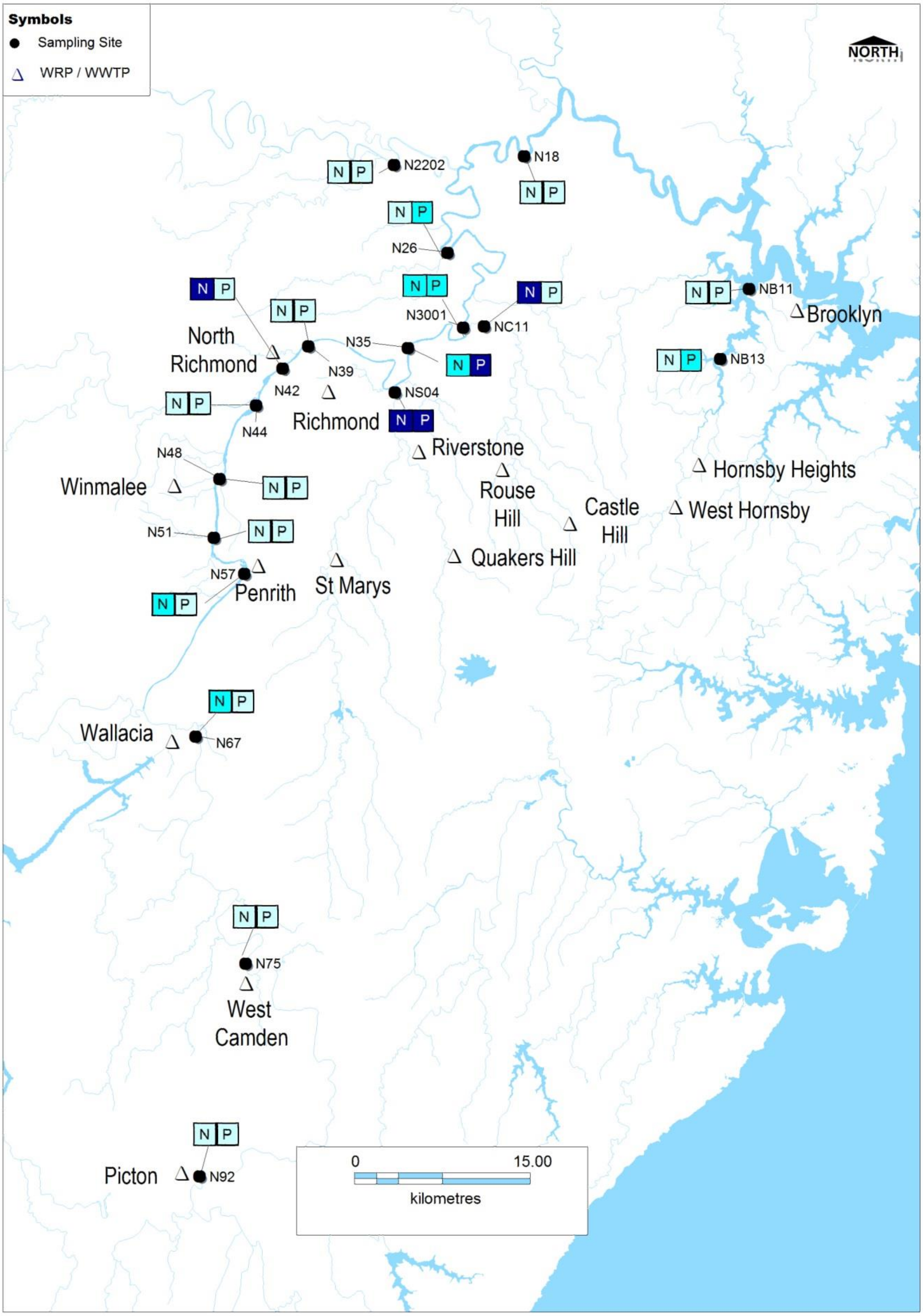
Last year (2013-14) was characteristically dry with the lowest rainfall recorded in the Hawkesbury Nepean River catchments since 2003-04. During 2013-14, the key nutrients (total nitrogen and total phosphorus) water quality rating was 'Good' at the majority of the monitoring sites (two thirds). The remaining sites were either 'Fair' or 'Poor' showing some levels of nutrient enrichment (Figure 1-26). For chlorophyll *a* and cyanobacteria a higher proportion of sites (more than half) were rated as 'Fair' or 'Poor' during 2013-14 compared to nutrients (Figure 1-27).

The water quality at most sites along the river remained similar, with a little improvement in status at some sites, especially in terms of chlorophyll *a* in comparison to last year (2012-13) (Appendix H, Table 6-34 and Table 6-35). Water quality ratings were mostly 'Poor' or 'Fair' at four sites of the Hawkesbury River downstream of South Creek and at two major tributaries, South and Cattai creeks.

Upper Nepean River (Maldon Weir to Wallacia Bridge)

Maldon Weir (N92) is a reference site for this monitoring program as it is located upstream of all our inland wastewater systems. The water quality at this site is influenced by other catchment factors as it receives inflows from the upstream Nepean River catchment and discharges from Nepean, Avon and Cordeaux dams. The water quality ratings for all four variables were 'Good' with 100% samples within the guideline values or cyanobacteria alert levels. The site had a low level of nutrients and chlorophyll *a*, with the maximum chlorophyll *a* concentration for 2013-14 being 4.4 µg/L, the lowest maximum value measured along the main stream river. The water quality rating has generally improved at this site in the last 10 years, especially in term of chlorophyll *a* (Appendix H Table 6-34).

The water quality ratings at Sharpes Weir (N75), downstream of Matahil Creek and the West Camden plant discharges were also 'Good' in 2013-14 with an exception on chlorophyll *a*. The chlorophyll *a* rating for this site was 'Fair'. The West Camden plant was upgraded five years ago resulting in a large change in the total nitrogen load discharged, from about 50 tonnes before the upgrade to less than 20 tonnes after. The benefit of this project is evident with 'Good' ratings for total nitrogen after the upgrade (since 2010-11), compared to 'Poor' ratings before the upgrade. The ratings for total phosphorus and chlorophyll *a* have also improved to some extent since the upgrade (Appendix H Table 6-34).



N P	Good	N P	Fair	N P	Poor

Figure 1-26 Water quality ratings based on total nitrogen and total phosphorus at Hawkesbury Nepean River monitoring sites (2013-14)

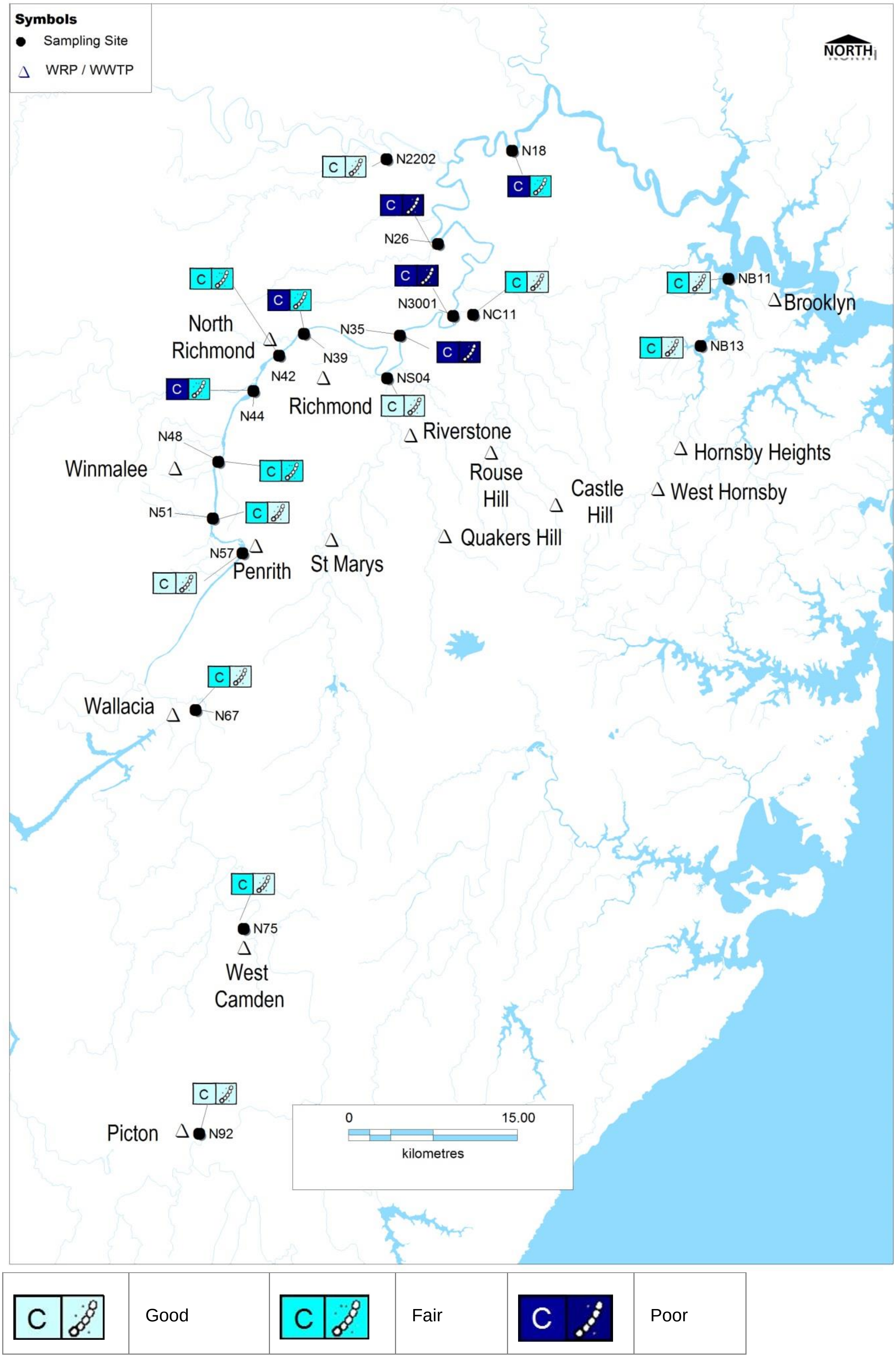


Figure 1-27 Water quality ratings based on chlorophyll *a* and cyanobacteria at Hawkesbury Nepean River monitoring sites (2013-14)

The chlorophyll *a* concentration exceeded the HRC (1998) guideline on about one third of the dry weather sampling occasions (5 out of 17) at Sharpes Weir. The maximum chlorophyll *a* concentration was 12.2 µg/L, which was about half of the previous year's dry weather maximum. The algal species composition was mixed, with some dominance of diatoms and flagellated monads algae. Cyanobacteria levels reached the 'Green' alert guideline for recreational water on two occasions (NHMRC 2008) at this site.

The water quality rating at Wallacia Bridge (N67) was 'Good' in terms of total phosphorus and cyanobacteria during 2013-14. However, the rating was 'Fair' for total nitrogen and chlorophyll *a*. This is consistent with previous years monitoring results.

The dry weather chlorophyll *a* concentrations exceeded the guideline on 10 out of the 17 sampling events. The chlorophyll *a* peaks were evident during October to November 2013 and then again in February to March 2014, with a maximum concentration of 20.6 µg/L. Algal populations were a mix of green, diatom and monad taxa. The cyanobacteria biovolume reached the 'Green' alert level twice and 'Amber' alert levels on only one occasion (28 November 2013), when non-toxic taxa *Spirulina* was present at a low level.

Lower Nepean and Upper Hawkesbury River (Penrith Weir to Freemans Reach)

The section of the river from Penrith to Freemans Reach receives regular discharge of treated wastewater from four Sydney Water plants, Penrith, Winmalee, North Richmond and Richmond. Recycled water is also discharged in this section river via Boundary Creek, a small tributary entering the Hawkesbury Nepean River downstream of Penrith Weir. The Winmalee plant discharges into a small creek which then flows into Winmalee Lagoon before entering the Hawkesbury Nepean River. The plants at North Richmond and Richmond also discharge into small tributaries of the Hawkesbury Nepean River but these volumes are much smaller than that discharged from the other two plants.

The water quality ratings at four out of six monitoring sites were 'Good' in terms of total nitrogen during 2013-14. At Penrith Weir (N57) and North Richmond (N42), the nitrogen rating was 'Fair' and 'Poor', respectively. The ratings were 'Good' at all six sites for total phosphorus. The ratings based on chlorophyll *a* were mixed for these sites and varied from 'Good' to 'Poor'. The cyanobacteria rating was 'Good' at two upstream sites and 'Fair' at four downstream sites (Figure 1-27). In recent years improved ratings were evident at Smith Street (N48) and Freemans Reach (N39) for total nitrogen, while deteriorating total nitrogen ratings were evident at Penrith Weir (N57) (Appendix H Table 6-34).

Water quality ratings based on chlorophyll *a* and cyanobacteria have deteriorated at five downstream sites from Hawkesbury Nepean River opposite Fitzgeralds Creek (N51) to Freemans Reach (N39) in the last couple of years. This may be linked with the macrophyte washout event in early 2012. This region of the Hawkesbury Nepean River is shallow and has been heavily infested with submerged and/or floating macrophytes in recent years. The chlorophyll *a* and algal level varies depending on the spread and colonisation of the macrophyte population because of competition for space and nutrients.

The chlorophyll *a* concentrations at all six sites from Penrith Weir (N57) to Freemans Reach (N39) generally exceeded the guideline on the majority of sampling occasions. The maximum chlorophyll *a* concentration at four upstream sites ranged between 19.6 to 23.1 µg/L. The maximum concentration increased further downstream at North Richmond (N42) and Freemans Reach (N39), with concentrations of chlorophyll *a* of 31.6 and 26.7 µg/L, respectively.

Algal populations were generally mixed at these sites. Cyanobacteria never reached ‘Amber’ alert level at the three upstream sites from Penrith Weir (N57) to Smith Street (N48). It reached ‘Amber’ alert level twice at Yarramundi Bridge (N44), once at North Richmond (N42) and four times at Freemans Reach (N39). However, the level of toxigenic taxa was very low at these sites. The cyanobacteria ‘Green’ alert level was more common at these sites during 2013-14.

Lower Hawkesbury River (Wilberforce to Leets Vale)

The lower Hawkesbury River section between Wilberforce (N35) and Leets Vale (N18) is tidal and the water quality is influenced by a significant volume of inflows coming from South Creek, Cattai Creek and the Colo River. The water quality of the lower river deteriorated further in this section. The nutrient water quality ratings for these sites were mixed from ‘Poor’ to ‘Good’ during 2013-14’. However, the ratings were all ‘Poor’ in terms of chlorophyll *a* and three out of four sites were ‘Poor’ in terms of cyanobacteria alert.

The overall condition at these sites is historically poor, being affected by many catchment factors including agricultural runoff, urban stormwater runoff and wastewater discharges. The concerns of high nutrient levels, chlorophyll *a* and algal blooms in this section of the Hawkesbury River continue as many sites in this section are prone to algal growth. The river is wider and deeper in this area, leading to higher residence times and lower water velocities. Nutrient levels are also relatively high and light is available for photosynthesis (too deep for macrophytes).

In recent years total nitrogen ratings improved from ‘Poor’ to ‘Fair’ or ‘Good’. The phosphorus rating also improved to some extent at two sites downstream of Cattai Creek. However, the chlorophyll *a* rating consistently remained ‘Poor’. The dry weather chlorophyll *a* at these sites exceeded the guidelines in 2013-2014 for almost all sampling occasions (89% to 94% of time). Overall, chlorophyll *a* was further elevated in 2013-2014 at these sites of the Hawkesbury River with the maximum values ranging from 38.3 to 78.4 µg/L.

Cyanobacteria ratings improved a few years ago (2010-11 and 2011-12), however, the 2013-14 rating was ‘Poor’ at three out of four sites. The ‘Green’ alert level for cyanobacteria was frequently triggered at these sites. The ‘Amber’ level was reached on 63% of sampling occasions at Sackville Ferry (N26) and on 25% to 38% of sampling occasions at three other sites. As expected from historical data, the abundance of toxigenic cyanobacteria was higher at Sackville Ferry (N26) with a combination of Anabaena and *Microcystis* taxa. There was also a ‘Red’ alert on cyanobacteria at Sackville Ferry on 5 June 2014. The 'Red' level toxigenic taxa reached over 40 thousands cells/mL during that cyanobacteria bloom and was mostly dominated by *Microcystis* (37,772 cells/mL).

Tributaries (South, Cattai and Berowra creeks, Colo River)

The water quality ratings were ‘Poor’ at South Creek in terms of nutrients. At Cattai Creek the rating was also ‘Poor’ in terms of total nitrogen but ‘Good’ in terms of total phosphorus. The concentrations of the key nutrients nitrogen and phosphorus were highest at these sites, compared to other Hawkesbury Nepean River and tributary sites. There is no definite change in nutrient ratings since monitoring started at these sites six years ago.

The rating in terms of chlorophyll *a* was ‘Good’ at South Creek (NS04) but ‘Fair’ at Cattai Creek (NC11) during 2013-14. However, an increase in algal abundance was noticed at South Creek. Chlorophyll *a* reached 94.6 µg/L on 5 September 2013, dominated by the diatoms *Thalassiosira* and *Skeletonema.*

Cyanobacteria were less common at South and Cattai creeks and therefore the rating was ‘Good’ at both sites. The level of cyanobacteria reached ‘Amber’ alert level on two occasions in South

Creek in 2013-14. In Cattai Creek, ‘Green’ alert levels occurred three times, but there were no ‘Amber’ alert levels.

The water quality ratings were ‘Good’ at the reference site of Colo River (N2202) for all four parameters with 100% of samples within the guideline values or cyanobacteria alert levels. The chlorophyll *a* concentration was low and reached a maximum of 4.0 µg/L in 2013-14.

The water quality rating of Oakey Point in Berowra Creek (NB11) was ‘Good’ for both total nitrogen and total phosphorus. The rating was ‘Good’ for total nitrogen but ‘Fair’ for total phosphorus at Calabash Bay (NB13), which is close to the source of pollution or upstream catchments. The chlorophyll *a* rating was ‘Fair’ for both sites during 2013-14. Cyanobacteria are less common at these brackish water sites and therefore the ratings based on cyanobacteria were ‘Good’ for both sites.

There is a strong tidal influence at both Oakey Point and Calabash Bay. Chlorophyll *a* exceeded the guideline on 41% to 47% of sampling occasions. Usually brackish water dinoflagellates were dominant in most algal counts with a mixture of monads, diatoms and other algae. There was no cyanobacteria alert at Berowra Creek at Oakey Point (NB11). On 28 November 2013, cyanobacteria reached a very high density to trigger a ‘Red’ alert at Calabash Bay (NB13). A non-toxic taxa *Synechococcus* was present in high number to trigger this alert (468,168 cells/mL). There was also a ‘Green’ alert for cyanobacteria at this site.

1.4.6 Wastewater overflows

Wastewater overflows can occur in dry weather due to blockages in the transport system or infrastructure faults and can occur in wet weather when the hydraulic capacity of the pipes or treatment capacity of plants are exceeded. Ocean systems have higher overflow frequency and volume because these are much larger systems.

Dry weather overflows are predominantly due to blockages caused by tree roots and wastewater pipe breakages by debris and soft chokes (a combination of residual solids and sanitary product). Wet weather overflows are normally due to infiltration of stormwater through breaks, combined systems and illegal connections exceeding the system’s capacity.

Dry weather overflows

The dry weather overflow volumes are measured whenever an incident occurs and is reported to Sydney Water. The total numbers of overflows and the overflow volume are estimated by each Sewer Catchment Area Management Plan (SCAMP) and the proportion that reaches receiving waters is reported via annual returns on each EPL.

In 2013-14, Sydney Water experienced 15,228 blockages across all its 25 wastewater systems (Sydney Water 2014a). The total number of overflows that resulted from these blockages was 808 (about 5%) and 270 resulted in wastewater overflow to water (approximately 1.8%). The primary cause of blockages was tree roots entering the system through cracks and broken joints (61%). Other causes of blockage were debris, soft choke and fat.

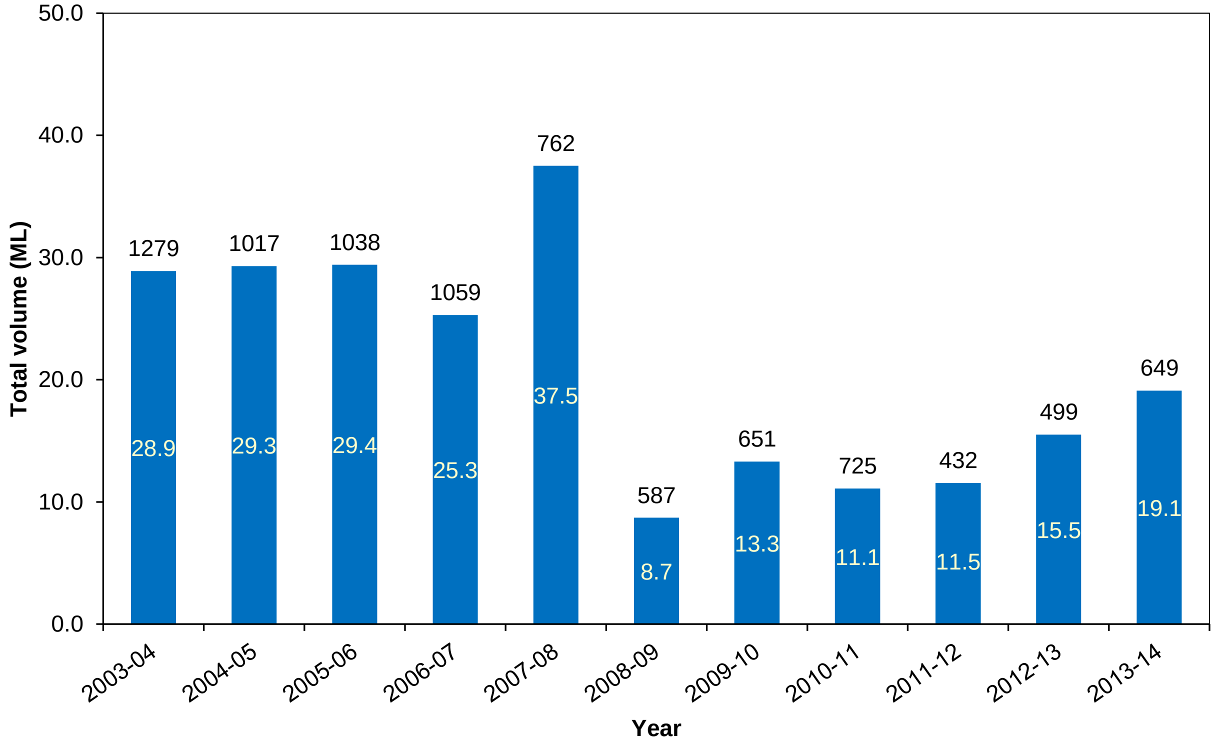
Thirty six out of 213 SCAMP areas exceeded their licence targets across 12 wastewater systems in 2013-14. Three wastewater systems exceeded their Licence Limits on number of overflows reaching water in 2013-14. These were Cronulla, Warriewood and Penrith. A detailed performance of dry weather overflow volume and frequency by each of the SCAMPs and wastewater systems in relation to compliance limits are presented in a separate report (Sydney Water 2014a).

In this report, a generalised summary of dry weather overflow volume and frequency is presented for ocean and inland catchments for last ten years.

Eight wastewater systems draining to the ocean plants were responsible for a total dry weather overflow volume of 19.1 ML in 2013-14 (Figure 1-28). The last ten years of dry weather overflow data, including 2013-2014, by each ocean wastewater system is presented in Appendix I (Table 6-36).

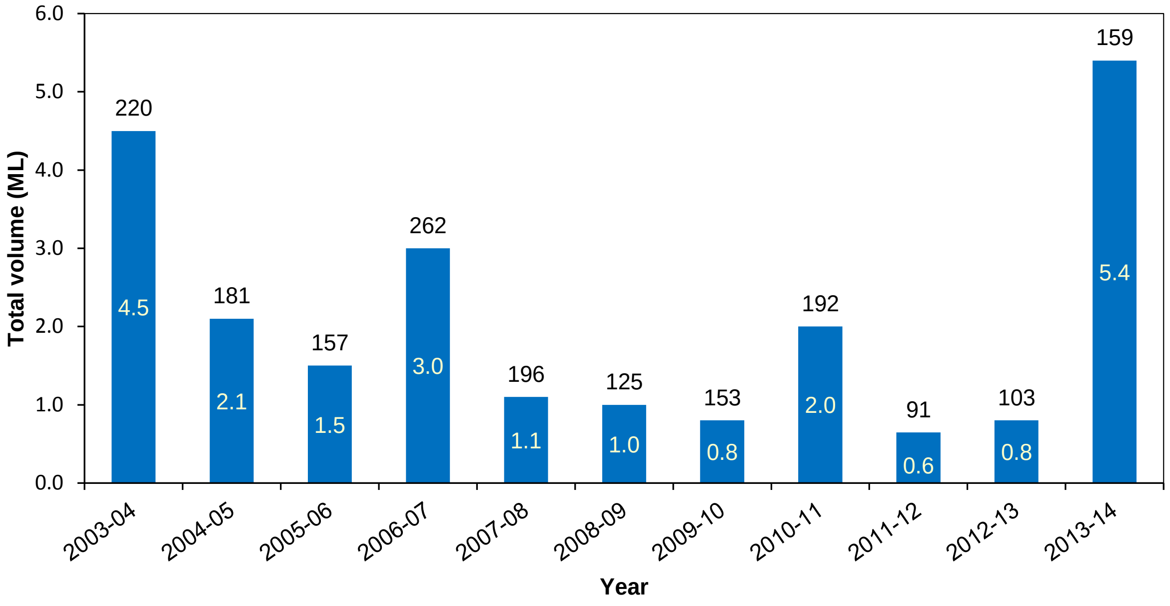
The two largest systems of Malabar and North Head were responsible for the largest number of dry weather overflows (82%). The total volume of overflows and the number of occurrences from ocean systems increased in 2013-14 in comparison to last year (2012-13). Sydney Water's choke reduction program proactively manages pipes and infrastructure at high risk of discharging to waterways.

The dry weather overflow data summaries (by each inland wastewater system) are presented in Appendix I (Table 6-37). Eleven inland wastewater systems networks were responsible for a total overflow volume of 5.4 ML in 2013-14 (Figure 1-29). The St Marys and West Hornsby systems contributed 56% of this total dry weather overflow volume. The total overflow volume and frequency of overflows in inland systems also increased in 2013-14 in comparison to last year.



Note: number of overflow events per year is shown at the top of each bar, volume at the middle of bar

Figure 1-28 Previous ten years of dry weather overflow volumes in ocean plant catchments



Note: number of overflow events per year is shown at the top of each bar, volume at the middle of bar

Figure 1-29 Previous ten years of dry weather overflow volumes in inland plant catchments

Wet weather overflows

Wet weather overflow performance

Each year, the wastewater system's wet weather overflow performance (system performance) is compared against the benchmark year system performance or target system performance, to determine if any deterioration has occurred. To meet the EPL requirements, Sydney Water has developed hydraulic sewer models that are calibrated yearly using strategic sewer and rainfall gauging of the systems (calibrated using ten years of data). These models allow a direct comparison of system performance between periods of differing rainfall.

Eighteen wastewater systems complied with all EPL conditions. Two systems (Picton and Brooklyn-Danger Island systems) don't have EPL compliance conditions. Three wastewater systems did not comply with either full or partial treatment conditions for wet weather overflows (Table 1-7). The reason for these non-compliances was investigated individually to prevent re-occurrences. The detail on these mitigation measures and progress was reported via the *Wet Weather Overflow System Performance Report* (Sydney Water 2014b).

Table 1-7 List of non-compliances by EPL clause (2013-14)

Wastewater system EPL Clause	Non-compliant systems
L7.2 Wet weather overflow limits	Wallacia and Rouse Hill[1]
O4.9 Wet weather partial treatment discharges	Fairfield

[1] Pollution Reduction Program U1-PRP 302 is returning this system to compliance

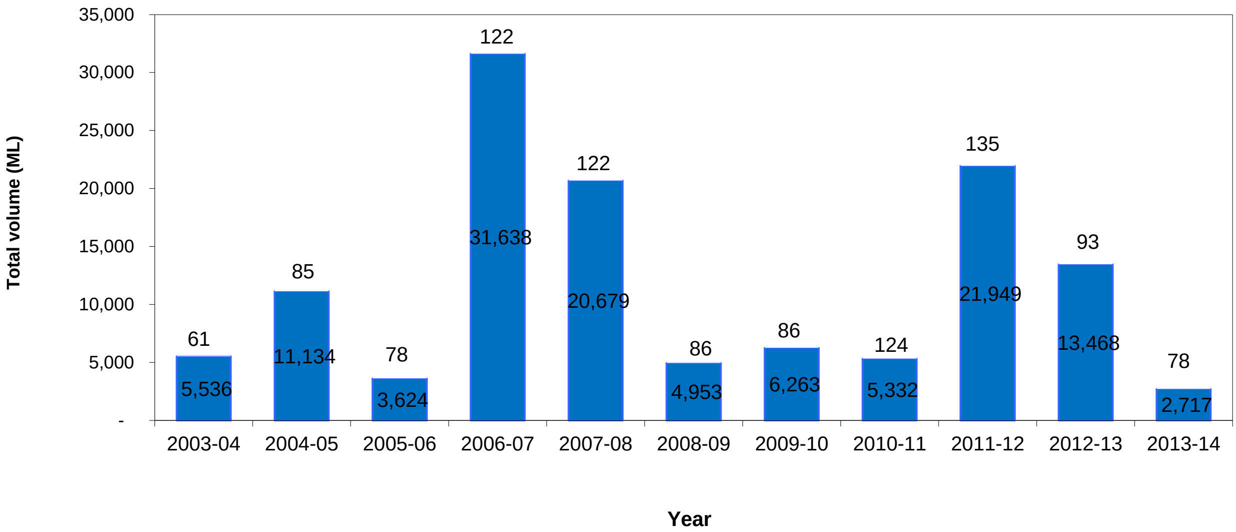
Modelled occurrence and volume of wet weather overflows

Wet weather wastewater overflows occur when the capacity of the network is overloaded. To estimate the volume of these overflows, a model is run based on an established protocol, the 'Trunk Wastewater System Model Update, Re-calibration and Annual Reporting Procedure'.

Last year (2013-14) was predominantly dry with the lowest rainfall recorded in ocean and inland catchments since 2006-07 and 2004-05, respectively. As a result, the wet weather overflow volumes and frequencies in both ocean and inland catchments were much less in 2013-14 in comparison to earlier years (Figure 1-30 and Figure 1-31). The total number of wet weather overflow events in this report is the total of individual overflow events at all overflow locations (mostly designated) of all wastewater systems.

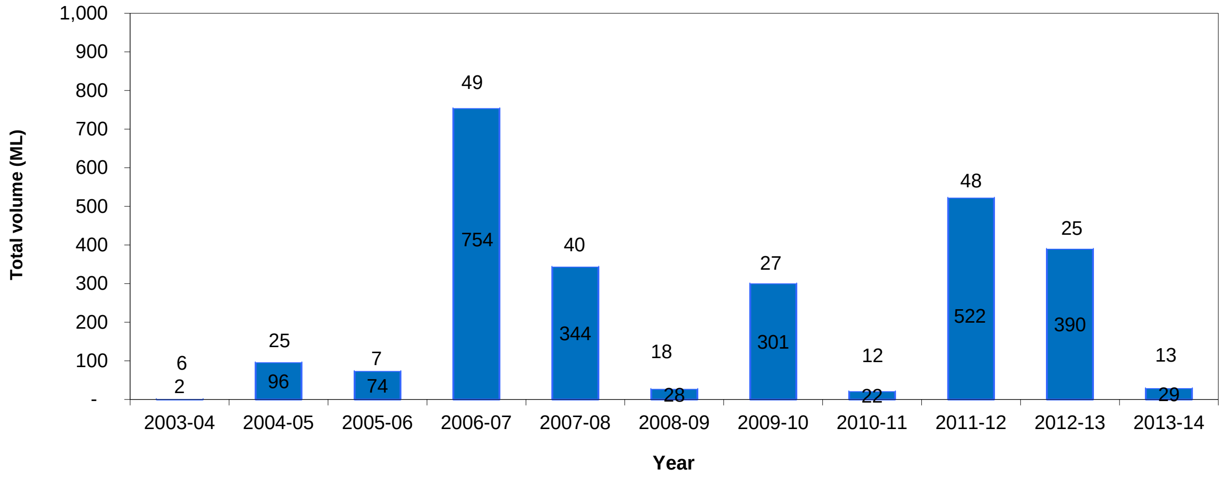
Summaries of wet weather overflow volume and frequency data by each ocean and inland wastewater systems are included in Appendix I (Table 6-38 and Table 6-39).

As expected, the wet weather overflow volume in inland systems was much less than those for the ocean systems due to the size of the catchments. In the ocean systems, the Malabar and North Head are large catchments contributing 73% of total volume of wet weather overflows. Among inland systems, Quakers Hill and St Marys contributed 97% of the total volume of wet weather overflows.



Note: number of overflow events per year is shown at the top of each bar, volume at the middle of bar

Figure 1-30 Previous ten years of modelled wet weather overflow volumes by all ocean wastewater systems



Note: number of overflow events per year is shown at the top of each bar, volume at the middle of bar

Figure 1-31 Previous ten years of modelled wet weather overflow volumes by all inland wastewater systems

Dry weather leakage detection program

The dry weather leakage detection program is specified in the EPLs and has been conducted since 2006. The program is designed to locate leakage from our sewer assets and repair it. The program requires annual monitoring of 211 stormwater sites near the outlet draining every SCAMP and investigating the source of faecal coliforms where levels exceed the EPL threshold (5,000 cfu/100 mL). During 2013-14, 248 routine site visits were conducted for the dry weather leakage program across our area of operations. Some catchments which have historically shown signs of leaks were visited multiple times (every quarter). Looking at results for the whole year, of the 211 catchments, 28 were dry at the time of sampling, indicating no dry weather leaks from the wastewater network to stormwater drains. Thirty seven sites exceeded the 5,000 cfu/100 mL faecal coliform threshold at least once during the year, and 146 sites had faecal coliform results below the threshold. That is, 17.6% of the catchments exceeded the threshold, and 82.4% were either dry or had low faecal coliform results (Figure 1-32).

A detailed summary of routine faecal coliform measurements is included in Appendix J (Table 6-40 to Table 6-49).

In general, the results for 2013-14 showed a similar pattern of compliance to previous years (Figure 132). SCAMPs that have failed the faecal coliform threshold of 5000 cfu/100 mL more than 50% of the time between 2006 and 2014 are shown in Figure 1-33. Figure 1-34 and Figure 1-35 show the range of results at these sites in details. There have been improvements in results in some areas following remediation works.

Eight of the 211 sites consistently exceeded the threshold (three or more times in a row) in 2013-14. These were Camperdown in the Bondi catchment; Ashfield, Bexley, Leichhardt, South Sydney and Summer Hill in the Malabar catchment; and Balgowlah Heights and Lidcombe in the North Head catchment (Figure 1-34). These sites are all located in inner Sydney areas and progress is being made in these sewer catchment areas to locate the source of pollution and fix any faults on the public sewer. Investigation includes visual inspection, faecal coliform and ammonia testing along the stormwater line to trace to source, CCTV inspection and dye testing.

In Camperdown, Ashfield, Bexley and Lidcombe sources of contamination were traced to non-Sydney Water assets. In these cases private sewer lines were incorrectly connected to the stormwater system or boundary traps on private property were broken. Sydney Water liaises with councils, businesses and home-owners in these situations to get leaks fixed.

In Camperdown and Bexley, secondary investigations are also underway to pinpoint other sources of contamination to the stormwater in addition to the private faults identified above.

Investigations into the source of contamination in Balgowlah Heights and Leichhardt also suggest private faults, but further investigation in conjunction with property owners is required to pinpoint the source.

Sources of contamination were traced to Sydney Water assets (e.g. broken, cracked or blocked sewer lines, faulty pipe junctions) in Ashfield and South Sydney. Sydney Water fixed the assets by repairing junctions, relining sewers and thorough cleaning of sections of the system to remove any blockages. In Ashfield, a damaged pipe was identified and repairs begun. A number of repair works took place in South Sydney. When follow up testing was done, results showed that the catchment is still impacted by dry weather sewage leakage so further investigations are still required.

In Summer Hill, the routine faecal coliform result at the start of the year was very high at 2.7 million cfu/100 mL (Appendix J Table 6-40), but no visual evidence of sewage contamination was observed. Similarly, ammonia was low, and no odour was detected. No sewer surcharge in the area had been reported that may have explained the exceedance. Upon resampling the faecal coliform result was much lower, at 7,400 and 6800 cfu/100 mL. There was no evidence of pollution to trace the source. Since then two further investigations have taken place, but no source has been identified.

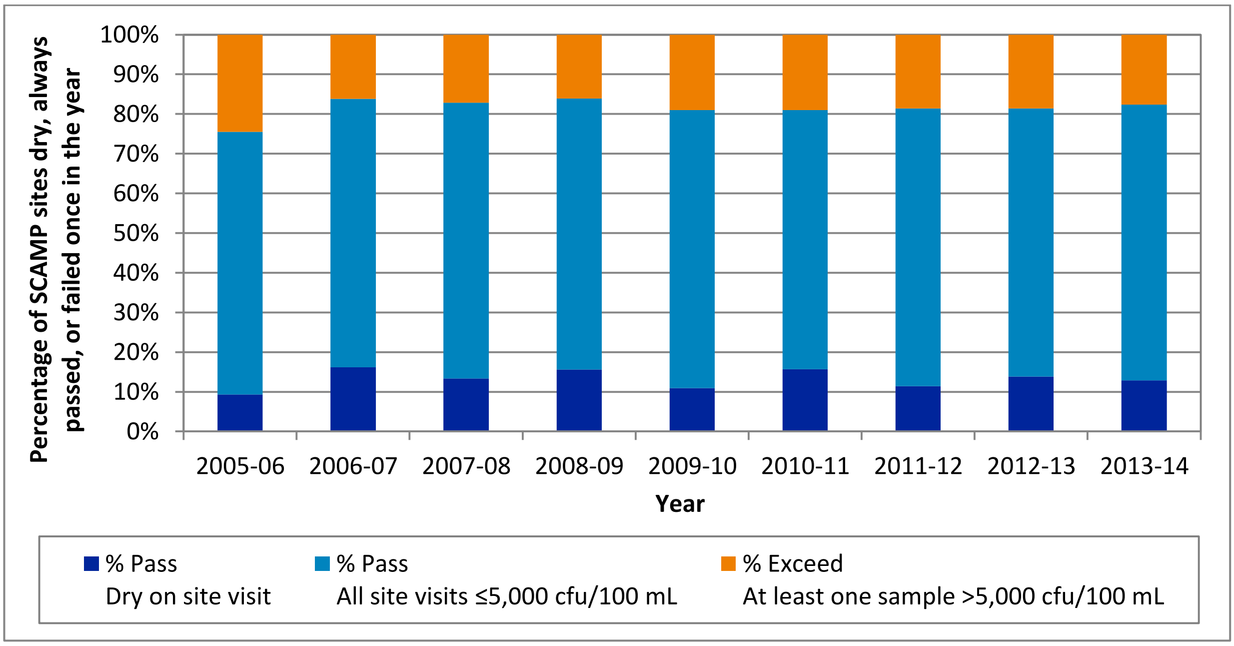


Figure 1-32 Percentage of SCAMPs that were dry, returned faecal coliform results below the 5,000 cfu/100 mL threshold, or exceeded the threshold over the history of the program

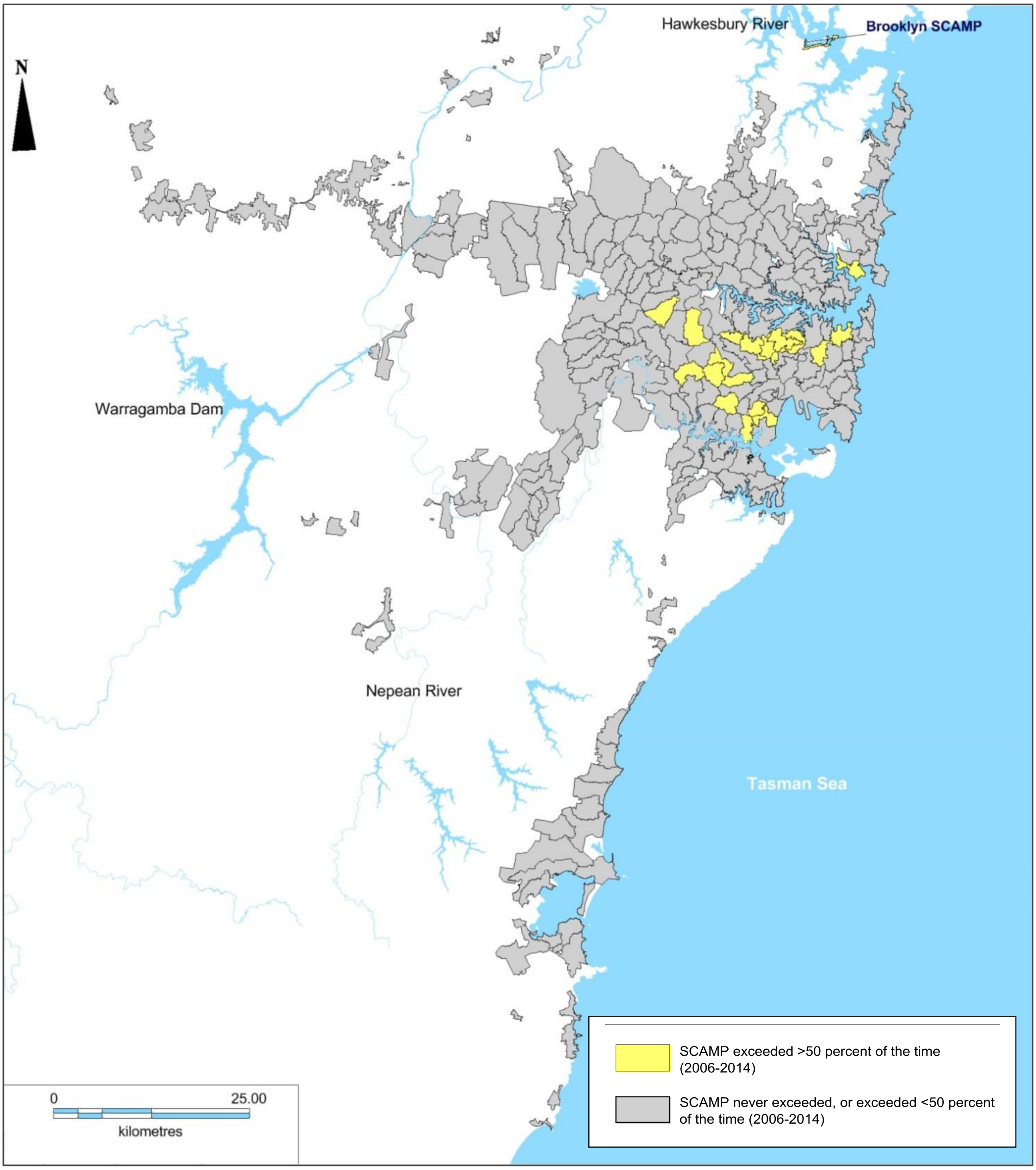


Figure 1-33 SCAMPS that have exceeded the faecal coliform threshold of 5000 cfu/100 mL more than 50% of the time since 2006

Figure 1-34 Central and southern Sydney SCAMPS that have exceeded the faecal coliform threshold of 5000 cfu/100 mL more than 50% of the time since 2006, with proportion of results exceeding shown

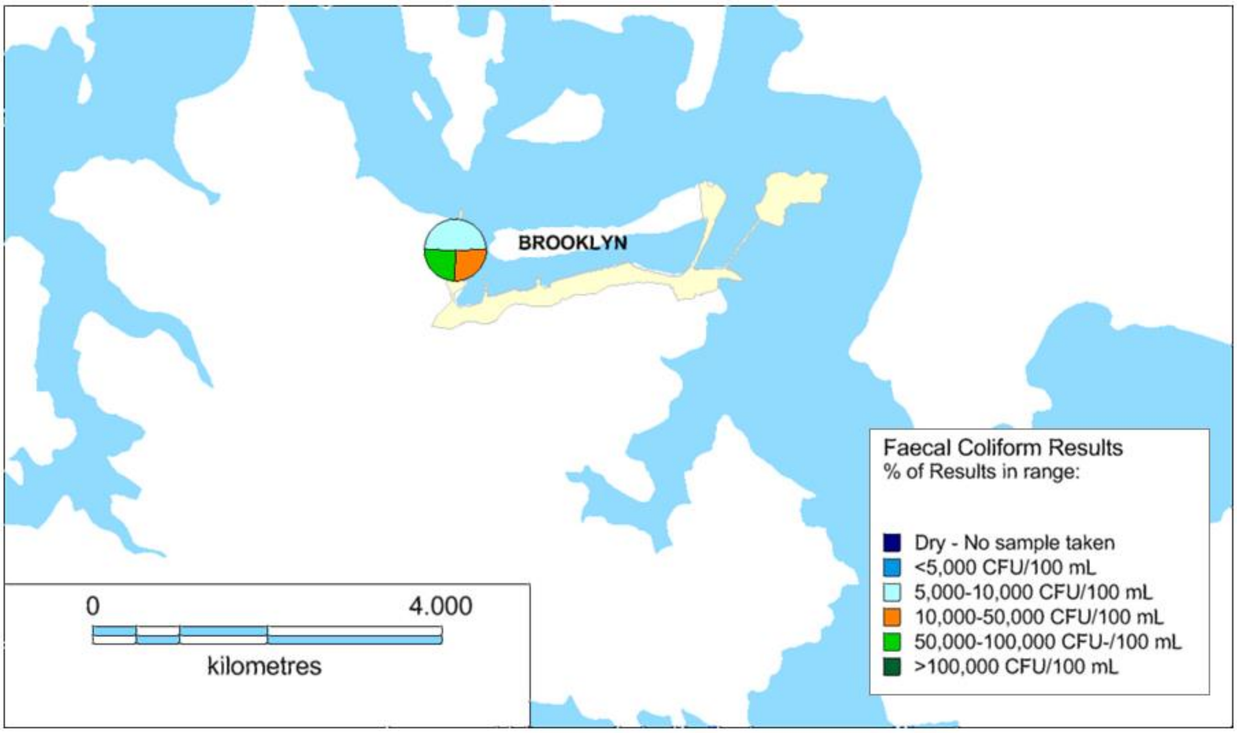


Figure 1-35 Brooklyn SCAMP exceeded the faecal coliform threshold of 5000 cfu/100 mL more than 50% of the time since 2012-13 when monitoring began, with proportion of results exceeding shown

1.4.7 Recycled water

Increased water recycling was a key focus of the 2010 Metropolitan Water Plan. Consistent with the Plan, we continue to take a range of initiatives to increase the use of recycled water across our area of operation to reduce the reliance on highly treated drinking water for non-potable applications. Recycled water is supplied to households, farmers, industries, local councils and recreational facilities such as golf courses and race courses. Recycled water also substitutes up to 18 billion litres of source water previously released from Warragamba dam each year to the Hawkesbury Nepean River system to provide source water to North Richmond Water Filtration Plant. Details of the reuse programs are presented in our annual Water Efficiency Report (Sydney Water 2014c).

Ocean plants

The volume of wastewater reused at each ocean plant during 2013-14 is listed in Appendix B Table 6-9. During 2013-14, a total of 9,511 ML of treated wastewater was reused from the ocean plants. Wollongong plant contributed 70% (6,703 ML) of this volume. The second highest volume was from Liverpool (2,737 ML) which included recycled water from the privately operated Rosehill-Camellia Recycling Water scheme. The scheme supplies recycled water to the Rosehill Race Course and five of Sydney's largest industries in the Rosehill and Smithfield areas.

Recycled water from the Wollongong plant is used in industrial processes at BlueScope Steel, Port Kembla Coal Terminal, Wollongong Golf Club and Wollongong City Council. This saves about seven billion litres of drinking water every year.

The trend in reuse water volume from all ocean plants is shown in Figure 1-36. Compared to 2012-13, water reuse dropped by 21% during 2013-14, but was comparable to 2011-12.

The recycled water plant installed at the North Head plant continues to supply recycled water for onsite reuse. This initiative has substantially reduced potable water usage within the plant.

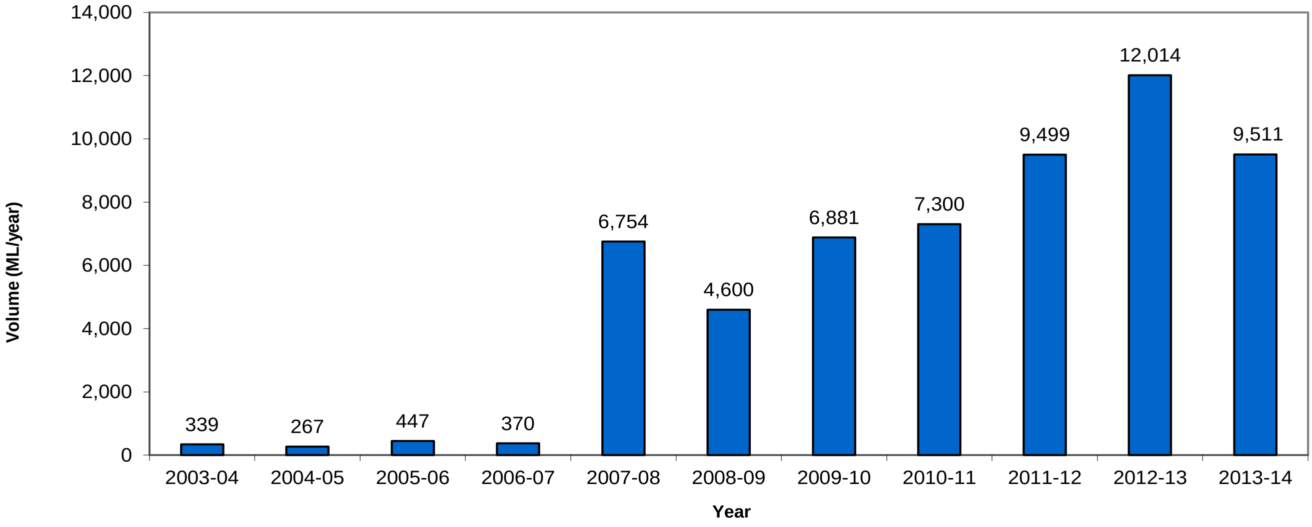


Figure 1-36 Previous ten years of recycled water volumes from all ocean plants

Inland plants

The volume of wastewater reused at each inland plant during 2013-14 is listed in Appendix B Table 6-14 and shown in Figure 1-37. The introduction of the St Marys AWTP in 2010-11 substantially increased the volume of reused water from all inland plants.

The AWTP produces up to 50 ML/day of highly quality recycled water which is discharged into Boundary Creek at Penrith and flows into the Hawkesbury Nepean River below Penrith Weir. As the highly treated recycled water is very low in nutrients, it dilutes nutrient loads in the Hawkesbury Nepean River. In 2013-14, a total of 14,990 ML highly treated recycled water was released into Boundary Creek. This constituted about 81% of the wastewater reused by all inland plants.

The Rouse Hill Recycled Water Scheme supplies recycled water to households via a dual reticulation system for non-potable uses such as toilet flushing and garden watering. In 2013-14, the supply of recycled water by the Rouse Hill plant was 2,137 ML compared to 2,063 ML for 2012-13, an increase of 4%. The Rouse Hill plant accounted for 12% of total wastewater recycled by all inland plants.

The Picton plant recycled 446 ML of wastewater in 2013-14, which was the third highest volume of recycled wastewater produced for reuse among all of the inland plants. The water was reused at an adjacent farm growing fodder crops.

Recycled water is also supplied from Richmond and West Camden plants. In 2013-14, 415 ML of recycled water was supplied from the Richmond plant to the University of Western Sydney for irrigation which is a 111% increase in comparison to 2011-12. About 215 ML was supplied from the

West Camden plant to Elizabeth Macarthur Agricultural Institute for irrigation, slightly less than 2012-13.

Recycled water from St Marys, Castle Hill, and Penrith plants was used to irrigate local playing fields and golf courses. The volume of recycled water produced by the Penrith plant increased to 30 ML in 2013-14 in comparison to 13 ML a year ago (2012-13).

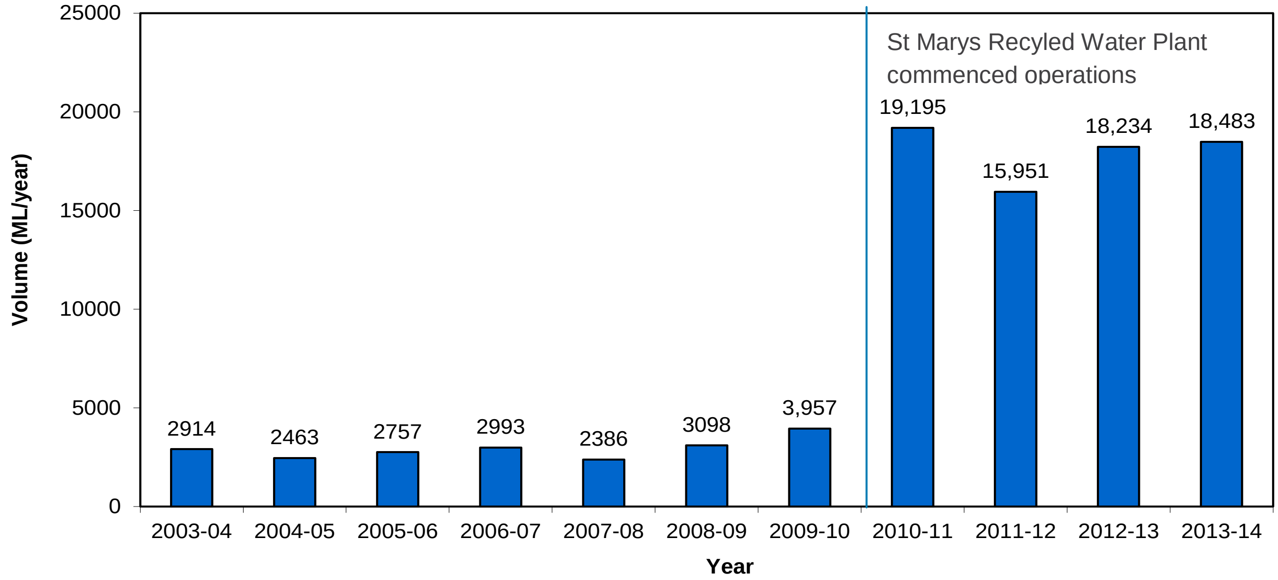


Figure 1-37 Previous ten years of recycled water volume from all inland plants

2 Testing of Shellharbour rocky intertidal assemblages

2.1 Introduction

Monitoring of rocky-intertidal communities under the shoreline outfall program assesses potential ecological impact from the Shellharbour plant, which discharges into the near-shore ocean environment. The structures of natural communities (without anthropogenic impacts) from two reference (control) sites were used in assessment of the Shellharbour outfall (impact) site (Figure 1-8). Shellharbour was the only plant that could be measured under this program, as health and safety risks precluded sampling at four other ocean outfall locations. The Shellharbour outfall site is situated about 2 km north of the two control sites (Figure 1-8). The control sites were situated about 400 m apart.

Rocky-intertidal communities are comprised of macro algae and macro invertebrates. These organisms will also colonise a variety of man-made structures such as breakwaters, jetties, docks, groynes, dykes and seawalls (Crowe et al., 2000). Wave exposure is known to influence distribution and abundance of rocky-intertidal communities between exposed headlands and sheltered bays or inlets (Crowe et al., 2000). To control this natural influence, sites were selected that had similar levels of wave exposure. Rocky-intertidal community structure was recorded from wave-exposed ocean headland locations on naturally occurring rock platforms that could be safely accessed at low tide. Measurements were also conducted in similar periods of the year, late winter to spring, to reduce the influence of annual recruitment.

At each site, community composition and enumeration was recorded once each year between late winter to late spring (to reduce the influence of annual recruitment). Photographs of a 0.25 m^2 quadrat were taken within two hours either side of low tide. To allow for differences in space and time, 14 randomly selected 0.25 m^2 quadrats were photographed between the low and high tide marks in the mid-littoral zone at each site. Back in the office counts were recorded for macro invertebrate taxa and estimates of percentage cover were made for macro algae off these photographs. The taxonomic level recorded was based on morphological characters that could be seen with the naked eye (presented in Appendix D). Identification of macro invertebrate taxa and macro algae was checked against Edgar (1997) and Dakin (1987).

An initial analysis of Spring 2013 rocky-intertidal community data was followed by a combined analysis of 2008 to 2011 and 2013 data collected under the STSIMP. Data for 2012 were omitted as only 10 replicates were collected for control site-2 instead of the usual 14 photo quadrat replicates from a site. This provided a balanced dataset in the comparison of these sites to each other through time.

Shoreline outfall discharges with documented measurable impacts in intertidal community structure are typically limited in spatial extent from 100 m to 300 m (Fairweather 1990 and AWT 1998). These intertidal community structures were dominated by extensive covers of green macro algae. A pictorial example of a localised spatial impact of about 50 m (Figure 2-1) was seen at Barrack Point outfall in 2001. At that time an extensive cover of green macro algae occurred with few invertebrates (EP Consulting 2003). This was prior to upgrade works conducted at the Shellharbour plant in the early to mid-2000’s (Sydney Water 2012).

Ceasing shoreline wastewater discharge at North Head and Malabar resulted in a decrease in the percentage cover of green macro algae together with an increase in other species present as was comparable with reference locations (Archambault et al. 2001). Hence the statistical analysis of the

STSIMP monitoring data should focus on changes in community composition in ecological assessment of wastewater discharges from the Shellharbour plant at the Barrack Point outfall.

Figure 2-1 Historic image (2001) of Barrack Point with an unhealthy intertidal rock platform community impacted by wastewater discharges from the Shellharbour plant prior to upgrade in the early to mid 2000's

Prior to multivariate analysis of community data, data were transformed with a fourth root transformation and an association matrix was constructed based upon the Bray-Curtis resemblance measure.

The Bray-Curtis resemblance measure is focused on compositional changes in taxa identities (Anderson and Walsh 2013). This is an appropriate choice since the impact from the near shore wastewater discharge at Shellharbour did cause a change in the composition of the intertidal rock platform community.

Multivariate data analyses were performed using statistical routines of the PRIMER Version 6.1.16 software package (Clarke and Warwick, 2001) and the add-on module PERMANOVA+ Version 1.0.6. (Anderson et al, 2008).

2.2 2013 analyses

Data patterns were visually displayed in ordination plots of the rocky-intertidal community photo quadrat data. Plots were based on the whole community (Figure 2-2).

The nonmetric multidimensional scaling (nMDS) ordination routine of PRIMER was employed to produce two–dimensional ordination plots. In these plots the relative distance between samples is proportional to the relative similarity in taxonomic composition and abundance – the closer the points on the graph the more similar the community (Clarke 1993). That is, site samples with similar taxa lie closer together and site samples with a differing taxon composition lie farther apart. An unconstrained ordination procedure such as nMDS inevitably introduces distortion when trying to simultaneously represent the similarities between large numbers of samples in only two or three dimensions. The success of the procedure is measured by a stress value, which indicates the degree of distortion imposed. In the PRIMER software package, a stress value of below 0.2 indicates an acceptable representation of the original data, although lower values are desirable. Where stress values are just above 0.2, the patterns displayed should be confirmed with other techniques such as permutational multivariate analysis of variance (PERMANOVA) and canonical analysis of principal coordinates (CAP). A two-dimensional stress values of 0.15 (Figure 2-2) indicated the pictorial representation provided a suitable display of these data.

The nMDS ordination displayed control site-1 to be partly overlapped with outfall site data points. Control site-2 data points were situated next to the mass of control site-1 and outfall site data points with one exception (Figure 2-2).

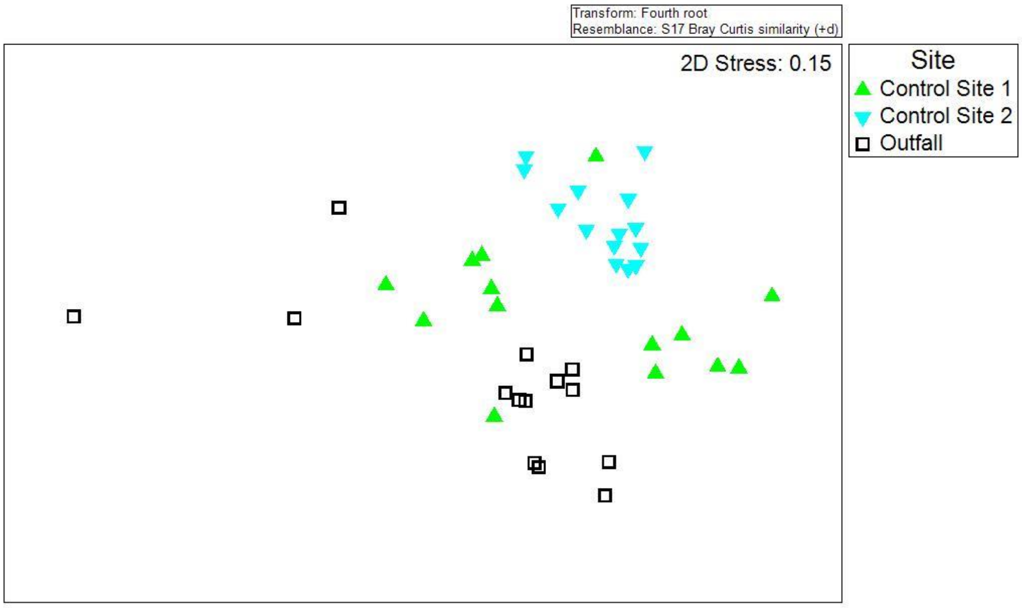


Figure 2-2 Two-dimensional ordination plot of rocky intertidal community structure at Shellharbour outfall and two control sites, with sites colour coded

Data were then further explored with hypothesis testing. An asymmetrical PERMANOVA was constructed with the fixed factor ‘Control / Impact’. The outfall site was the only site under the ‘Impact’ location and the two reference sites formed the ‘Control’ location. As there was only one outfall site P values were obtained with the Monte Carlo test option. Sites nested within ‘Control / Impact’ were treated as a random factor ‘Site (Control / Impact)’. This design was also balanced, as the same results were produced under Type III and Type I Sums of Squares. PERMANOVA was run with 9999 permutations under a reduced model. P values were obtained with the Monte Carlo test option.

Before running asymmetrical PERMANOVA multivariate dispersions were assessed with PERMDISP. This testing indicated homogeneous dispersions for the factor ‘Control / Impact’ (df1 = 1, df 2 = 40, F = 0.1454 P(perm) = 0.7653). This test outcome suggested variability between photo quadrat samples from the outfall site lay within the range of natural variability shown by between photo quadrat samples of the control sites.

Assessment under asymmetrical PERMANOVA indicated there was no measurable difference in community structure between Control / Impact locations (df = 1, MS = 7577.5, Pseudo F = 1.4048, P(MC) = 0.6718). Test statistics returned for the 'Site (Control / Impact)' factor indicated significant differences between sites (df =1, MS = 5294.2, Pseudo F = 8.0892, P(MC) = 0.0001).

A summary of 2013 results is provided in Figure 1-8.

2.3 2008 to 2011 and 2013 analyses

Data from 2013 were analysed with data from 2008 to 2011. This data pattern was visually displayed in a two-dimensional nMDS ordination plot (Figure 2-3). This plot had a similar pattern to that displayed in the 2013 ordination plot (Figure 2-2). That is, control site-1 partly overlapped with outfall site data points, and control site-2 data points were situated next to a mass of control site-1 and outfall site data points (Figure 2-3).

To further inspect this ordination pattern, site by year sample groups were colour coded (Figure 2-4). This colour coding suggested there was some shift in community structure within each site between years. The nMDS ordination plot of centroids for each site-time group of samples provided a clearer view of temporal shifts in community structure at each site (Figure 2-5).

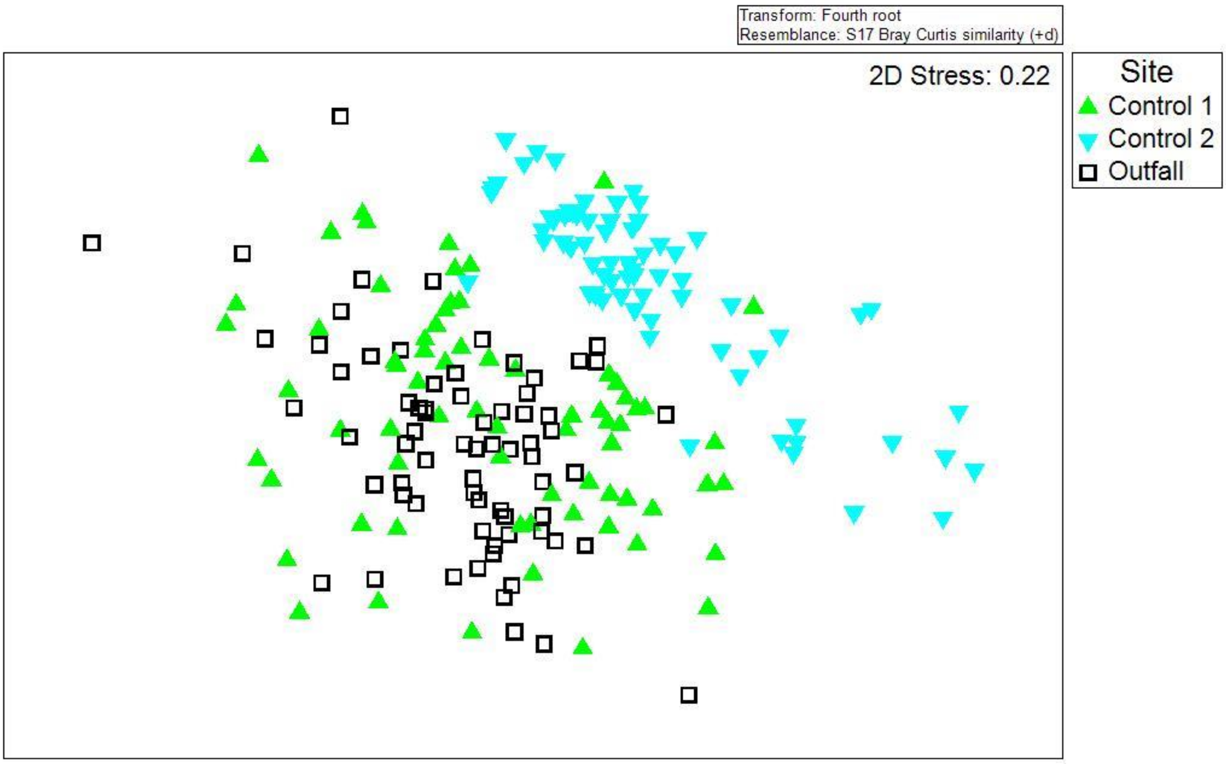


Figure 2-3 Two-dimensional ordination plot of rocky intertidal community structure at Shellharbour outfall and two control sites for years 2008 to 2011 and 2013, with sites colour coded

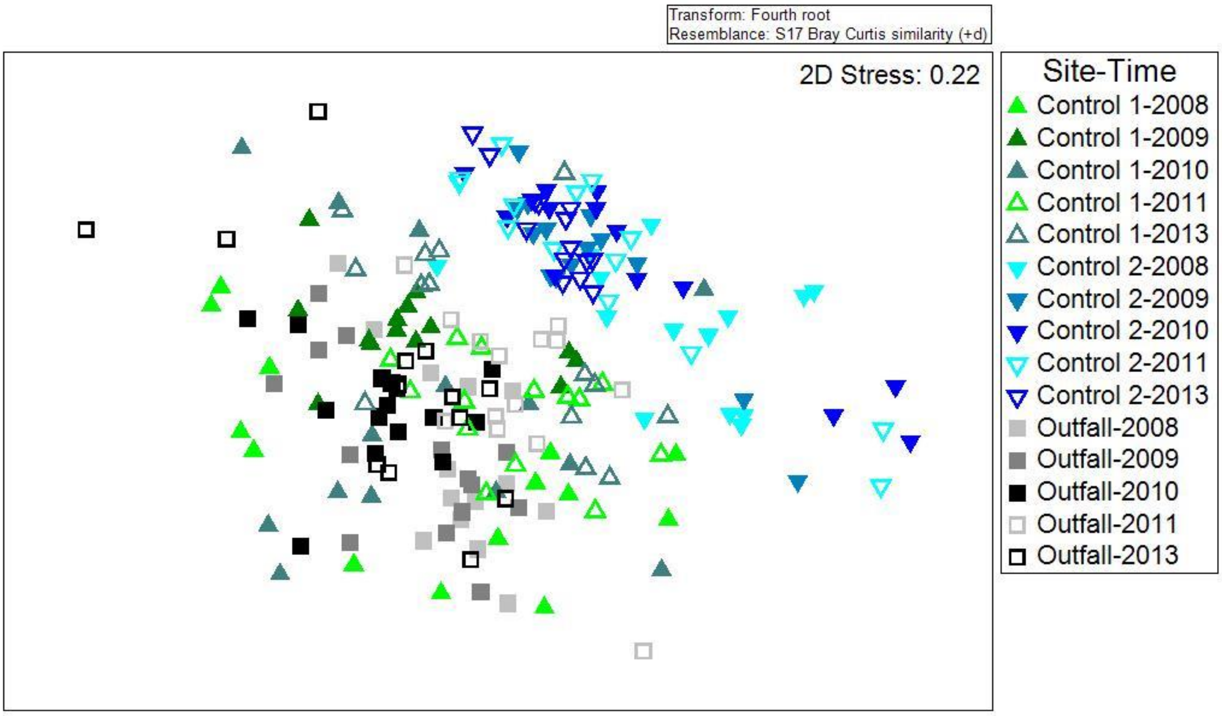


Figure 2-4 Two-dimensional ordination plot of rocky intertidal community structure at Shellharbour outfall and two control sites for years 2008 to 2011 and 2013, with site and year colour coded

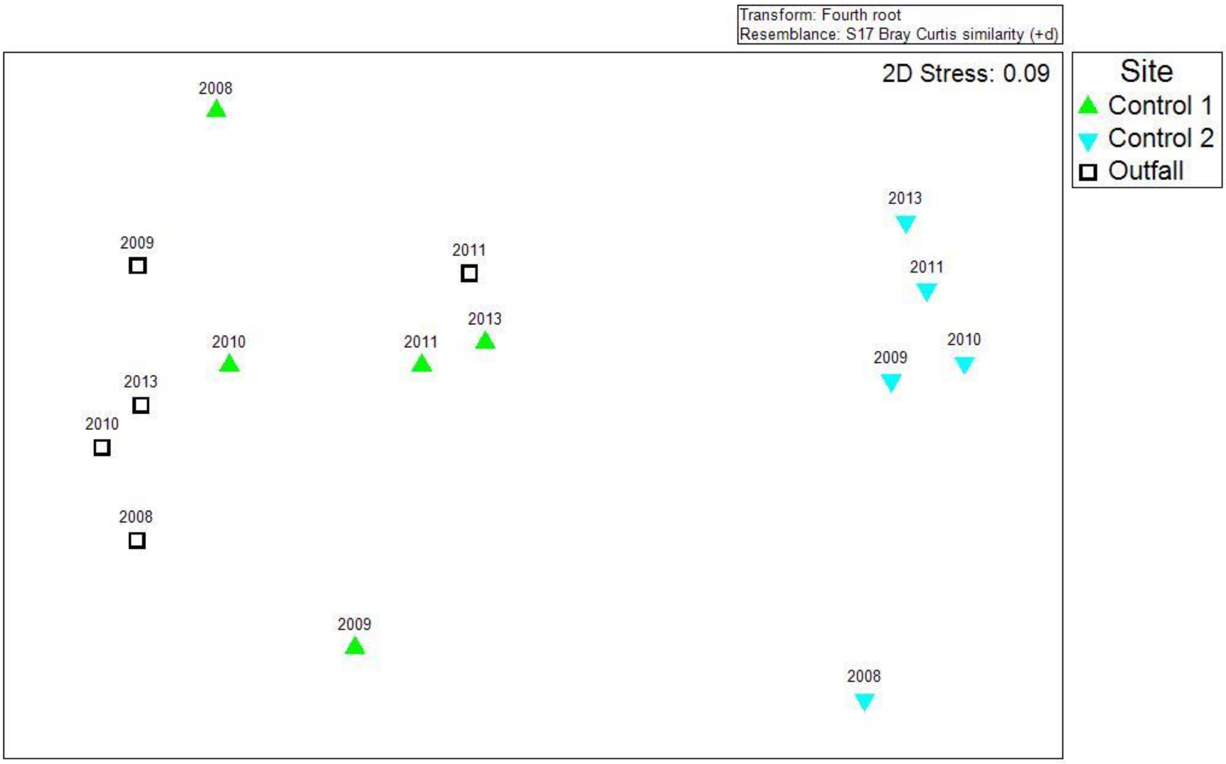


Figure 2-5 Two-dimensional ordination plot of site-year centroids of rocky intertidal community structure at Shellharbour outfall and two control sites for years 2008 to 2011 and 2013

The group average classification technique was used to place the sampling sites into groups, each of which had a characteristic community structure based on the relative similarity of their attributes. The tree diagram output from the classification analysis was checked to see if control (site 1 and site 2) and outfall (a-priori) groups of samples were separated high up in the tree diagram. This was not the case. Rather the initial group of samples were mainly from control site-2. Then seven divisions in the tree diagram were required before two broad groups of samples presented. These two broad groups generally mirrored the pattern in the ordination plots with the remaining control site-2 samples forming one group and a mixture of outfall and control site-1 samples formed the other group. Although a few control site-1 samples and an outfall sample clustered with the control site-2 samples (Figure 2-6). As the tree diagram did not display a group of outfall site samples and another group of control site samples in the first split of the plot, the returned groupings suggests wastewater discharges did not measurably impact the rocky intertidal community at Barrack Point within the 2008 to 2013 period.

The similarity percentages (SIMPER) routine was used to explore which taxa were principally responsible for differences between sets of samples defined a-priori. These groups were from control and outfall sites of each year. This routine employed Bray Curtis similarities to examine the contribution of individual taxa to the average similarity between groups and within groups.

Analysis of the 2008 to 2011 and 2013 period indicated the percentage contribution of each taxon to the community structure generally changed between years at each site (Appendix D). The most dominant taxon was usually barnacles, but this did vary between years and sites. Variability in community structure at all three sites within the five study years was not surprising, as Underwood and Chapman's (1998) study of sheltered rocky-intertidal communities generally supported the view that communities on rocky-intertidal shores are haphazardly constructed and temporally dynamic in composition.

This SIMPER analysis also put into context the community structure recorded in 2013 at the outfall site which had a contribution of about 20% green macro algae and 35% of barnacles. A similar community structure was recorded at control site-1 in 2010 where green macro algae had a contribution of about a 20% while barnacles contributed about 30% to the community structure. In both these years at these sites invertebrates comprised about 75% of the community (Appendix D). These SIMPER results suggest there was no measurable impact from wastewater discharges near the Shellharbour outfall at Barrack Point.

In 2012 small patches of green macro algae were present between numerous barnacles at Barrack Point (Figure 2-7). The intertidal rock platform community at Barrack Point in 2013 had an increase in green macro algae from that present in 2012. A similar fluctuation such as this was evident in SIMPER statistics for Barrack Point between 2008 and 2009 (Appendix D).

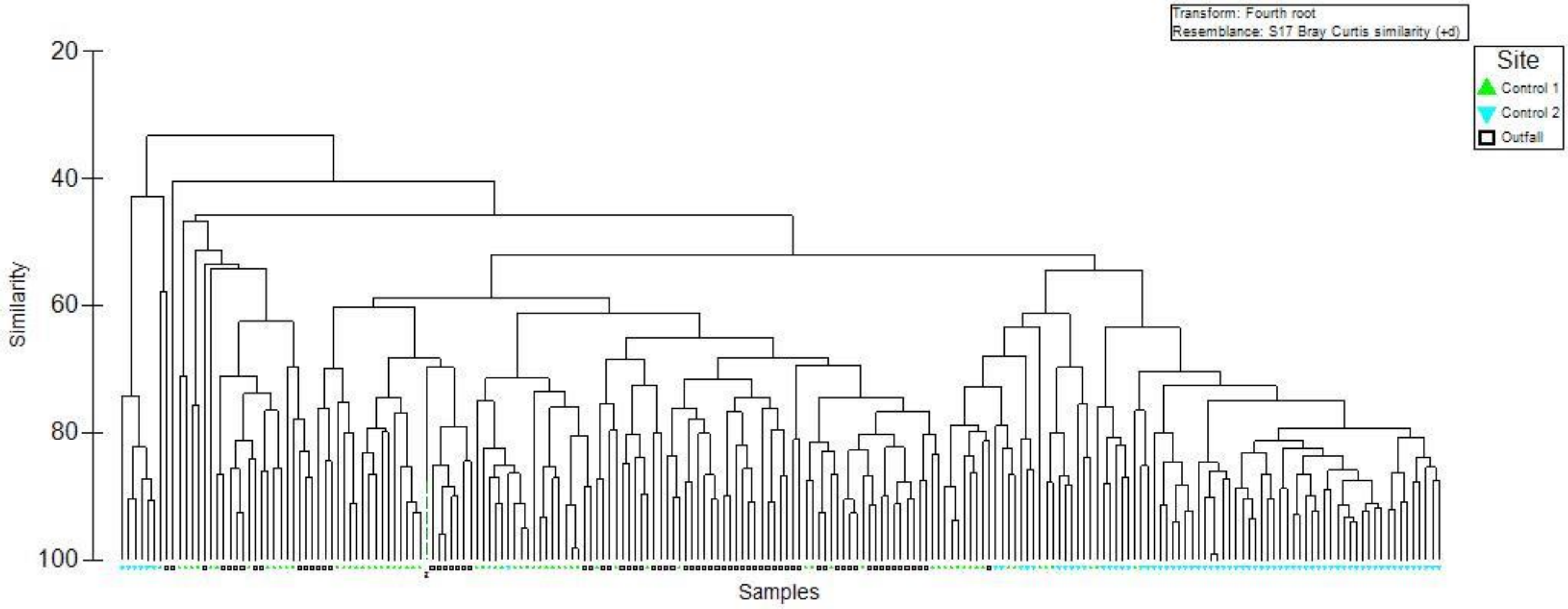


Figure 2-6 Tree diagram of rocky intertidal community structure at Shellharbour outfall and two control sites for years 2008 to 2011 and 2013, with site colour coded

Figure 2-7 A healthy intertidal rock platform community at Barrack Point in 2012

The CAP routine is designed to 'ask are there axes in multivariate space that best separate groups' (Anderson et al. 2008). An unconstrained ordination such as nMDS attempts to display the greatest total variation across the multivariate data cloud, whereas CAP was able to search out groups that may be in a different direction to the primary direction of greatest variation. A first pass of the CAP routine was run and after viewing diagnostic statistics an 'm' value of 2 was chosen to make the second pass. The second pass indicated a 76% allocation success and the first squared canonical correlation was moderately large ($\delta 12 = 0.75$). The Pillar's trace statistic was significant (0.75002 $p = 0.0001$) and indicated there was more than one group of samples in multivariate space.

The CAP plot (Figure 2-8) of the control and outfall samples had a similar pattern to that of nMDS plot (Figure 2-3) with one distinct group of samples from control site-2 and another group of overlapped samples from the outfall site and control site-1. This suggested there was no additional dimensionality to that shown in the nMDS ordination plot, and it also indicated that the nMDS plot displayed an adequate representation of the data.

The 'cross validation leave-one-out allocation of observations to groups' part of the CAP routine shed light on the displayed pattern. Virtually all of the samples from control site-2 were grouped together, with an allocation success of 97% indicating a distinct community composition. Whereas allocation success was 61% for control site-1, and 69% for the outfall site. These lower allocation percentages reflected the overlap in community structure of the outfall site and control site-1. This overlap in community structure is shown in the misclassified sample statistics. Of the 27 misclassified samples from control site-1, 23 were allocated to the outfall site. Likewise of the 22 misclassified samples from the outfall site, 20 were allocated to control site-1. These CAP findings also suggested the operation of the Shellharbour plant over the five year period has not measurably impacted ecological health of the rocky intertidal community at Barrack Point.

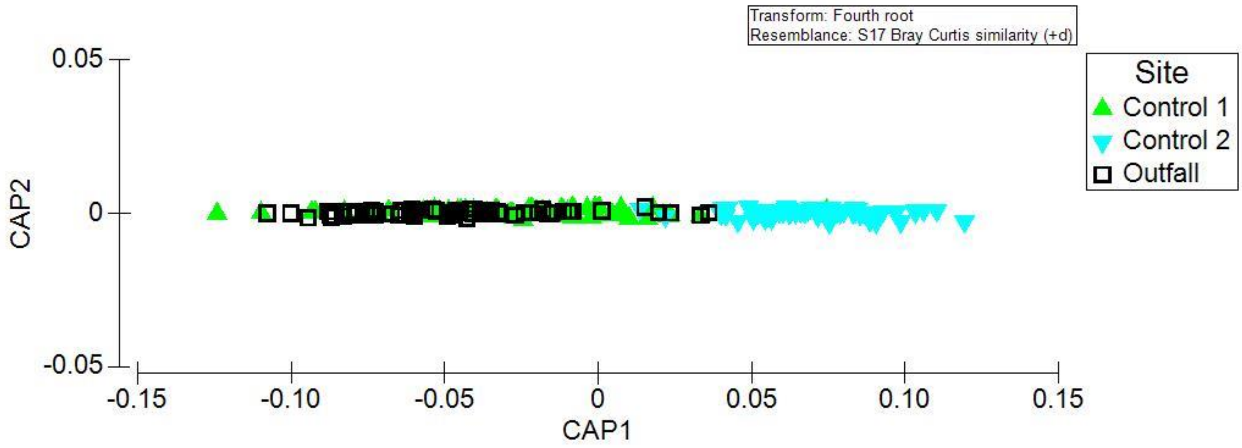


Figure 2-8 CAP ordination plot of rocky intertidal community structure at Shellharbour outfall and two control sites for years 2008 to 2011 and 2013, with site colour coded

It should be noted it is not appropriate to use a CAP plot to describe multivariate dispersion, as the CAP routine is designed to seek out separation of group centroids, and in the process it ignores or destroys differences in dispersion amongst groups (Anderson et al. 2008). Inspection of datasets for multivariate dispersion can be done visually with nMDS plots and formally tested with the PERMDISP routine.

The PERMDISP routine was run on site sample groups for the five years of data as displayed in the ordination plot in Figure 2-3. The PERMDISP analysis indicated a similar pattern of dispersion between control site-2 and the outfall site (t = 0.7670 P(perm) = 0.5003) while a different pattern of dispersion existed between control site-1 and the outfall site (t = 2.355 P(perm) = 0.0329) and control site-2 and control site-1 (t = 2.8567 P(perm) = 0.0139). These results confirm the balanced dataset employed in this statistical analysis was appropriate and the decision to omit 2012 data was correct.

PERMDISP was then run on a finer dissection of site-time groups of samples as displayed in the ordination plot in Figure 2-4. A second run of PERMDISP based on site-time groups indicated there was a mix of significant and non-significant results (Appendix E). Heterogeneous multivariate dispersion occurred between control site-1 and control site-2 in about one third (36%) of the site-time comparisons. A similar level of heterogeneous multivariate dispersion occurred for comparison of control site-1 with the outfall (36%). Less heterogeneous multivariate dispersion (16%) was recorded in the site-time comparisons of control site-2 to the outfall site. Thus no consistent change occurred in multivariate dispersion across these five years and this in turn suggested wastewater discharges had not influenced the variability in community structure at Barrack Point.

To explore community structure differences, hypothesis testing was conducted with the same balanced asymmetrical PERMANOVA model as used for 2013 data. Model terms were the fixed factor 'Control / Impact' and random factor 'Sites (Control and Impact)'.

The returned test result for the 'Control / Impact' factor was non-significant (df = 1 MS = 25101 Pseudo F = 0.7368 P(MC) = 0.6063), while differences were indicated between sites as a significant result was returned for the 'Site (Control / Impact)' factor (df = 1 MS = 34065 Pseudo F = 37.656 P(MC) = 0.0001). A negative value was returned for the 'estimate of the component of variation' for the 'Control / Impact' factor (-96.048) suggesting removal from the model would be appropriate. In other words the ‘Control / Impact’ factor did not contribute to the variation in the model when variation was partitioned according to the inputted model terms.

To further partition variation in the above asymmetrical PERMANOVA model the random factor ‘Time’ was added. This model then comprised the fixed factor ‘Control / Impact’, and the random factors ‘Sites (Control and Impact)’ and ‘Time’, which represented years 2008 to 2011 and 2013. ‘Time’ was considered a random factor as surveys were conducted at varying times through late winter to late spring each year.

Test results indicated was no significant difference between ‘Control / Impact’ locations for 2008 to 2011 and 2013 survey data (df = 1 MS = 25101 Pseudo F = 0.7581 P(perm) = 0.6603). The ‘Time x Control / Impact’ factor was also non-significant (df =4 MS = 3331.5 Pseudo F = 1.0255 P(perm) = 0.4785), as was the ‘Time’ factor (df = 4 MS = 4701.1 Pseudo F = 1.4473 P(perm) = 0.1953). The ‘Control / Impact’ and ‘Time’ factors were returned at a level that allowed removing them from the model as it met rule-of-thumb criteria of Winer et al (1991) and Underwood (1997). Removal of the ‘Control / Impact’ factor was also suggested as appropriate since a negative value was returned for the ‘estimate of the component of variation’ of this factor (-96.937). This negative value also indicated the ‘Control / Impact’ factor did not contribute to the variation in the model when variation was partitioned according to the inputted model terms.

Results from hypothesis testing of models suggested there was no measurable impact in the rocky intertidal community from wastewater discharges at Barrack Point.

2.4 Conclusion

Community structure of the outfall site was shown to vary through time as also occurred at control sites. The level of variation was within that observed at the control sites, particularly control site 1. Based upon morphological surveys of the intertidal rock platform community indicator multivariate analyses of community structure indicated there was no measurable impact in the intertidal rock platform community near the outfall at Barrack Point from wastewater discharges of the Shellharbour plant since the start of monitoring under the Sewage Treatment System Impact Monitoring Program (2008 to 2013).

3 Ecosystem health: Intertidal communities

3.1 Surveys of rocky-intertidal communities

The objective of this indicator was to measure the general ambient condition of Sydney estuaries that may be impacted by Sydney Water activities. Monitoring of rocky-intertidal communities occurred at relatively wave-sheltered sites in Sydney's estuaries. Wave-sheltered areas have infrequent wave activity.

The gradient of salinity within estuaries has a known effect on patterns of distribution and abundance of rocky-intertidal communities (Crowe et al., 2000). To minimise this natural influence, locations were divided into two salinity zones. In each salinity zone, test (impact) sites fell into two categories: those situated in bays below urbanised areas that may be impacted by sewer overflows; and in other urbanised areas that may have other catchment influences. The latter were studied as urban (positive-control) sites. Locations in bays below natural bushland acted as reference (near-pristine control) sites to allow comparison of test site community structure.

Rocky-intertidal communities are comprised of macro algae and macro invertebrates (macro is defined as visible to the naked eye). These organisms will also colonise a variety of man-made structures such as breakwaters, jetties, docks, groynes, dykes and seawalls (Crowe et al., 2000). Rocky-intertidal community structure was recorded from wave-sheltered locations on naturally occurring rock platforms that could be safely accessed at low tide. Sites with similar levels of low wave exposure were selected in an attempt to minimise this natural influence. This natural influence is known to influence distribution and abundance of rocky-intertidal communities between exposed headlands and sheltered bays or inlets (Crowe et al., 2000).

The abundance and diversity of littoral flora (macro algae) and fauna (macro invertebrates) that occur on suitable intertidal rocky reef substrates were used to assess rocky-intertidal community health. Measurements were conducted from 26 sites (Table 3-1) annually, between late winter and late spring to reduce the influence of annual recruitment. Measurements were made within two hours either side of low tide using a 0.25 m^2 quadrat. The taxonomic level recorded was based on physical (morphological) characters that could be seen with the naked eye. This had the benefit of making the method relatively rapid. Identification of macro invertebrate taxa and macro algae was checked against Edgar (1997) and Dakin (1987).

Reference (control) sites were situated in wave-sheltered bays of non-urbanised National Park catchments far removed from boats and receiving only natural rain runoff. Reference sites had a community structure dominated by oysters and gastropods. In contrast, barnacles and green algae tended to dominate test sites predominantly disturbed by sewer overflows.

Data prior to 1997 were omitted as test and urban sites may have been influenced by the increase in oyster numbers in response to the partial ban of tributyltin based antifouling paints in 1989 (Birch et al. 2013).

Table 3-1 Estuarine rocky-intertidal community monitoring sites

Estuary	Code	Site description	Relative salinity zone	Site category
Port Jackson	PJ01	Silverwater Bridge/ Wilson Park	Low	Urban positive-control
	PJ025	Kissing Point Bay	Low	Test
	PJ082	Hawthorn Canal arm of Iron Cove	Low	Test
	PJ115	Lavender Bay	High	Test
	PJ33	Rushcutters Bay	High	Test
	PJ13	Little Sirius Cove	High	Test
	PJ28	Quakers Hat Bay	High	Test
	PJ05	Lane Cove River/ Woolwich Baths	Low	Test
	PJ295	Sugarloaf Bay / Castlecrag	High	Test
	PJ315	Bantry Bay	High	Urban positive-control
Botany Bay	CR04	Alexandra Canal at Canal Bridge Road	Low	Urban positive-control
	CR06	Wolli Creek	Low	Urban positive-control
	GR01	Cooks River (d/stream Muddy Creek)	High	Test
	GR085	Quibray Bay / Kurnell	High	Urban positive-control
	GR175	Georges River (Edith Bay)	Low	Test
	GR115	Georges River (Kyle Bay)	Low	Test
	GR15	Woronora River / Como	Low	Test
	GR18	Salt Pan Creek d/s road bridge	Low	Urban positive-control
Port Hacking	PH04	Gunnamatta Bay	High	Test
	PH05	Maianbar	High	Reference (control)
	PHe05	Southwest Arm	High	Reference (control)
	PH10	Hacking River near Wants Beach	Low	Reference (control)
Pitt Water	PW10	McCarrs Creek	High	Reference (control)
	PW12	The Basin	High	Reference (control)
Hawkesbury	N06	Marlo Bay	Low	Reference (control)
	NB115	Kimmerikong Bay	Low	Reference (control)
	NCC01	Coal and Candle Creek	Low	Reference (control)
	NCC02	Smiths Creek	Low	Reference (control)

In light of recent research the statistical test based on the ANOSIM technique run in 2011 was not repeated in 2014. Recent evaluation of this technique indicated ANOSIM performed poorly in the presence of heterogeneity in multivariate dispersion (Anderson and Walsh, 2013). Heterogeneity in multivariate dispersion is a common feature of ecological data.

In the 2014 assessment year the Principal Coordinates Analysis (PCO) that was also run in 2011, was run again as it was unaffected by outcomes of recent research. Longer term trends at sites over the period 1998 to 2013 were explored with years plotted against coordinates of axis one of a PCO. A separate analysis was conducted for each salinity zone.

PCO is an ordination technique that is a projection of points onto axes that minimise the residual variation in the space of a chosen dissimilarity measure (Anderson et al 2008). The user chooses the number of axes to include in the output, but usually the first 2 or 3 axes contain most of the percent variation explained. In the analysis presented here, PCO was based on a matrix from a distance among centroids analysis, which was calculated from a Bray-Curtis distance measure matrix of square root transformed data for site by year. The Bray-Curtis resemblance measure is focused on compositional changes in taxa identities (Anderson and Walsh 2013). As such, this is an appropriate choice since we understand in wave-sheltered areas at sites that had measurable impacts after remediation a change in taxonomic composition was recorded (Sydney Water 2012).

The subsequent PCO output allowed visualisation of these centroids in Bray-Curtis space for each site by plotting output for PCO axis 1 against year. This explained 27% variation for the high salinity zone and 59% variation of the low salinity zone. This suggested the low salinity analysis provided a better and more adequate model of the data (72% of variation explained by first two PCO axes) than for the high salinity analysis (46% for the first two PCO axes) (Figure 3-1 and Figure 3-2).

In the relatively higher salinity zone community structure of test sites in more recent years since 2006 has more closely approached that of reference (control) sites. Sydney Water (2004) remediation in the early 2000's possibly contributed to improvement at test sites such as Rushcutters Bay (PJ33) and in the Cooks River downstream of Muddy Creek (GR01). A number of other test sites had relatively similar community structure to reference sites (Figure 3-1). The same trend was observed for the urban positive control site at Quibray Bay (GR085) and at Bantry Bay (PJ315).

Apparent in the plot of sites from the lower salinity zone is the decline in two reference sites situated in the Hawkesbury Nepean River (N06 and NB115). This decline occurred after 2006 and is attributed to natural QX disease that is specific to the Sydney Rock oyster (*Saccostrea glomerata*). QX is caused by a protozoan (single-celled) parasite (*Marteilia sydneyi*) (Butt and Raftos, 2007). From the mid-2000's the occurrence of QX disease has been present in farmed oysters of the Hawkesbury Nepean River (Summerhayes et al 2009a, Summerhayes et al, 2009b).

As oysters are a dominant taxon in the community structure of reference sites, these two sites were no longer representative of the best attainable reference condition. Thus two new reference sites were added into monitoring for the lower salinity zone in 2012. These new sites are currently unaffected by QX disease and are situated away from oyster leases in the Cowan arm of the Hawkesbury Nepean River.

When the above two sites were taken into account, a contrast to the higher salinity zone was shown in the lower salinity zone where community structure of the reference and positive control sites differed. The only exception to this was for the Wolli Creek urban site (CR06) in 2013 that had community structure like that of the reference sites.

In the lower salinity zone, apparent positive responses in community structure of test sites occurred in the lower Lane Cove River (PJ05) and in the Hawthorne Canal arm of Iron Cove (PJ083) and seemed to coincide with sewer remediation (Sydney Water 2004 and 2005) (Figure 3-2). Two test sites (Edith Bay GR175, Kyle Bay GR115) added into monitoring in 2007 had similar community structure to that of the longer term test site at Como in the mouth of the Woronora River (GR15). The community structure of these sites was intermediate to that of reference and urban positive-control sites. The other test site added in 2007 at Kissing Point (PJ025) had a community structure more similar to the nearby urban control site at Silverwater in the Parramatta River arm of Sydney Harbour (PJ01).

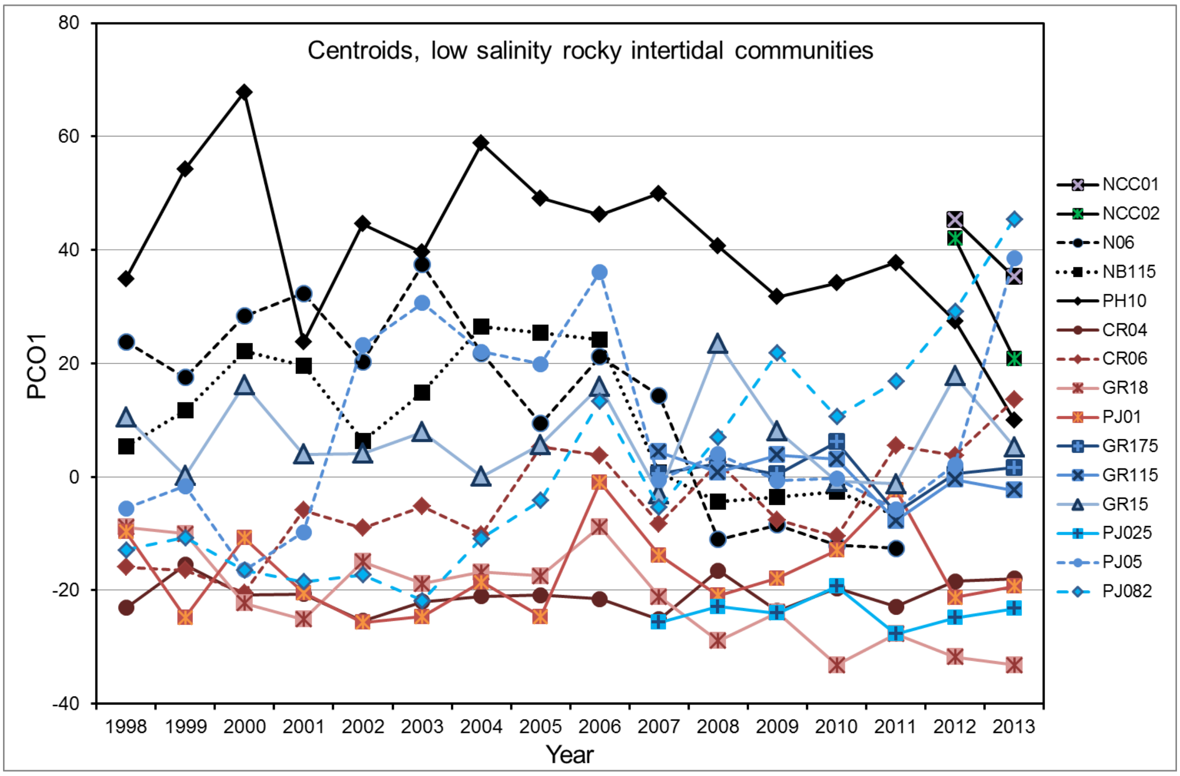


Figure 3-1 Year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites of the relatively lower salinity zone

Lines colour represents site types: black = reference; red = test; blue = urban (positive control)

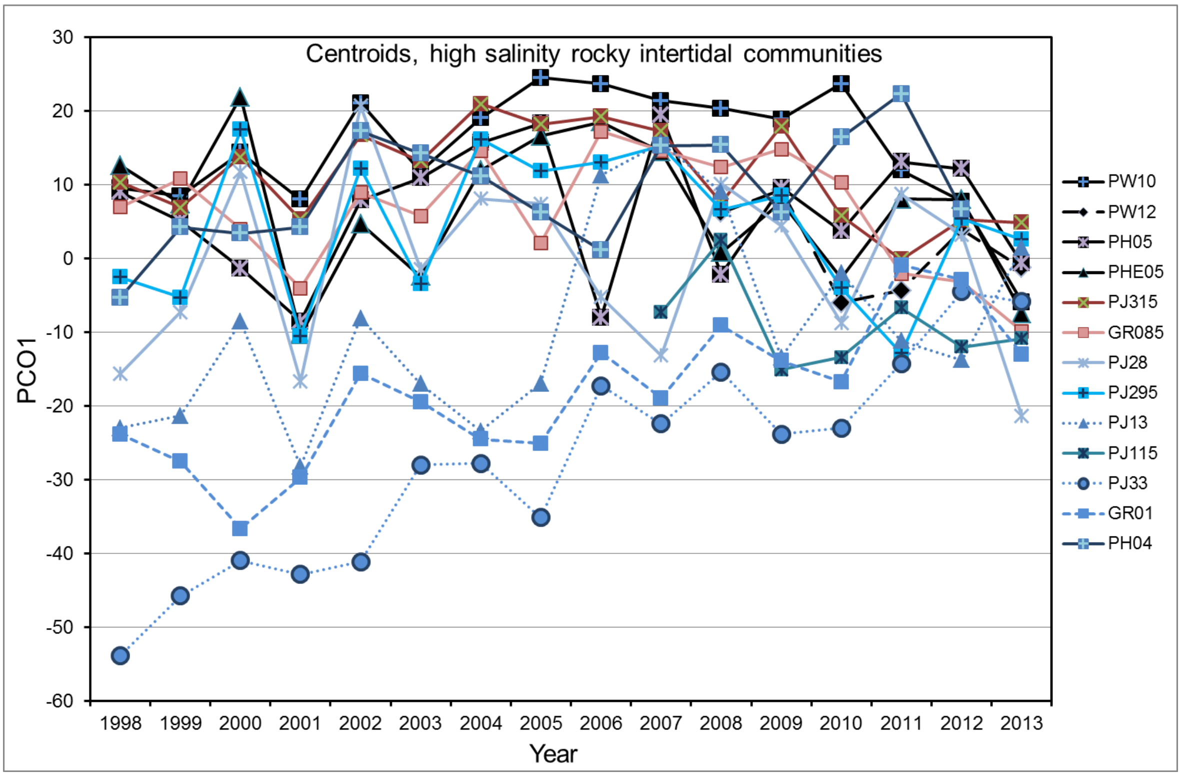


Figure 3-2 Year plotted against Principal Coordinates Analysis axis 1 of distance among centroids for sites of the relatively higher salinity zone

Lines colour represents site types: black = reference; red = test; blue = urban (positive control)

3.2 Settlement Panels

Settlement panels were used to supplement intertidal rock platform measurements and provide a focus on colonisation of intertidal larvae at the swimming juvenile life stage. Settlement panels were deployed at a number of sites that each included a large, muddy intertidal area with mangroves. These areas of the estuaries did not have regular wave activity.

The settlement panels consisted of weathered hardwood fence palings (weathered to remove tannins) that were vertically hammered into the mud at an intertidal height just below the lowest growing mangroves, and were left for three months to allow intertidal organisms to settle. After that time, they were removed and measured for the area covered by barnacles. Panels were deployed twice a year, at the beginning of autumn and spring.

The two dominant taxa have been found to settle on panels during the three-month deployment periods. These taxa were barnacles and green algae. Barnacles were a mixture of small types like *Elminius* and *Chamaesipho,* as well as some larger animals like *Balanus*. The green algae consisted of *Entromorpha* and *Ulva* species.

The relatively short time of three months that the panels were deployed, was inadequate for taxa such as snails (Mollusca) to develop to a sufficient size to have a grazing impact on the panels. This allowed algal taxa to grow unchecked, with the exception of competition for space on the panels with barnacle taxa. Barnacles developed in a relatively shorter time period where conditions were suitable for barnacle settlement.

In context of the lack of snail grazing, green algal growth also occurred on settlement panels at reference sites. Analysis under Sydney Water (2012) showed algal cover varied greatly through time and did not appear to respond to catchment contamination, as bushland reference sites were mixed with potentially contaminated test sites. A conclusion of that assessment was that green algal cover was an unsuitable indicator for assessing the presence of sewage from time to time. Whereas barnacle cover was found to be a useful indicator in wave-sheltered areas of the estuaries around Sydney.

In wave exposed areas of the coast and outer estuaries where there is regular wave occurrence, barnacles naturally grow and are not an indicator of the presence of sewage.

An estimate of barnacle cover was formed by multiplying the average size of barnacles with measured abundance.

The 2011-13 period measurements of barnacle cover were similar to those recorded in the 2006 to 2010 period with the same pattern of similar and dissimilar sites shown. In both of these periods, higher levels of barnacle cover occurred in the Hawthorne Canal arm of Iron Cove and in the mouth of the Cooks River (GR01). These results suggest the presence of sewage from time to time.

Reductions in barnacle settlement occurred between the1998-2001 and 2006-2010 periods at three sites (Table 3-2 and Table 3-3) Change at two of these sites appeared to follow Sydney Water remediation in the 2002 to 2005 period (Sydney Water 2005). As a significant reduction in barnacle settlement occurred at Rushcutters Bay (PJ33), and in the Iron Cove Creek (PJ083) arm of Iron Cove following sewer repairs. The 2011-13 results suggest these sewer remediations have remained effective. The third reduction occurred in Quibray Bay (GR085), but this did not coincide with any known major Sydney Water activities.

Table 3-2 Comparison of barnacle settlement from high salinity sites for periods: 1998-01; 2006-10; and 2011-13

Means with the same letter are not significantly different											
1998 to 2001				2006 to 2010				2011 to 2013			
SNK Grouping	Mean	N	Site	SNK Grouping	Mean	N	Site	SNK Grouping	Mean	N	Site
A	86.2	14	GR01	A	103.9	37	GR01	A	49.4	28	GR01
A	74.2	13	GR085	B	10.4	26	PJ33	B	6.1	23	PJ33
A	63.5	14	PJ33	B	6.4	29	PHE05	B	2.6	19	GR085
B	25.6	10	PJ13	B	3.1	14	PW12	B	0.3	4	PHE05
B	8.9	21	PH05	B	0.8	31	PJ295	B	0.2	20	PJ13
B	4.3	11	PJ295	B	0.8	28	PH05	B	0	20	PW10
B	2.0	22	PJ28	B	0.7	29	PJ13	B	0	6	PH05
B	0.8	22	PW10	B	0.1	28	GR085	B	0	14	PJ295
B	0.8	20	PHE05	B	0	30	PJ315	B	0	7	PJ315
B	0	18	PJ315	B	0	32	PJ28	B	0	2	PW12
				B	0	32	PW10				

Student-Newman-Keuls (SNK) multiple range test of mean barnacle cover (mm^2) recorded on hard wood fence palings that were put out for three months twice a year.

Table 3-3 Comparison between barnacle settlement from low salinity sites for the period: 1998-01; 2006-10; and 2011-13

Means with the same letter are not significantly different											
1998 to 2001				2006 to 2010				2011 to 2013			
SNK Grouping	Mean	N	Site	SNK Grouping	Mean	N	Site	SNK Grouping	Mean	N	Site
A	127.1	26	PJ082	A	70.8	37	PJ082	A	58.1	20	PJ082
B	92.1	24	PJ083	BA	52.5	16	PJ083	BA	44.6	13	PJ025
C	26.9	22	CR04	BC	39.6	20	GR175	BDC	39.4	23	PJ05
C	16.9	21	CR06	BC	36	38	CR04	BDC	25.4	22	GR15
C	13	23	PJ01	BC	35.9	18	PJ05	BDC	23.4	16	GR175
C	7.6	23	NB115	BC	33.6	19	PJ025	BDC	15.1	21	PJ01
C	4.1	23	GR18	C	16.9	31	PJ01	BDC	15	23	CR04
C	0.2	24	PH10	C	9	28	NB115	DC	11.3	20	CR06
				C	8.3	38	CR06	D	6.9	21	GR115
				C	7.1	21	GR115	D	3.2	21	NB115
				C	5.9	20	GR15	D	1	24	GR18
				C	2.2	36	GR18	D	0.2	6	PH10
				C	0	16	PH10				

Student-Newman-Keuls (SNK) multiple range test of mean barnacle cover (mm^2) recorded on hard wood fence palings that were put out for three months twice a year.

4 Freshwater macroinvertebrates

4.1 Introduction

Monitoring of freshwater macroinvertebrate communities assesses potential ecological impact from inland wastewater discharges into stream environments.

Macroinvertebrates are small animals without a backbone that can be seen without a microscope. They live on the surface or in the sediments of water bodies. They include many insect larvae for example mosquitoes, dragonflies and caddis flies. Other examples of common macroinvertebrates include crustaceans (such as crayfish), snails, worms and leeches. Macroinvertebrates can populate ponds or streams in large numbers − some of them up to thousands in a square metre.

A healthy stream is comprised of many different types of macroinvertebrate animals. The types present will vary according to natural factors such as stream type, altitude and geographic region. The types present will also vary according to human disturbance, particularly water pollution. Water pollution in a stream will change the macroinvertebrate assemblage in a predictable way. As the level of pollution increases, the more sensitive macroinvertebrate animals become excluded or lost. A natural waterway that is not impacted by human activity will include a large proportion of sensitive macroinvertebrate animals that represent high stream health. A more disturbed or polluted stream has a higher proportion of insensitive types of macroinvertebrate animals present and lower stream health occurs.

Sydney Water has assessed 'stream health' with the Stream Invertebrate Grade Number Average Level (SIGNAL) biotic index tool. This tool provides a sensitivity score of a macroinvertebrate assemblage sample and can range from 1 to 10. The latest version of SIGNAL-SG has determined sensitivity grades of 367 genera for the greater Sydney region and is tailored to organic pollution and takes into account stream type and altitude (Chessman et al, 2007). SIGNAL-SG biotic index has been demonstrated as an easily communicated measure of sewage impacts on macroinvertebrates in Blue Mountain streams (Besley and Chessman 2008).

The primary degrading process to urban streams is suggested to be 'effective imperviousness' (Walsh et al, 2005a), provided sewer overflows, sewage treatment plant discharges, or long-lived pollutants from earlier land uses are not operable as these can obscure stormwater impacts (Walsh et al, 2005b). Walsh et al (2005a) defines 'effective imperviousness' as the proportion of a catchment covered by impervious surfaces directly connected to the stream by stormwater pipes. Walsh (2004) determined macroinvertebrate community composition was strongly explained by the gradient of urban density and that most sensitive taxa were absent from urban sites with greater than 20% connection of impervious surfaces to streams by pipes. The direct connection of impervious surfaces, such as roofs, gutters, roads, paths and car parks, to a stream allows small rainfall events to produce surface runoff that cause frequent disturbance to the stream through regular delivery of water and pollutants (Walsh et al, 2005a). Walsh et al (2004) suggested road crossings in rural catchments also act as stormwater drains delivering water and pollutants by bypassing filtration in the riparian zone. Conclusions of research conducted in the greater Melbourne area that looked at water quality, epilithic diatoms, benthic algae and macroinvertebrate indicators suggested minimisation of directly piped stormwater drainage connection of impervious surfaces to be beneficial in mitigation of urban impacts on receiving streams (Hatt et al, 2004; Walsh, 2004; Taylor et al, 2004; Newall & Walsh, 2005).

Given this direct connection between a stream and sources of surface runoff in urban and rural streams, even small rainfall events have the ability to produce measurable impacts on stream health above treatment plants. As such, upper catchment stream health may limit downstream stream health in urban and rural streams. It is from this background we are assessing potential stream health changes from wastewater discharge.

The level of impaired stream health can fluctuate through time as demonstrated by the upstream site in the urban Katoomba Creek over the period 1992 to 2003 (Besley & Chessman, 2008). This variation was probably driven by wetter and drier periods with higher and lower levels of catchment pollution transport respectively. Whereas in permanent streams in natural bushland catchments, stream health was not impacted by weather variation as demonstrated by the upstream site in Blue Mountains Creek (Besley & Chessman, 2008).

The urban Katoomba Creek example suggests that when streams upstream of wastewater treatment plants are used as control / reference locations, a longer time series is required to establish variation in stream health. This supports the ANZECC (2000) recommendation that three to five years of data be gathered from control / reference locations.

The longer a time series can be collected in an urban stream the better. A longer period enables the recorded range of stream health to become more inclusive of the variability in levels of pollution transport from the upper catchment over drier and wetter periods. DECC (2009b) suggest that to understand the natural climate cycle and changes made by humans in the past, long-term monitoring is essential for assessing trends. The number of pre-commissioning autumn and spring collections represent more inclusive measurements and should minimise falsely declared impacts from wastewater discharges. This longer record of data held provides a sound basis for assessment of sites in the STSIMP and also overcomes concerns mentioned in ANZECC (2000) for basing decisions on a too short ‘pre’ monitoring period.

Biotic indices used in other parts of the world include the ASPT index in Britain (Hawkes, 1997), the ASPT index of the South African Scoring System (SASS: Dickens & Graham, 2002), the Spanish average Biological Monitoring Water Quality (a-BMWQ) score (Camargo, 1993), the New Zealand macroinvertebrate community index (MCI) and its quantitative and semi-quantitative equivalents (Stark, 1998; Stark & Maxted, 2007), and the North Carolina Biotic Index (Lenat, 1993). The conceptual basis underlying all of these indices is that in the presence of stressors such as organic pollution, taxa that are sensitive to the stressors tend to be eliminated or greatly reduced in abundance. Conversely, tolerant taxa persist, and may multiply as a result of less competition or predation, or because their food supply is increased by organic or nutrient enrichment. Consequently, stress results in a decline in the average sensitivity value of the taxa and individual organisms that are collected. Index scores therefore act as indicators of the presence and intensity of those stressors to which the index is attuned (Besley & Chessman 2008).

After laboratory identification and counting an assessment of stream health was carried out with the macroinvertebrate indicator. This analysis was based on ANZECC (2000) guidelines, and the Sydney region specific Stream Invertebrate Grade Number Average Level genus taxonomic version (SIGNAL-SG) biotic index analysis tool (Chessman et al, 2007), with SIGNAL-SG scores calculated as described by Besley and Chessman (2008).

In brief a SIGNAL-SG biotic index sensitivity score is calculated as follows:

- The first step is to apply predetermined sensitivity grade numbers (from 1, tolerant to 10, highly sensitive) to genera counts that occur within a sample

- Then multiply the square root transformed count of each genus by the sensitivity grade number for that genus, summing the products, and dividing by the total square root transformed number of individuals in all graded genera
- Genera that were present in the samples but with no grade numbers available (relatively few) were removed from the calculation of the SIGNAL-SG score for the sample.
- These steps were repeated for each habitat sampled
- Habitat adjustment values (Besley & Chessman, 2008) were then applied to habitats other than pool edges when collected to provide a location specific average score. These adjustment values enable comparisons of stream health between locations and times and allow calculation of a site-specific average and a measure of variation (one standard deviation of the average) through time as recommended by ANZECC (2000) for ecosystem health comparisons.

In other words a SIGNAL-SG score can simplistically be thought of as an average of the sensitivity grades of the macroinvertebrate types present that also incorporates a measure of the animal counts (abundance).

Once average SIGNAL-SG scores and standard deviations are calculated a comparison between sites can be made. Typically Sydney Water's monitoring of wastewater treatment plant point source discharges is conducted upstream and downstream of the discharge pipe to determine if any impact has occurred from operation of these facilities. Upstream and downstream (paired site) comparisons in this manner allow separation of wastewater treatment plant discharge impacts on ecosystem health from upstream catchment influences on ecosystem health.

This region specific version of SIGNAL-SG was raised in response to suggestions that region specific models are more suitable than those derived for the broad scale as was the case for the original version of SIGNAL (Bunn 1995, Bunn and Davies 2000). The Sydney region specific version of SIGNAL-SG (Chessman et al 2007) has benefited from development and testing since the original version (Chessman, 1995). This testing included the response of SIGNAL to natural and human influenced (anthropogenic) environmental factors (Growns et al, 1995), variations in sampling and sample processing methods (Growns et al, 1997; Metzeling et al, 2003) and most importantly setting sensitivity grades of the taxa objectively (Chessman et al, 1997; Chessman 2003). 'G' indicates taxonomy is at the genus taxonomic level and 'S' indicates Sydney region version. SIGNAL-SG has been derived from macroinvertebrate data of the greater Sydney region and defined sensitivity grades for 367 genera (Chessman et al, 2007). SIGNAL-SG allows a direct measure of test site condition and incorporates abundance information from the rapid assessment sampling.

Application of interpretation of organic pollution impacts with this tool was demonstrated in Besley and Chessman (2008). They presented univariate analysis of paired (upstream and downstream) sites for five decommissioned Blue Mountains sewage treatment plants using the tolerance based SIGNAL-SG statistical analysis tool. The analysis was based on temporal replication (each six months as per national protocol) and within time replication (from collection of multiple habitats at each visit). Within time replication was made possible by applying habitat correction factors to SIGNAL-SG scores of habitats other than pool edge waters.

4.2 Graphical assessment

The range of each site period has been plotted in this report with ± one standard deviation of the mean for basing ecological decisions (ANZECC, 2000). Presenting data in this way attempts to take account of temporal variation at study sites and provide a basis in future years to enable management tracking and/or as a basis for making management decisions. Finer assessment of was performed by plotting each financial year of data for each site. This style of chart is along the lines of a process control chart for ecological monitoring presented by Burgman et al, (2012) to display information in a simple, practical and scientifically credible way. This style of chart will also illustrate temporal trends and allow interpretation of data against background natural disturbance and variation of the respective streams.

4.3 Univariate tests of upstream and downstream site pairs

For the three plants identified from visual inspection of stream health plots with differing stream health in 2013-14, t-tests were used to determine whether the difference in stream health of upstream and downstream sites was lower or higher from discharge points. These univariate statistical tests provide a more stringent assessment than under the ANZECC (2000) comparisons of ± one standard deviation of mean. Statistical test ranges approximate a generally tighter two standard errors of the mean. More than five years of data were available for this testing.

Pooled or Satterthwaite t-test methods were used subject to equality of variance test results. Where variances were shown to be equal the Pooled results were appropriate to be adopted.

4.4 Multivariate tests of upstream and downstream site pairs

In the case where ecological change was indicated by both ANZECC (2000) assessment and a significant univariate t-test result, multivariate statistics were used to verify the ecological response for a site pair.

Multivariate data analyses were performed using statistical routines of the PRIMER Version 6.1.16 software package (Clarke and Warwick, 2001) and the add-on module PERMANOVA+ Version 1.0.6. (Anderson et al, 2008).

Balanced designs have been found to provide more reliable test outcomes when heterogeneity of dispersions is present in a dataset (Anderson and Walsh 2013). Heterogeneity of dispersions is a common feature of ecological data. To balance datasets for multivariate analysis samples were omitted if they were not collected from the same habitat at both sites for each time period (Table 4-1). PERMDISP tests were run on balanced datasets to assess dispersion of samples.

Table 4-1 Summary of monitoring periods omitted from multivariate analysis

Plant	Stream	Periods with unbalanced sample habitats
West Camden	Hawkesbury Nepean River	Autumn 2004
		Autumn 2005
		Spring 2005
		Autumn 2006
		Spring 2006
		Autumn 2007
		Autumn 2008
		Spring 2008
		Autumn 2009
		Spring 2009
		Autumn 2010
		Spring 2010
		Autumn 2011
		Spring 2011
		Autumn 2013
West Camden	Matahill Creek	Spring 2004
		Autumn 2006
		Autumn 2009
		Spring 2010
		Spring 2011
		Autumn 2012
		Autumn 2014
Winmalee	Hawkesbury Nepean River	Spring 2007
		Autumn 2012
		Spring 2013
		Autumn 2014
	Unnamed creek	none
Hornsby Heights	Calna Creek	Spring 2013

Prior to multivariate analysis of community data, rare taxa observed in only one sample were removed. Data were transformed with a square root transformation and an association matrix was constructed based upon the Bray-Curtis resemblance measure. This measure was used as the basis for classification, ordination and hypothesis testing.

The Bray-Curtis resemblance measure is focused on compositional changes in taxa identities (Anderson and Walsh 2013). As such, this is an appropriate choice since we understand downstream measurable impacts recorded at former aged Blue Mountains plants did cause a change in the composition of the freshwater macroinvertebrate community.

The group average classification technique was used to place the sampling sites into groups, each of which had a characteristic invertebrate community based on relative similarity of their attributes. The group average classification technique initially forms pairs of samples with the most similar taxa and gradually fuses the pairs into larger and larger groups (clusters) with increasing internal variability.

Classification techniques will form groups even if the data set actually forms a continuum. In order to determine whether the groups were 'real' the samples were ordinated using the non-metric multidimensional scaling (nMDS) technique. Ordination produces a plot of sites on two or three axes such that sites with similar taxa lie close together and sites with a differing taxon composition lie farther apart. Output from classification analysis was then checked against sample groupings on the ordination plot to see if site pre-post (a-priori) groups of samples occurred which would indicate a response from wastewater discharge.

An unconstrained ordination procedure such as nMDS usually introduces distortion when trying to represent the similarities between large numbers of samples in only two or three dimensions. The success of the procedure is measured by a stress value, which indicates the degree of distortion imposed. In the PRIMER software package a stress value of below 0.2 indicates an acceptable representation of the original data although lower values are desirable.

Hypothesis testing of multivariate macroinvertebrate assemblage data was conducted with the PERMANOVA routine. This routine was able to mirror univariate t-tests of SIGNAL-SG scores. PERMANOVA was run with 10,000 permutations with the ‘Permutation of residuals under a reduced model’ option as outlined in Anderson et al (2008).

If PERMDISP test results were non-significant ANOSIM tests were run. ANOSIM provides an absolute measure of how separated groups of samples are on a scale of -1 to 1 (Clarke 1993). As the R-value approaches 1, this indicates all temporal samples from a site were more similar to each other than they were to temporal samples from another site; that is, groups are clearly different. When the R-value approaches 0, temporal samples within and between sites are equally similar; that is, no differences between groups. If the R-value approaches –1, then pairs consisting of one temporal sample from each site are more similar to each other than pairs of temporal samples from the same site (Clarke 1993).

4.5 Results of univariate tests of upstream and downstream site pairs

Significant differences were found between upstream and downstream site pairs for periods (Table 4-2). Respective periods are displayed in Figure 4-2, Figure 4-4 and Figure 4-5.

Table 4-2 t test results of SIGNAL_SG scores for upstream and downstream site pairs

Plant	Degrees of freedom	t value	P value
Hornsby Heights	73	-3.22	0.0019
West Camden	38	-5.37	<0.0001
Winmalee	38	-4.15	0.0002

NB equality of variance test was non-significant for Hornsby Heights, West Camden and Winmalee, and as such t-tests were based on equal variance.

4.6 Results of ecological control chart graphical assessment

Process control charts of ecological monitoring at the three plants were constructed along the lines of Burgman et al, (2012) and Besley & Chessman (2008). These control charts displayed temporal data in an expanded manner to that presented in charts of Section 1.4.5. These ecological control charts indicate that stream health was not affected in the Hawkesbury Nepean River. This is due to stream health being similar at sites upstream and downstream of the Hawkebsury Nepean River confluences with feeder streams that receive wastewater discharges from the West Camden and Winmalee plants (Figure 4-1 and Figure 4-3). In contrast control charts for feeder streams indicated measurable localised impacts occurred in stream health for wastewater discharges from the West Camden and Winmalee plants (Figure 4-2 and Figure 4-4). The localised disturbance in the unnamed creek near the Winmalee plant was not evident at the second downstream site situated 3 km below the plant. At that point stream health had recovered to levels typical of the Hawkesbury Nepean River above the confluence with this unnamed creek (Figure 4-3 and Figure 4-4). The actual localised impact distance may have been less than 3 km but access to the sandstone gorge area between the two downstream sites had unacceptable health and safety risks to allow monitoring to be conducted.

The control chart for Calna Creek indicated there were periods where stream health downstream of the Hornsby Heights plant was measurably different. While in other periods downstream stream health was the same as recorded upstream of the plant (Figure 4-5) on the same monitoring occasion.

Expanded ecological control charts for the remaining plants without localised impacts (Section 1.4.5) are presented below in Figure 4-6 to Figure 4-16.

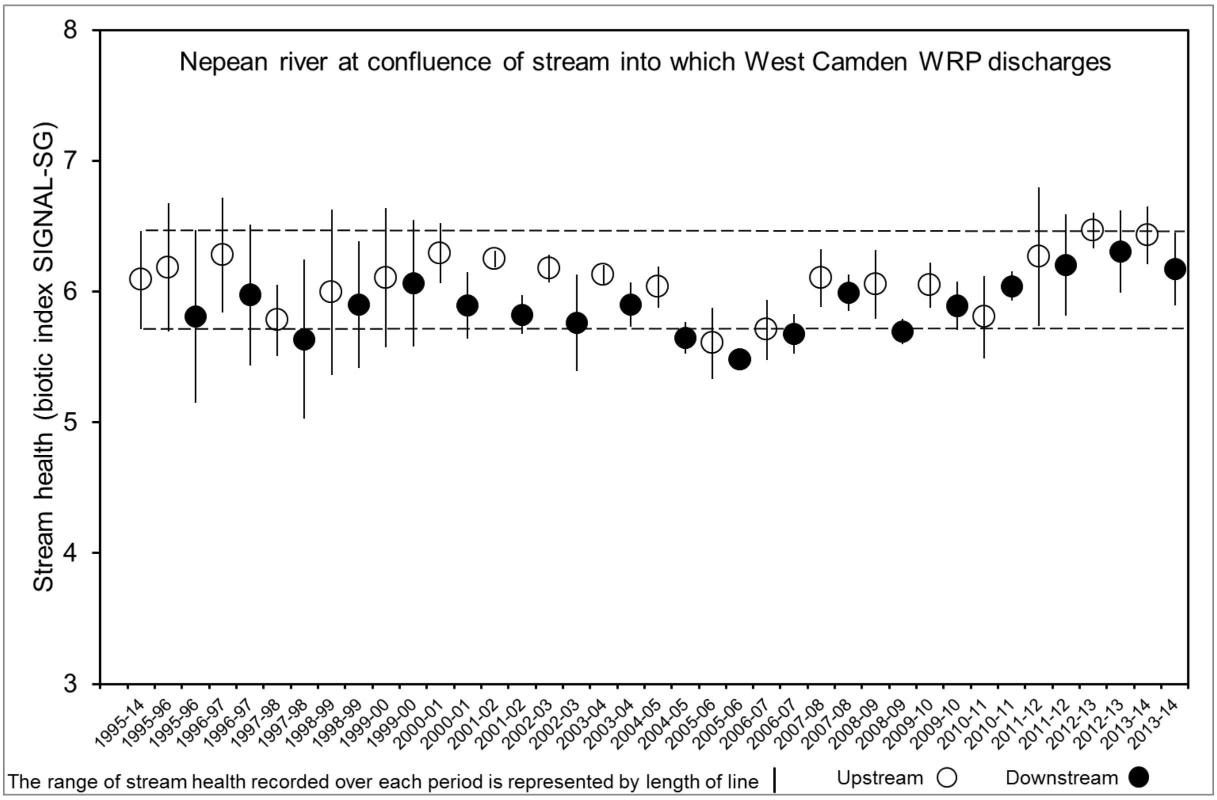


Figure 4-1 Ecological monitoring control chart for Hawkesbury Nepean River at West Camden

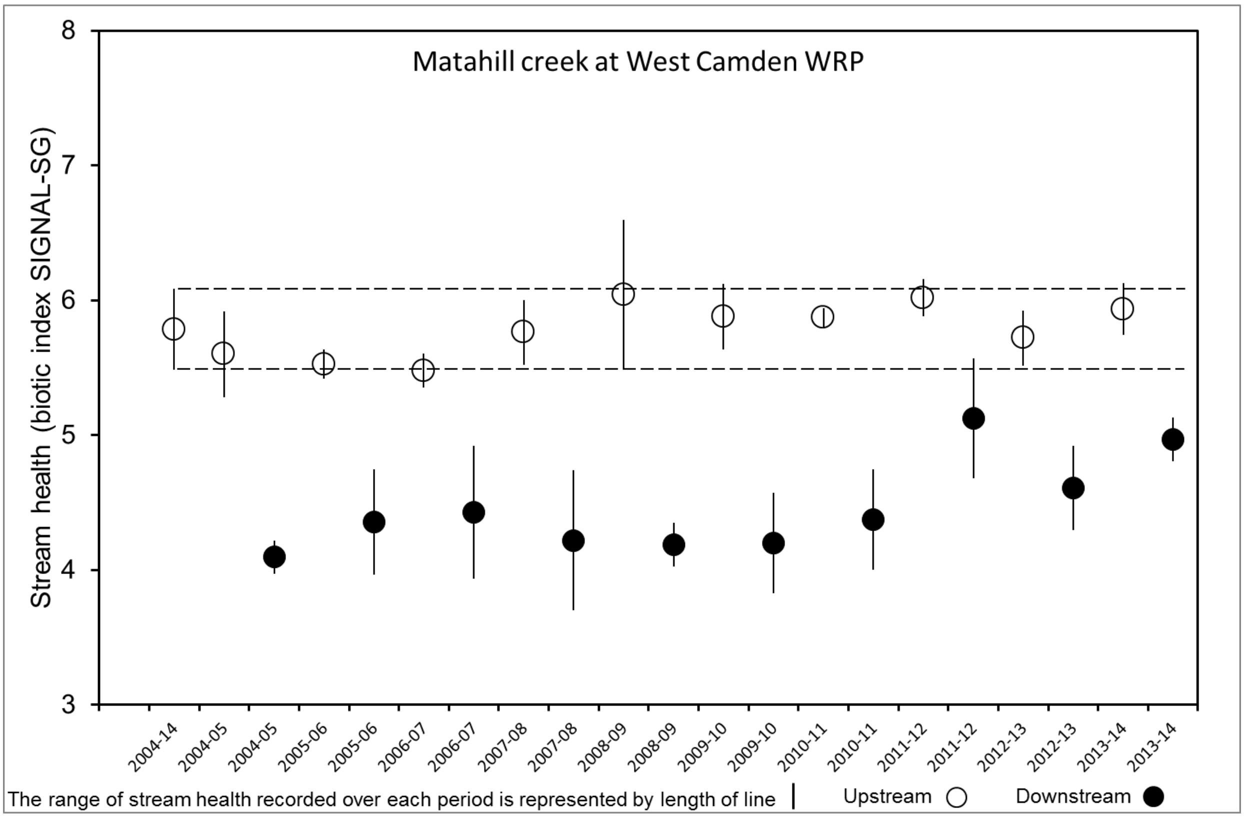


Figure 4-2 Ecological monitoring control chart for Matahill Creek at West Camden

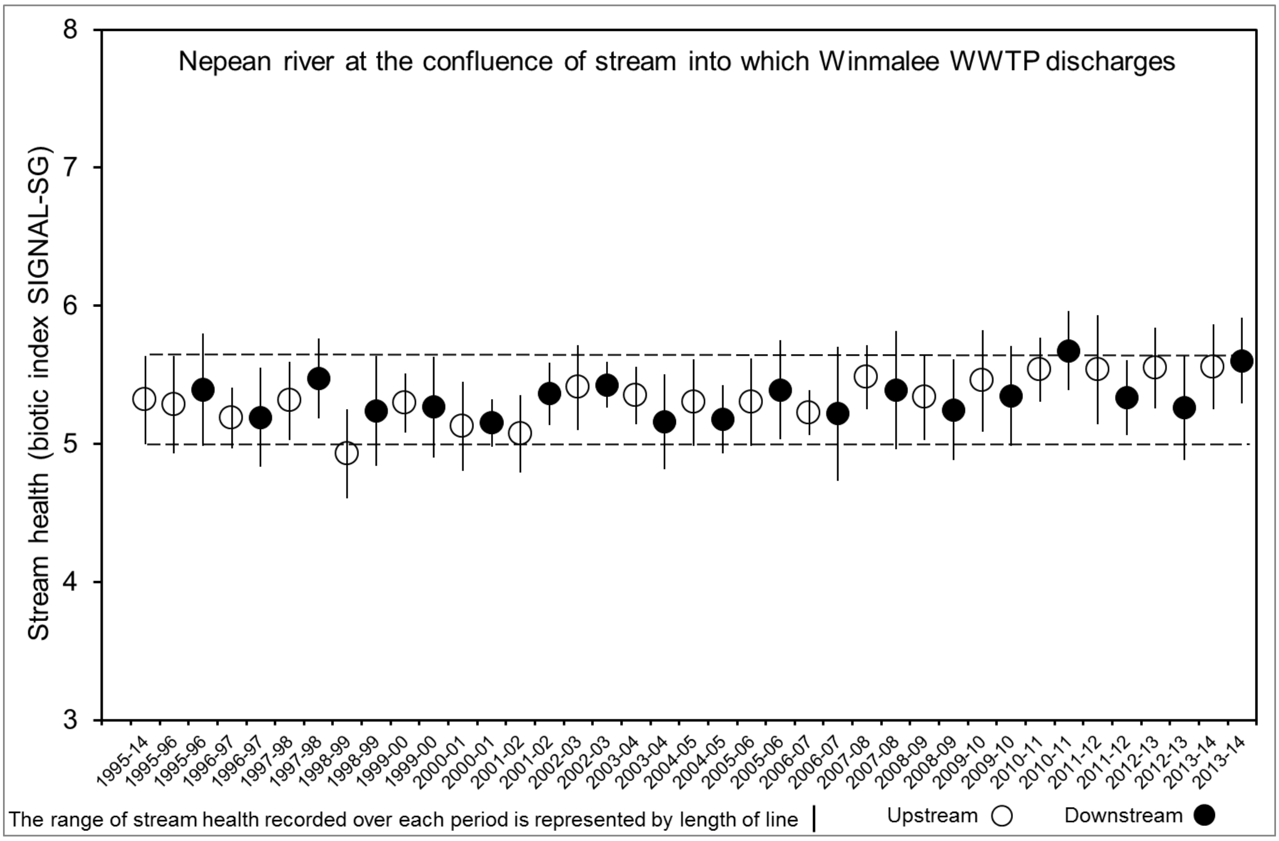


Figure 4-3 Ecological monitoring control chart for Nepean River at Winmalee

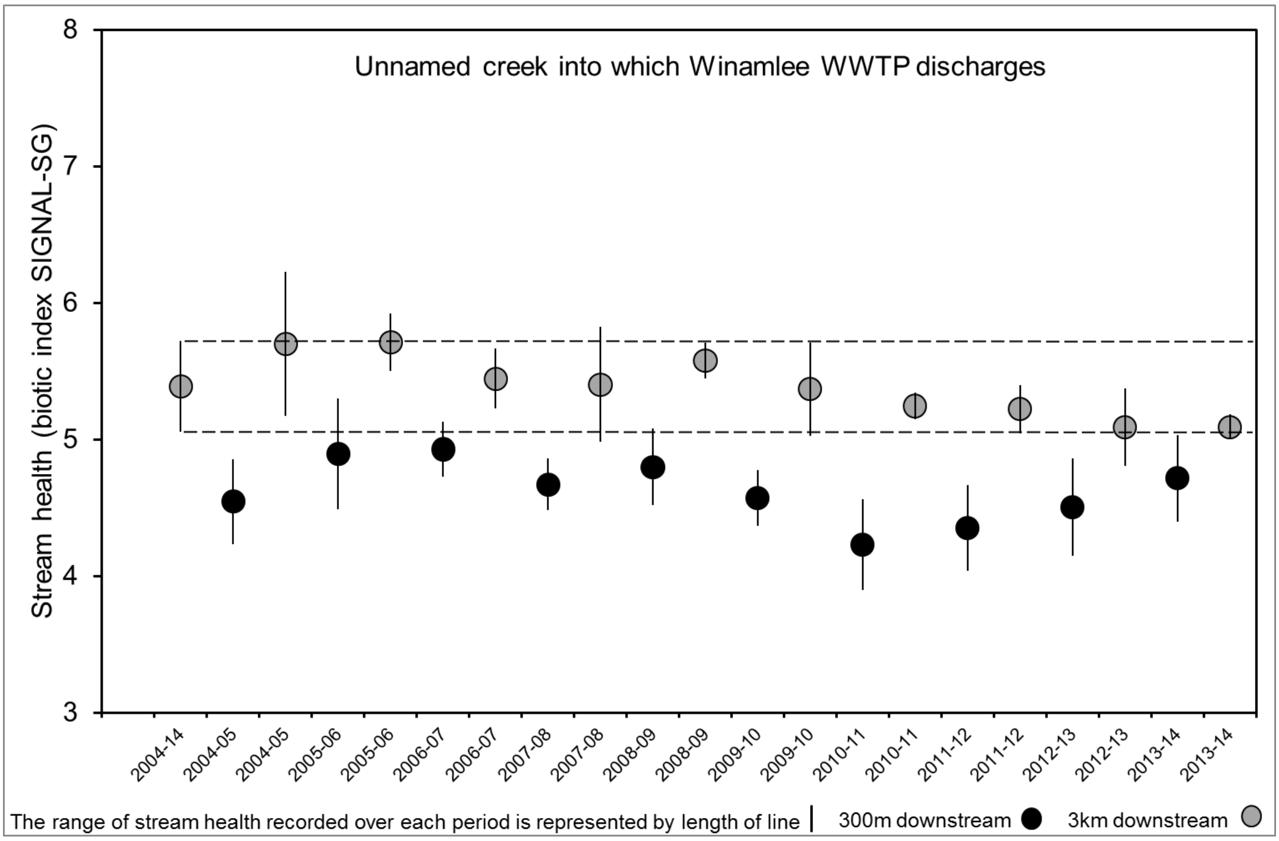


Figure 4-4 Ecological monitoring control chart for unnamed creek at Winmalee

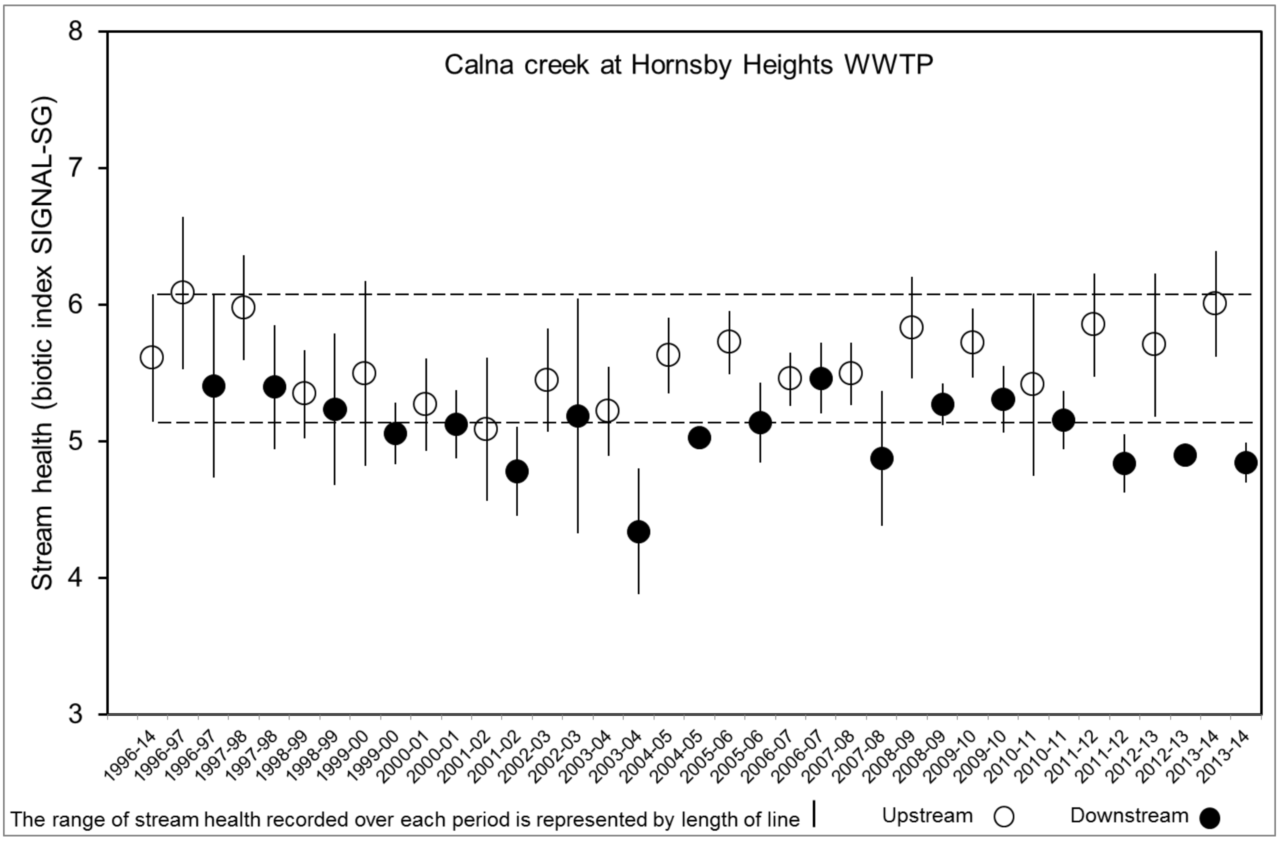


Figure 4-5 Ecological monitoring control chart for Calna Creek at Hornsby Heights

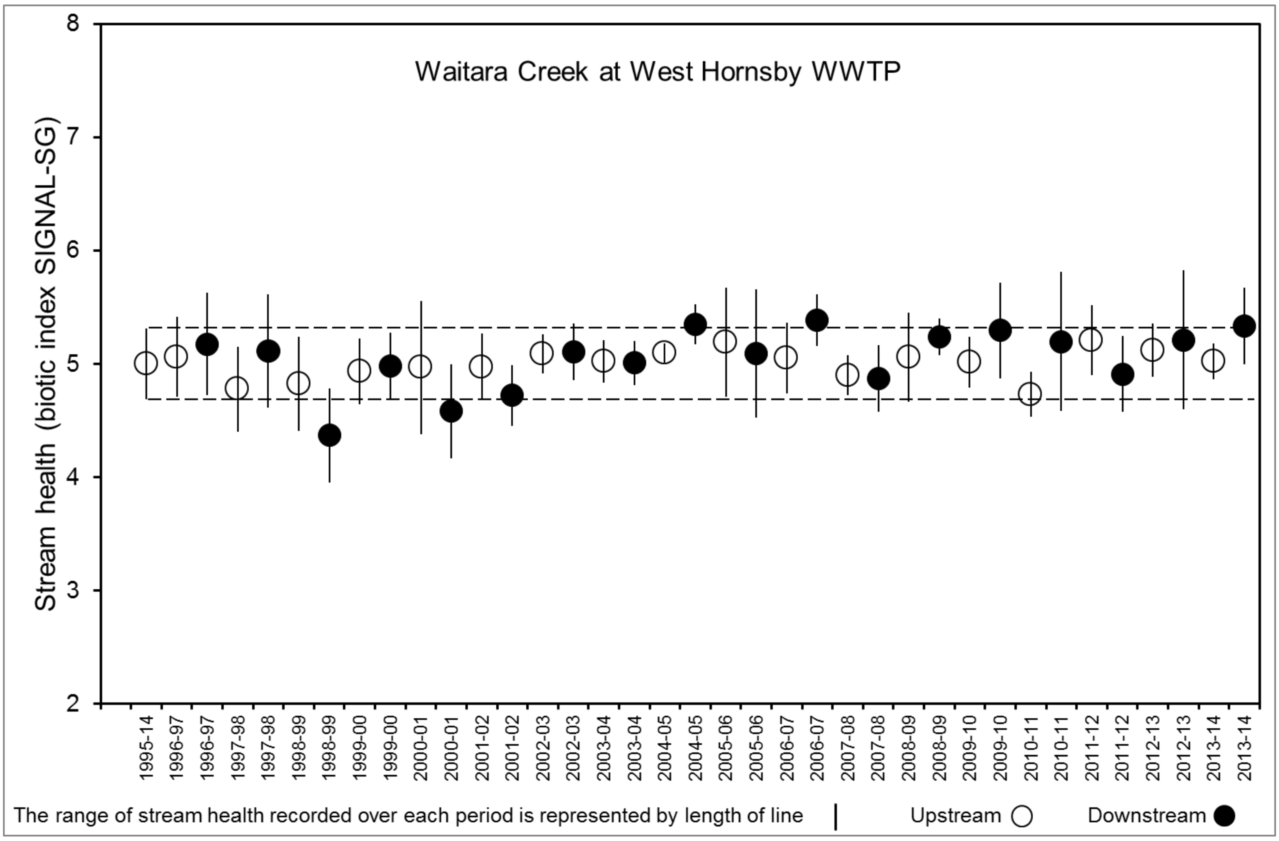


Figure 4-6 Ecological monitoring control chart for Waitara Creek at West Hornsby

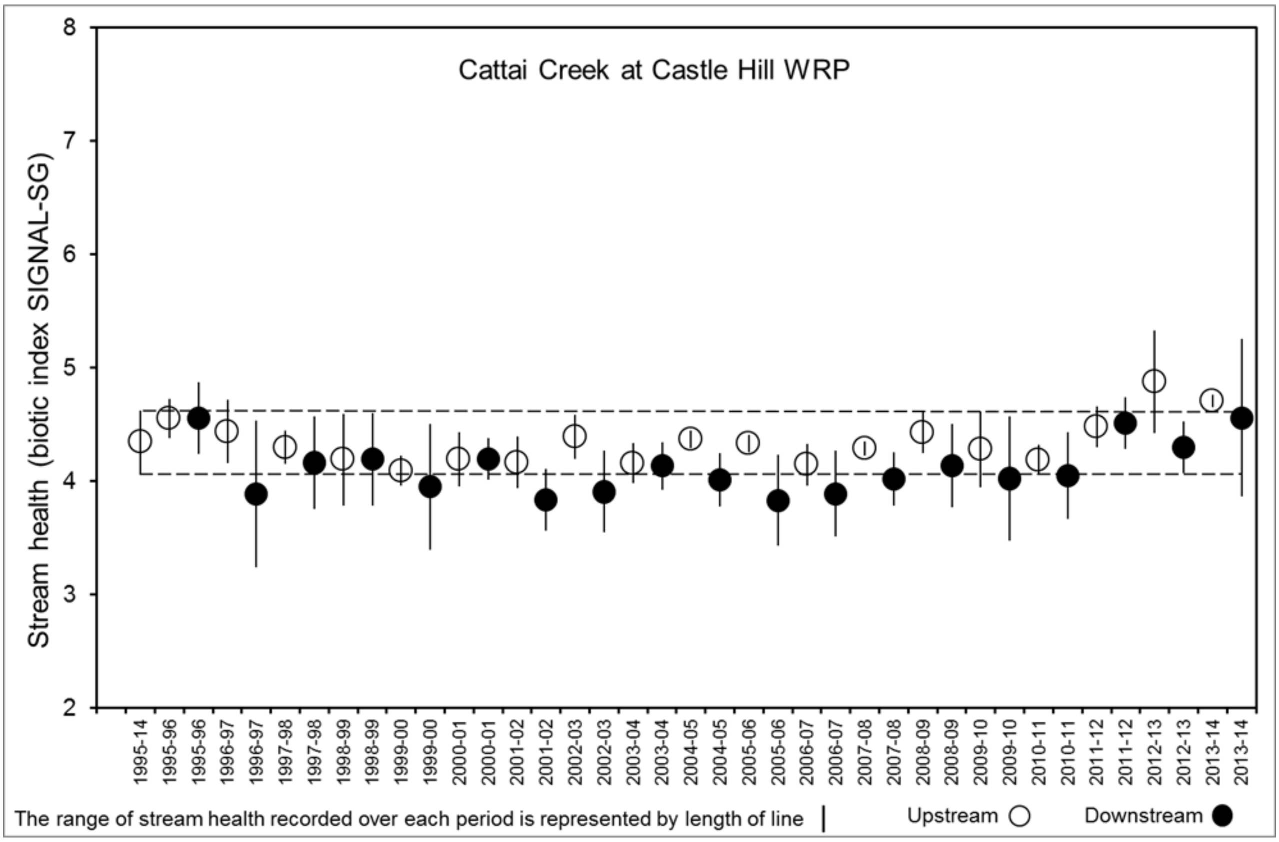


Figure 4-7 Ecological monitoring control chart for Cattai Creek at Castle Hill

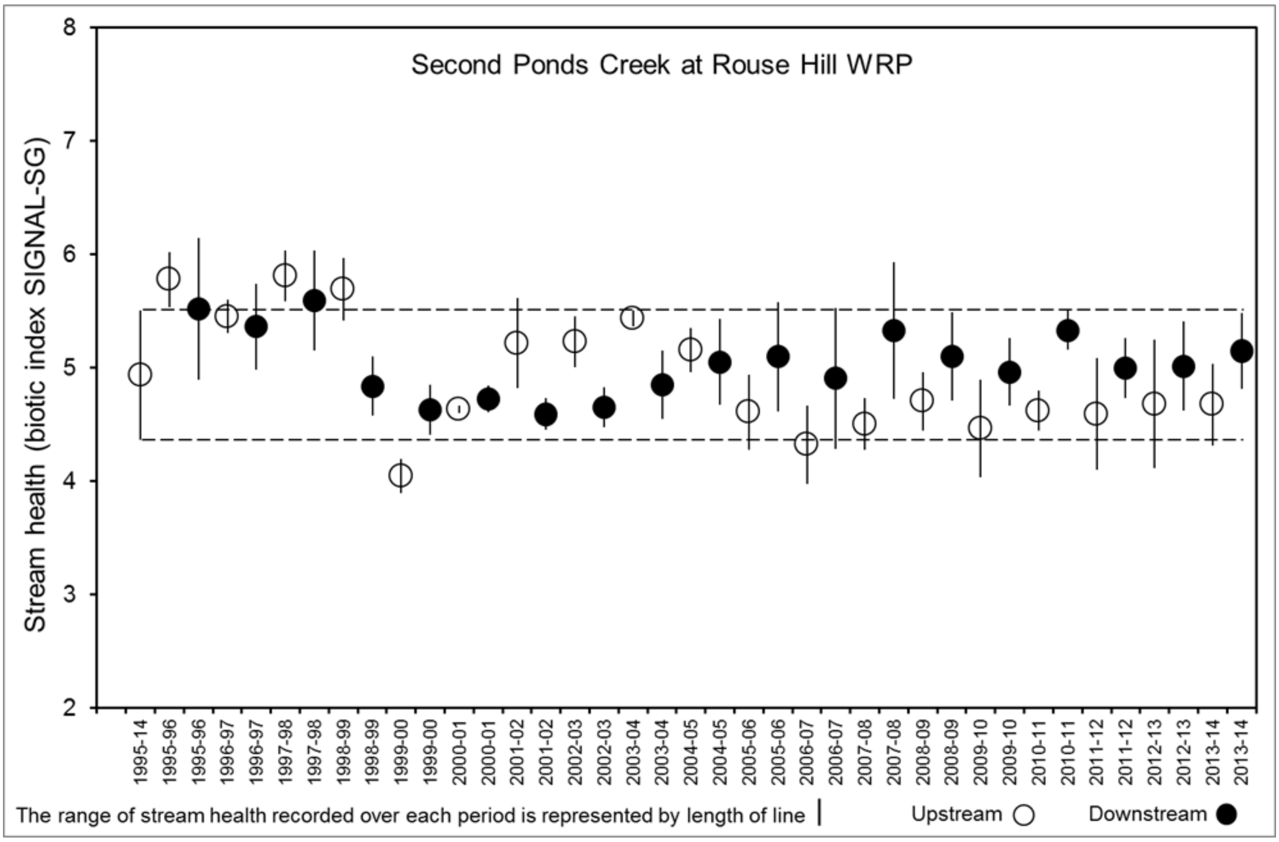


Figure 4-8 Ecological monitoring control chart for Second Ponds Creek at Rouse Hill

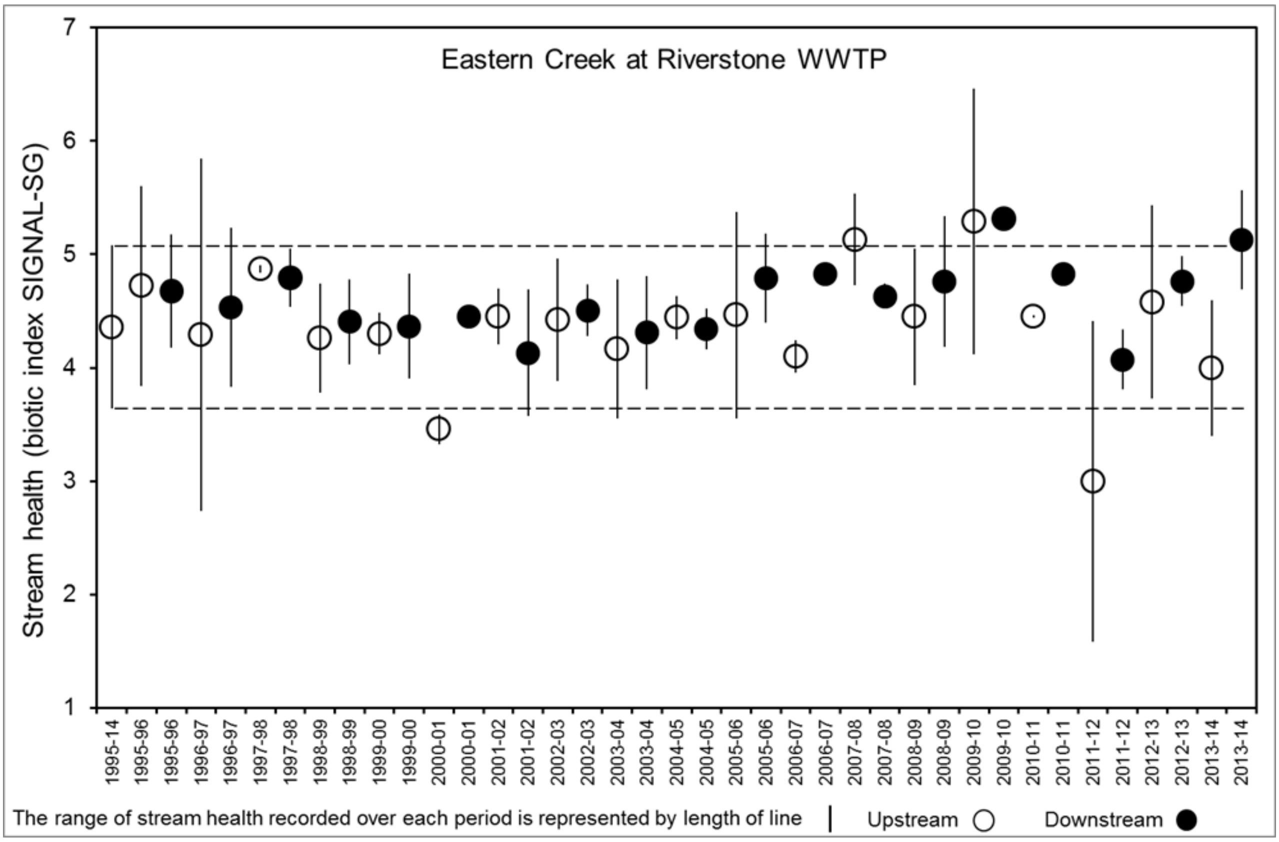


Figure 4-9 Ecological monitoring control chart for Eastern Creek at Riverstone

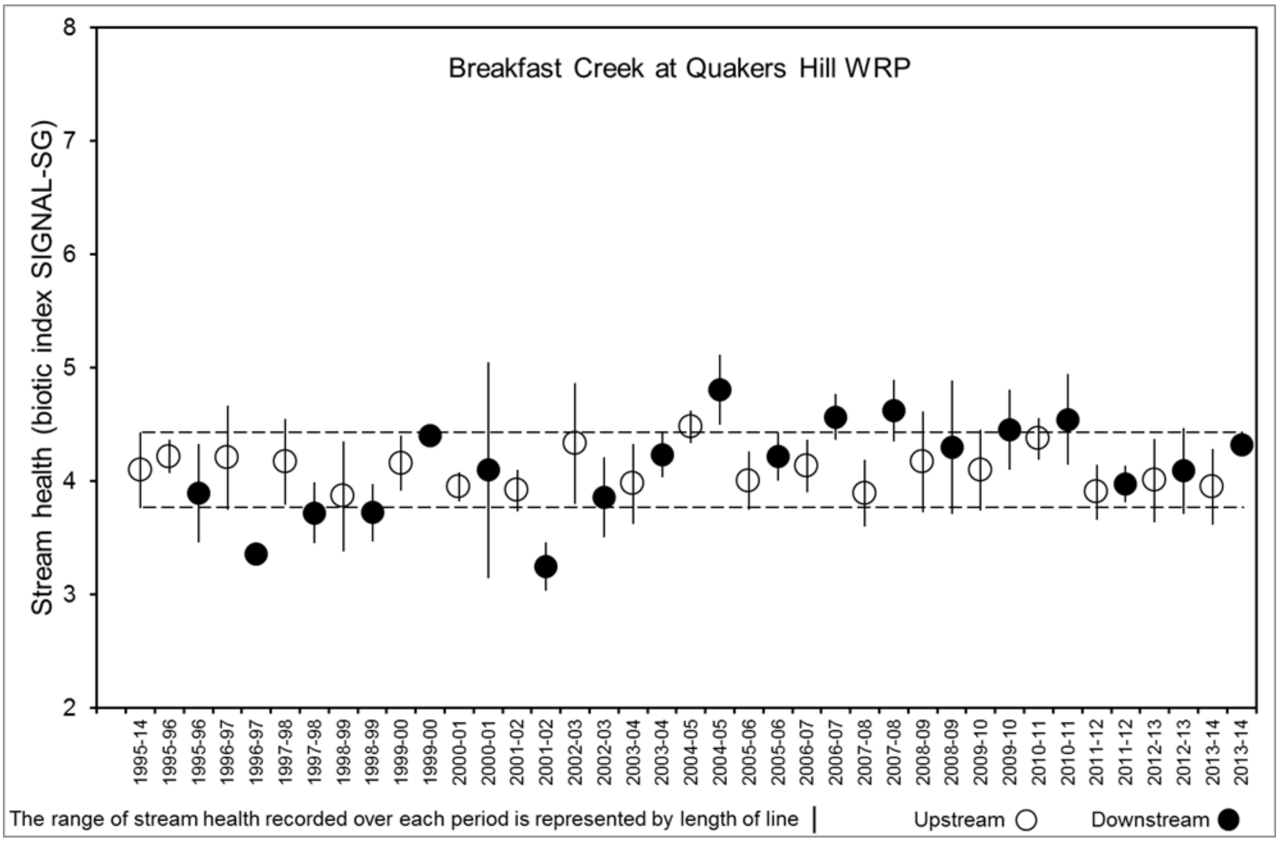


Figure 4-10 Ecological monitoring control chart for Breakfast Creek at Quakers Hill

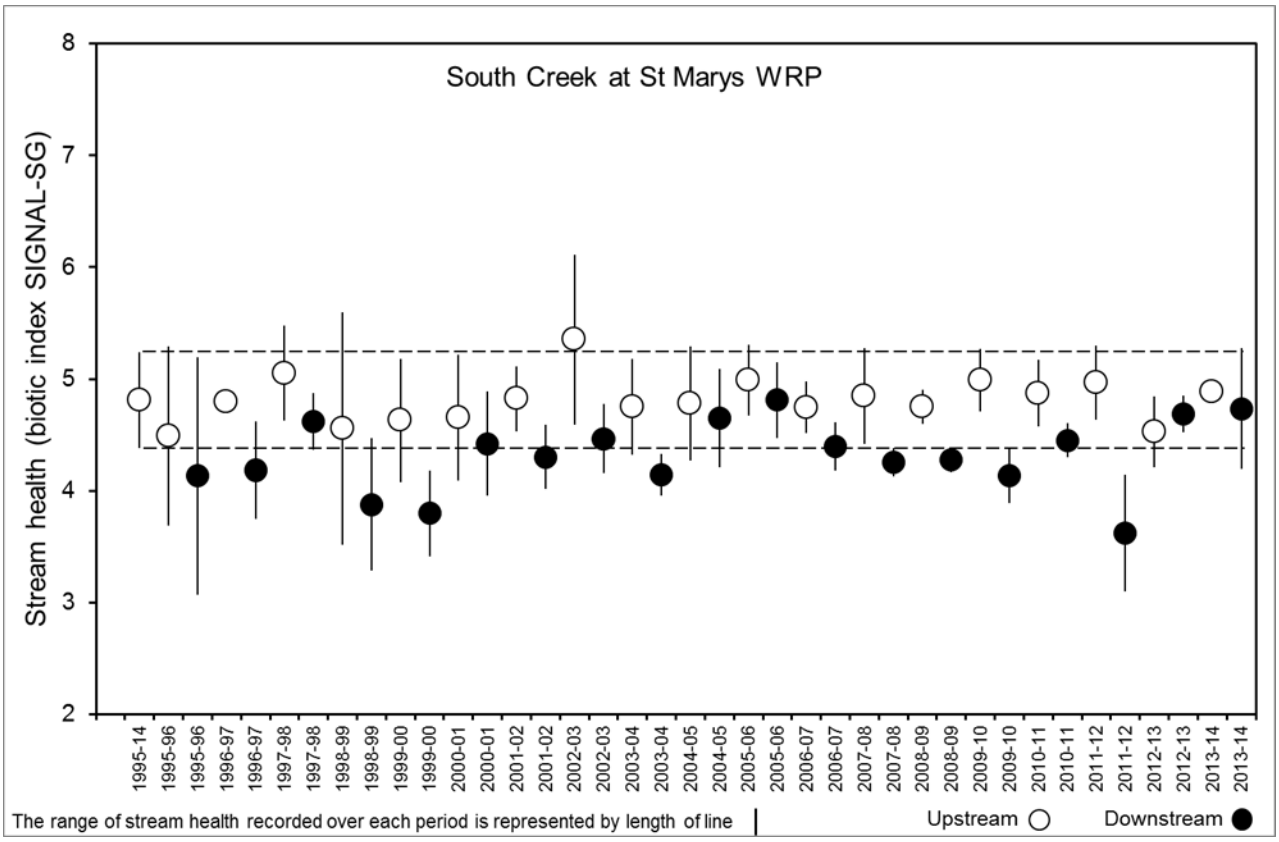


Figure 4-11 Ecological monitoring control chart for South Creek at St Marys

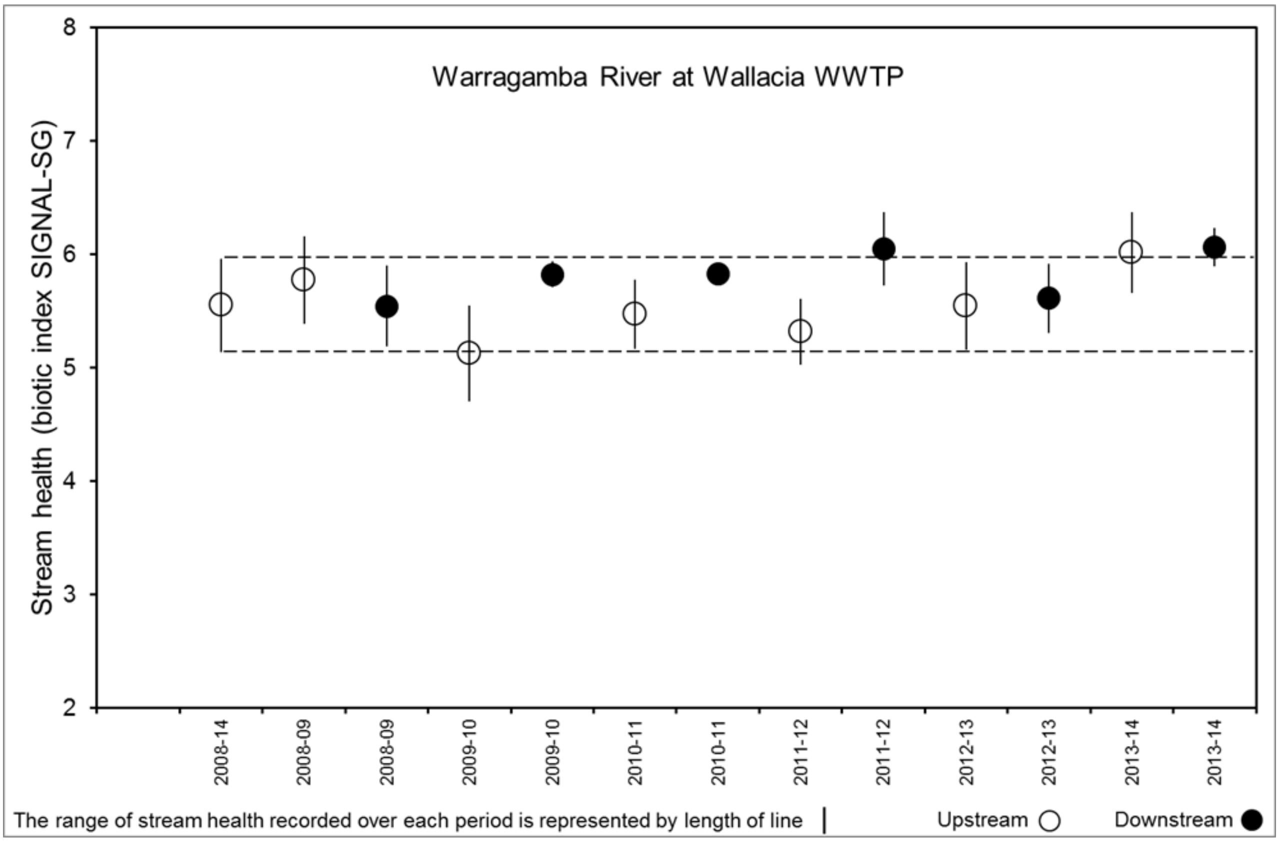


Figure 4-12 Ecological monitoring control chart for Warragamba River at Wallacia

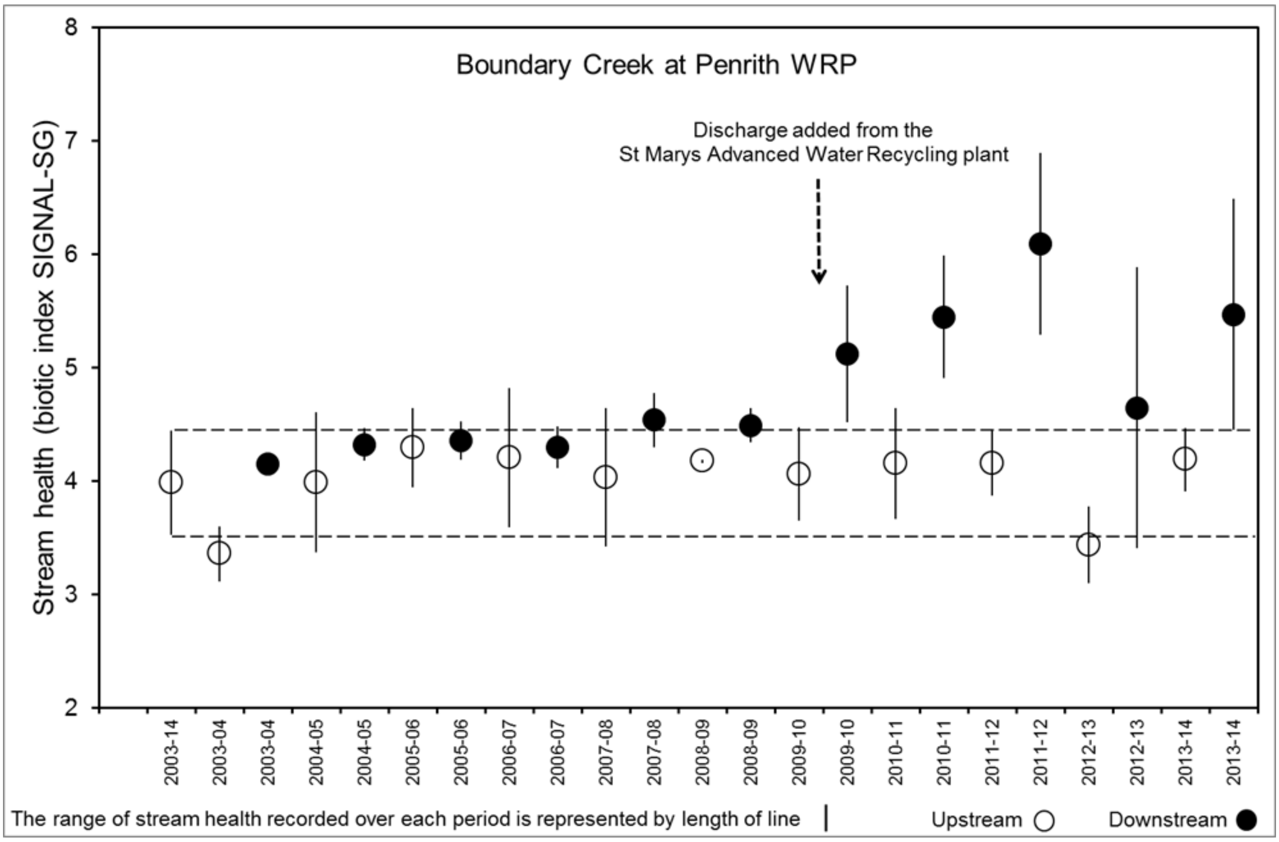


Figure 4-13 Ecological monitoring control chart for Boundary Creek at Penrith

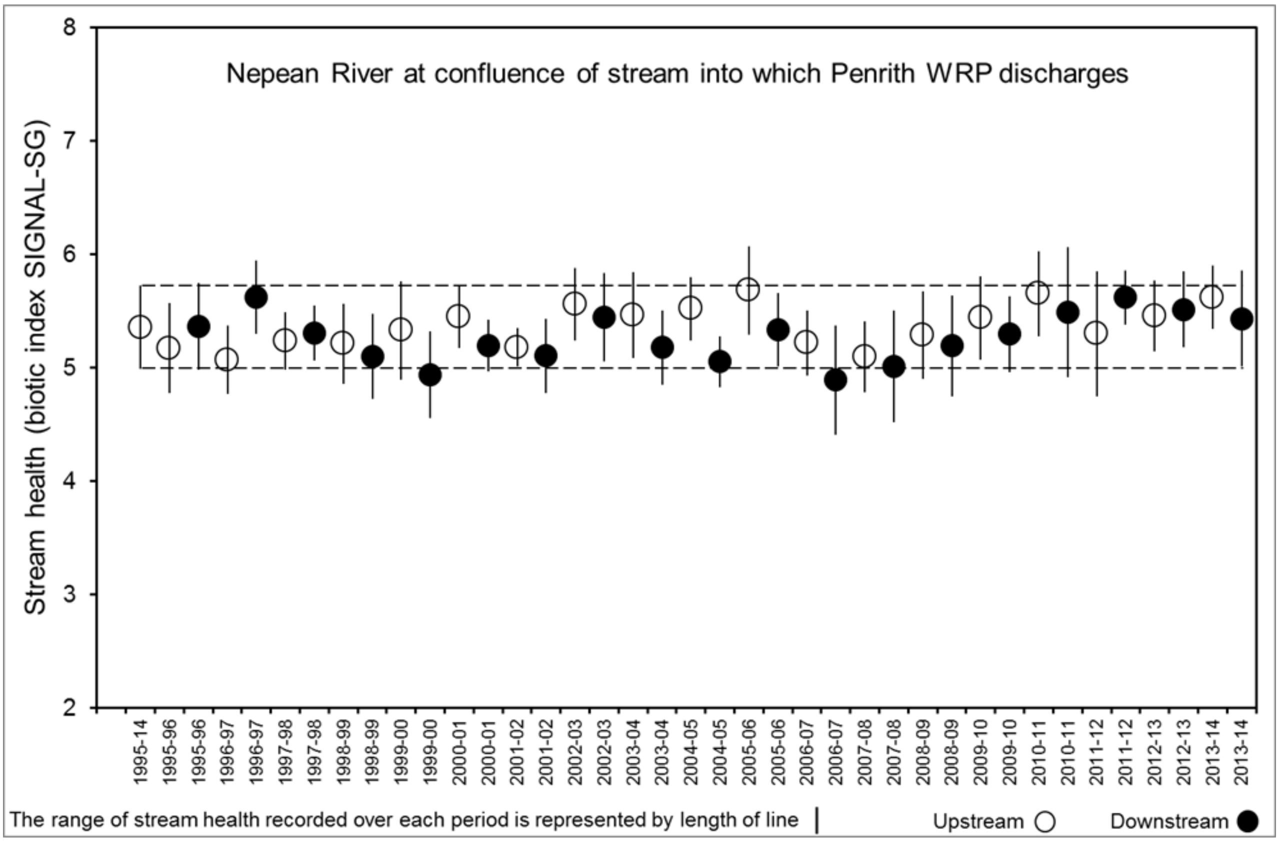


Figure 4-14 Ecological monitoring control chart for Nepean River at Penrith

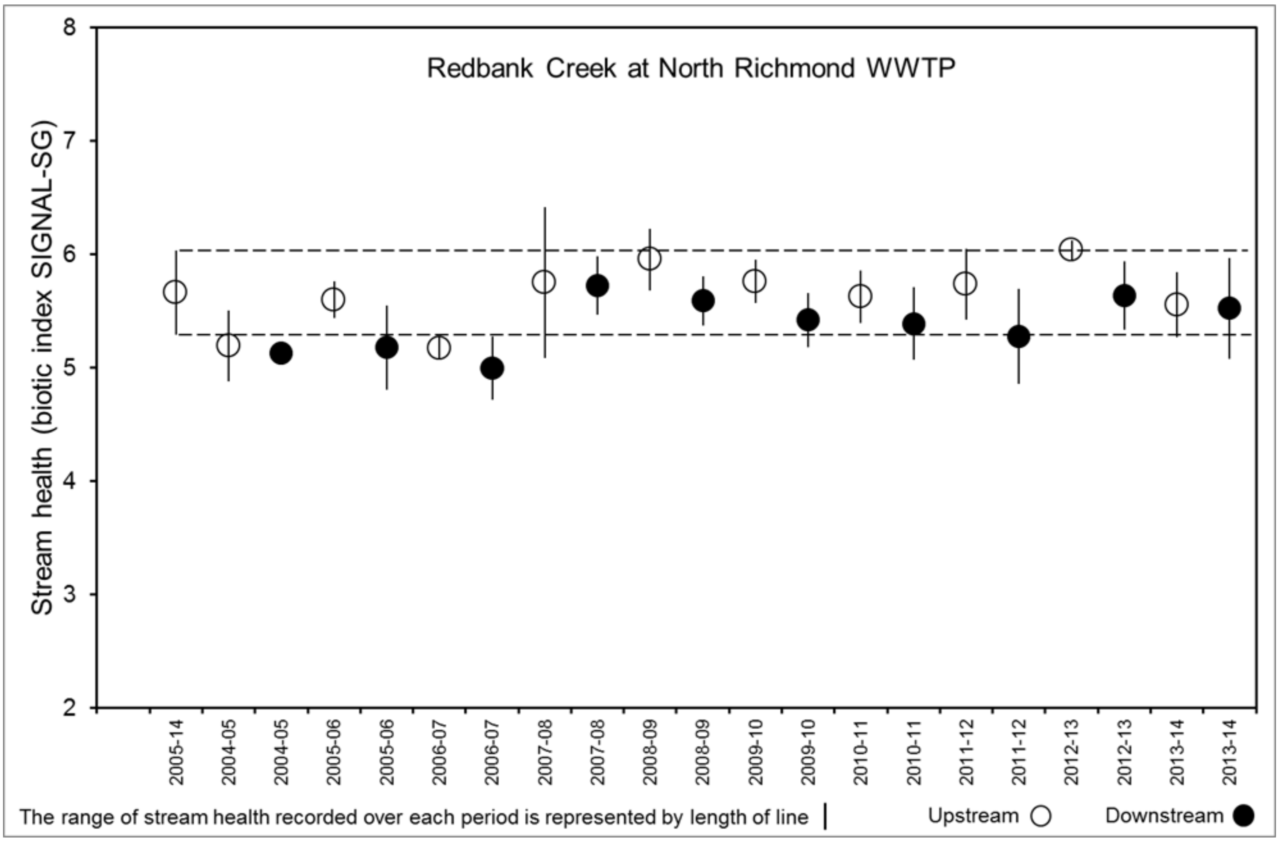


Figure 4-15 Ecological monitoring control chart for Redbank Creek at North Richmond

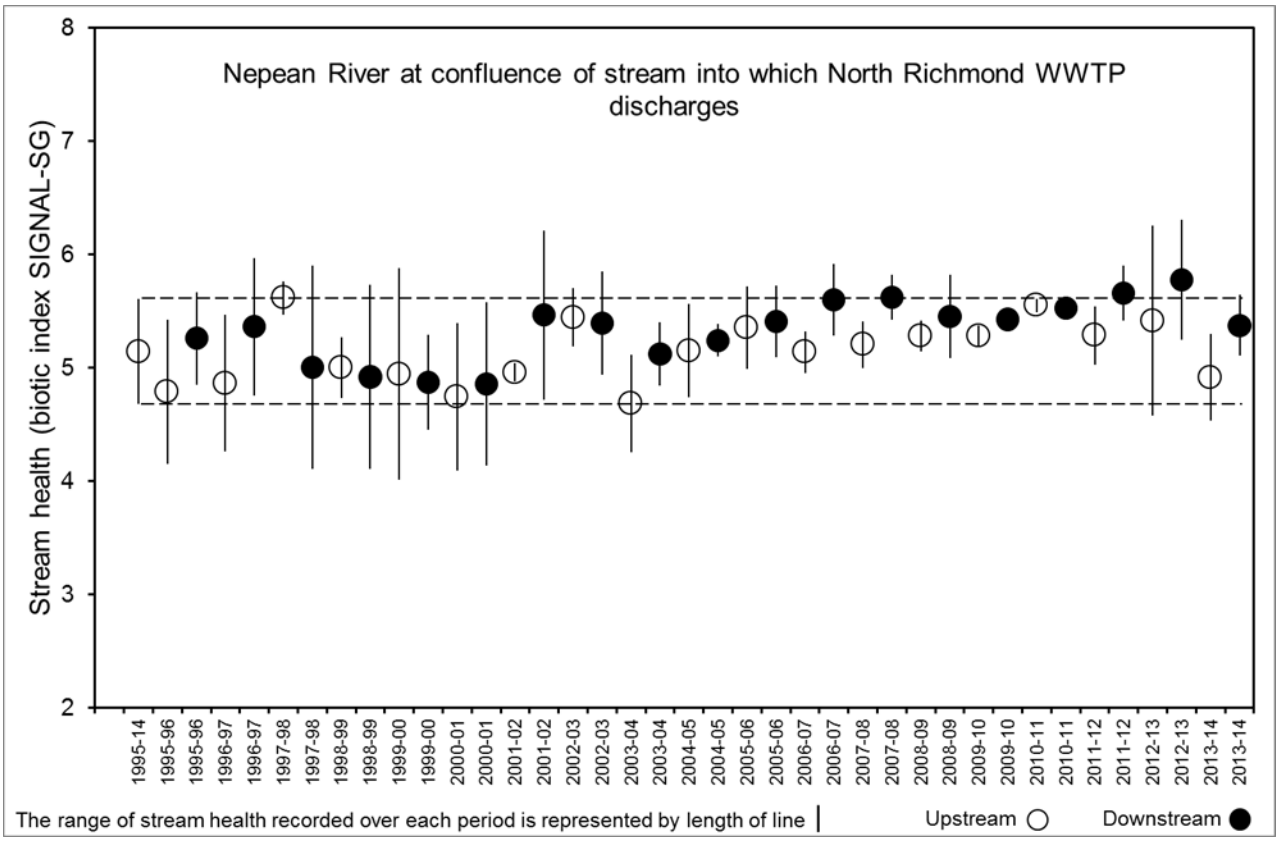


Figure 4-16 Ecological monitoring control chart for Nepean River at North Richmond

4.7 Results of multivariate tests of upstream and downstream site pairs

4.7.1 Hawkesbury Nepean River at West Camden

In light of recent research (Anderson and Walsh 2013) that has shown a balanced dataset provides more reliable test outcomes, and given the gap in edge habitat data outline in Table 4-1, a factor 'time' was introduced into this analysis. Time was comprised of two periods. 'Period 1' comprised data prior to 2005 and the time 'Period 2' comprised data onward from 2012.

Hawkesbury Nepean River edge habitat data pattern was visually displayed in a three-dimensional nMDS ordination plot (Figure 4-17) as a two dimensional plot had an unacceptable fit (stress) value of 0.28. A stress value of that size potentially represents points being placed almost arbitrarily in two dimensional space. Addition of a third dimension provided a just acceptable stress value of 0.19. To inspect this ordination pattern, data points were colour coded by Site-time periods. This colour coding suggested there was some shift in community structure at both sites between time periods but there was no clear separation of upstream-downstream site data points as would be expected if community structure was being altered by wastewater discharge Figure 4-17).

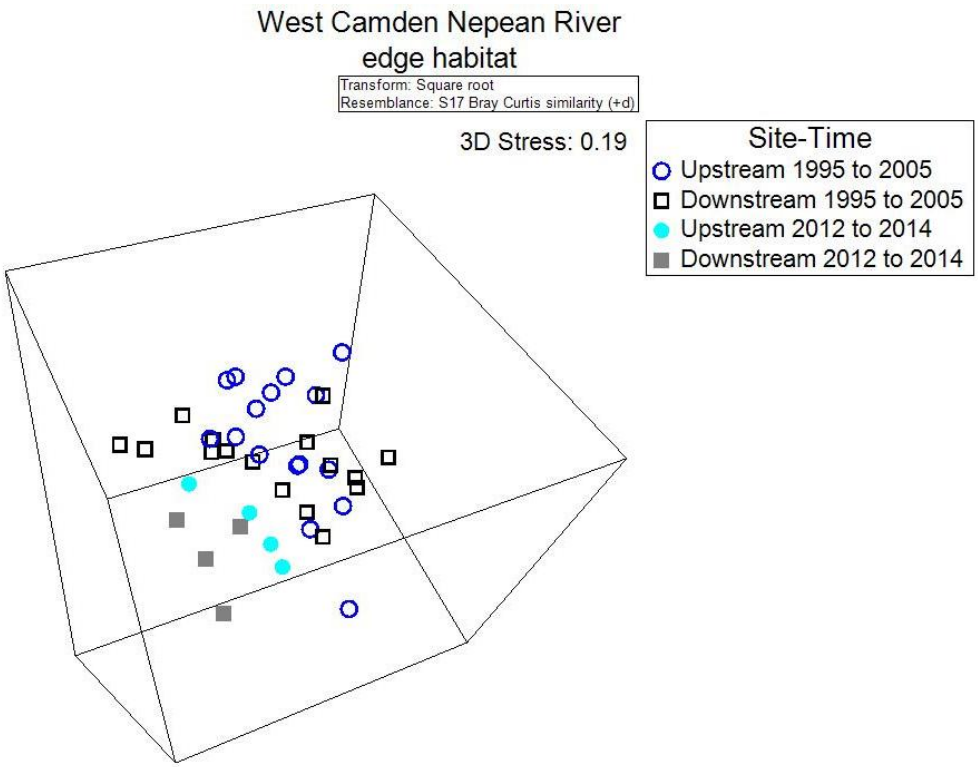


Figure 4-17 Three-dimensional ordination plot of freshwater macroinvertebrate community structure of Hawkesbury Nepean River upstream and downstream sites of West Camden plant for two periods (Period 1 data 1995 to 2005 and Period 2 data from 2012 to 2014)

The tree diagram output from classification analysis was checked to see if upstream and downstream (a-priori) groups of samples were separated high up in the tree diagram (Figure 4-18). This was not the case. As the tree diagram did not display a group of downstream site samples and another group of upstream site samples in the first split of the plot, the returned groupings suggests wastewater discharges did not measurably impact the macroinvertebrate community structure of the Hawkesbury Nepean River near West Camden within the two periods.

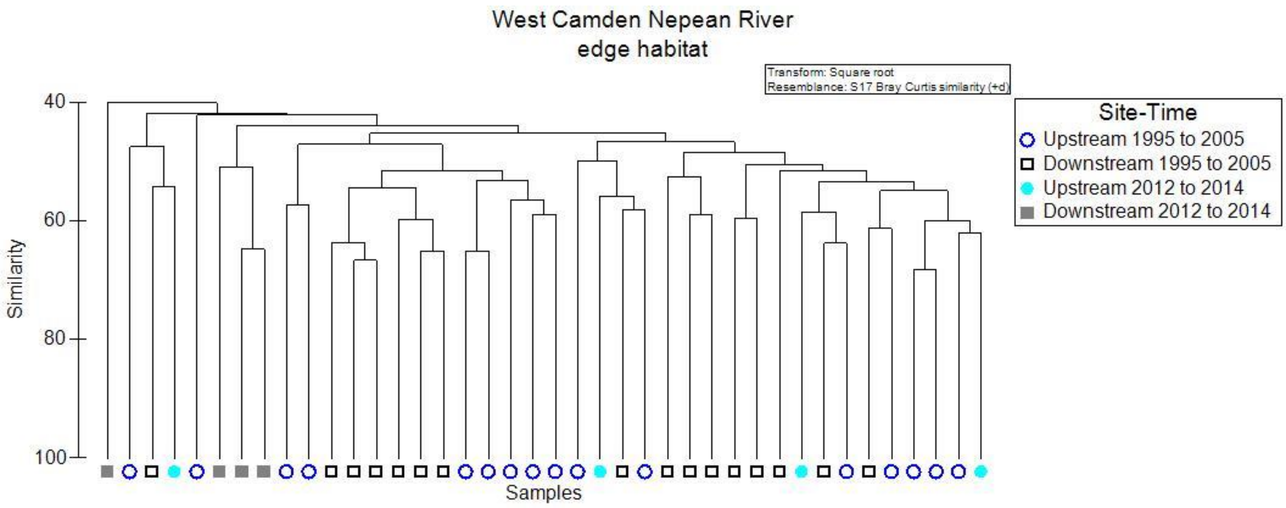


Figure 4-18 Tree diagram from classification analysis of freshwater macroinvertebrate community structure of Hawkebsury Nepean River upstream and downstream sites of West Camden plant for two periods (Period 1 data 1995 to 2005 and Period 2 data from 2012 to 2014)

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) for the two sites (F = 1.619; df1 = 1; df2 = 38; P (perm) = 0.2297). That is community structure at each site upstream and downstream of the confluence of the Matahill Creek was relatively similar through time. This non-significant result allowed an ANOSIM test to be run on the factor ‘Site’. ANOSIM indicated community structure was almost the same at both sites as the R-value was almost 0 (R = 0.084; P = 0.0220).

To explore if there had been a shift in community structure between sites, hypothesis testing was conducted with a PERMANOVA model. This model comprised the fixed factor ‘Site’ and the factor ‘Time’, which was treated as a random factor. ‘Time’ represented periods outlined above. ‘Site’ had two levels, upstream and downstream.

A statistically non-significant ‘Site x Time’ interaction was returned (df = 1; MS = 1446.5; Pseudo-F = 1.0384; P (perm) = 0.4091). This non-significant result allowed us to view the ‘Site’ and ‘Time’ results. A non-significant result was returned for ‘Site’ (df = 1; MS = 2172.7; Pseudo-F = 1.5597; P (perm) = 0.0567) while a significant result was returned for Time (df = 1; MS = 3806.7; Pseudo-F = 2.7327; P (perm) = 0.0002). Hence each site supported a relatively similar community structure, although a shift in community structure occurred at both sites between time periods. These results suggest wastewater discharges had not measurably altered downstream community structure in the Hawksebury Nepean River.

4.7.2 Matahill Creek at West Camden

In contrast to the Hawkesbury Nepean River sites, distinct groups of site samples were evident for the Matahill Creek sites in a two-dimensional ordination plot. This is the expected pattern in community structure if it was being altered by wastewater discharge.

This plot had a good measure of fit (stress) value of 0.10 (Figure 4-19). In this plot there was clear separation of upstream-downstream site data points (Figure 4-19) which indicated a distinctly different community structure at each site over the 2004 to 2014 monitoring period.

The ordination pattern was confirmed in the corresponding tree diagram (dendrogram) from classification analysis. The first division separated a group of upstream site samples from another group of downstream site samples (Figure 4-20). This separation occurred at a quite low similarity (Figure 4-20) compared with the higher similarity seen for the first separation in the Hawkesbury Nepean River sites tree diagram (Figure 4-20).

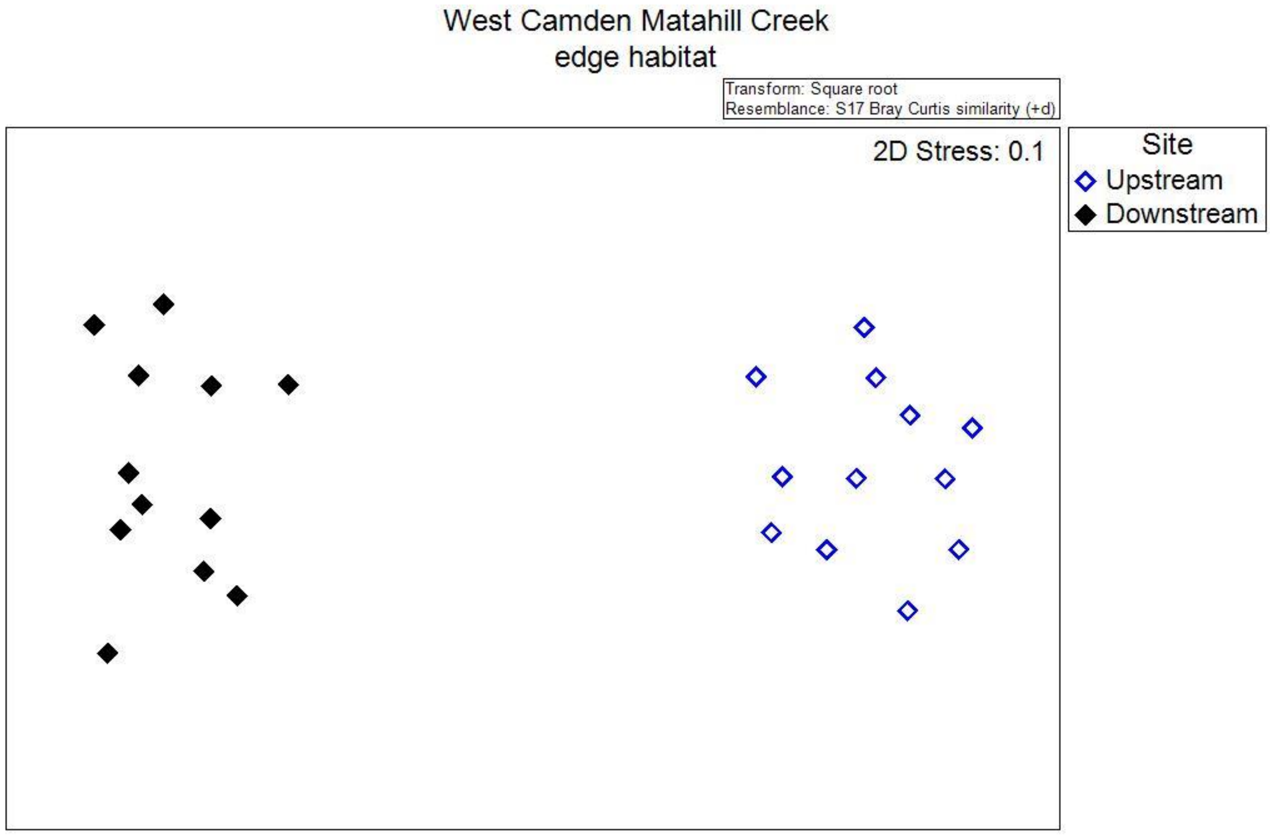


Figure 4-19 Two-dimensional ordination plot of freshwater macroinvertebrate community structure of Matahill Creek upstream and downstream sites of West Camden plant

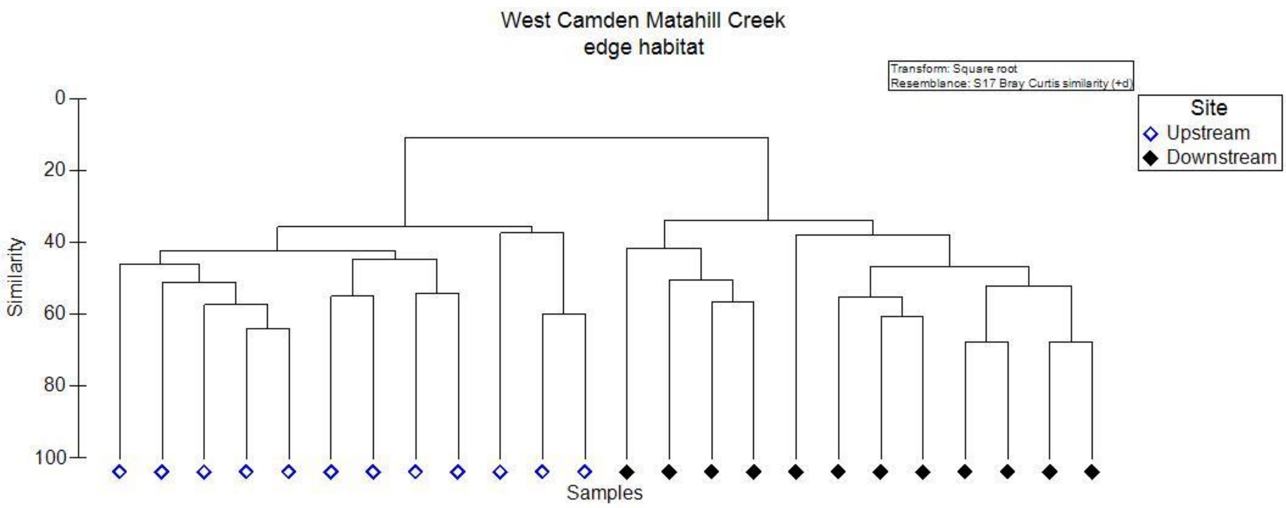


Figure 4-20 Tree diagram of freshwater macroinvertebrate community structure of Matahill Creek upstream and downstream sites of West Camden plant

A PERMANOVA test was run on the following model. This model had a single term 'Site' and tested edge habitat data. Temporal samples (2004 to 2014) from the two sites provided replication within each site (df = 1, MS = 28396 Pseudo F = 15.982 P (perm) = 0.0001). This model result confirmed the difference in community structure between sites that was evident in the ordination plot (Figure 4-19) and tree diagram (Figure 4-20).

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) for the two sites (F = 0.0544; df1 = 1; df2 = 22; P (perm) = 0.8214). That is, community structure at the upstream site varied a similar amount through time as at the downstream site for 2004 to 2014 monitoring period.

The non-significant PERMDISP result allowed an ANOSIM test to be run on the factor 'Site'. ANOSIM indicated community structure was very different at each site (R = 0.996; P = 0.001). As the R-value was almost 1, this indicated all temporal samples from a site were more similar to each other than they were the temporal samples from the other site, that is community structure was clearly different between upstream and downstream sites.

These results suggested community structure in Matahill Creek was altered by wastewater discharge.

4.7.3 Hawkesbury Nepean River at Winmalee

Hawkesbury Nepean River macroinvertebrate data were analysed for the monitoring period of 1995-2014 less gaps outlined in Table 4-1. Samples from each habitat, edge, macrophyte and riffle were analysed separately.

Evident in nMDS ordination plots for each habitat was an overlap of temporal upstream and downstream site samples for the macrophyte (Figure 4-21) and edge (Figure 4-22) habitats while groups of upstream and downstream site samples were just separated in ordination space for the riffle habitat (Figure 4-23).

An acceptable stress value was returned for the two-dimensional nMDS ordination of the macrophyte habitat (0.17) while three-dimensional ordinations were required for the edge (stress = 0.15) and riffle (stress = 0.15) habitat due to inherent variability within these data.

A mix of site samples was apparent in the corresponding tree diagrams (dendrograms) for each of the three habitats (Figure 4-24, Figure 4-25 and Figure 4-26). Except for a few samples, the similarity of taxonomic composition of samples between and within sites was usually greater than 40%.

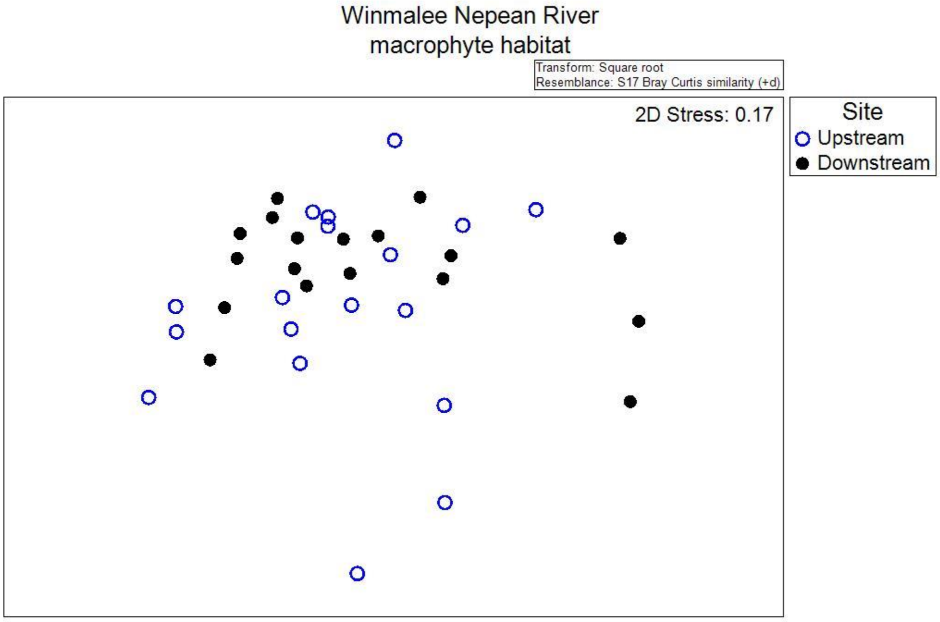


Figure 4-21 Two-dimensional ordination plot of freshwater macroinvertebrate macrophyte habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

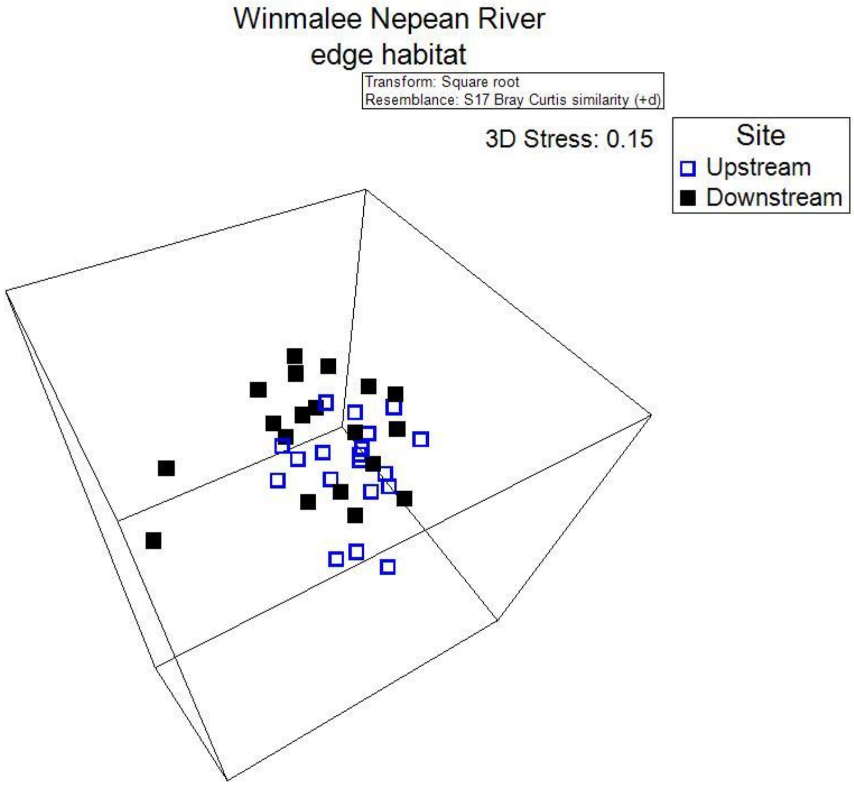


Figure 4-22 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

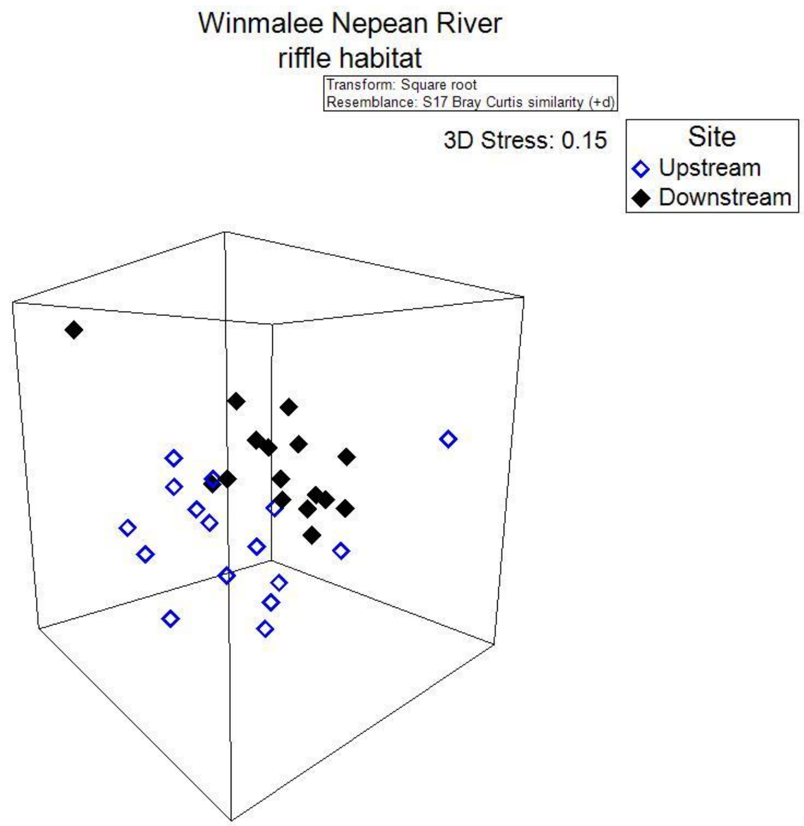


Figure 4-23 Three-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

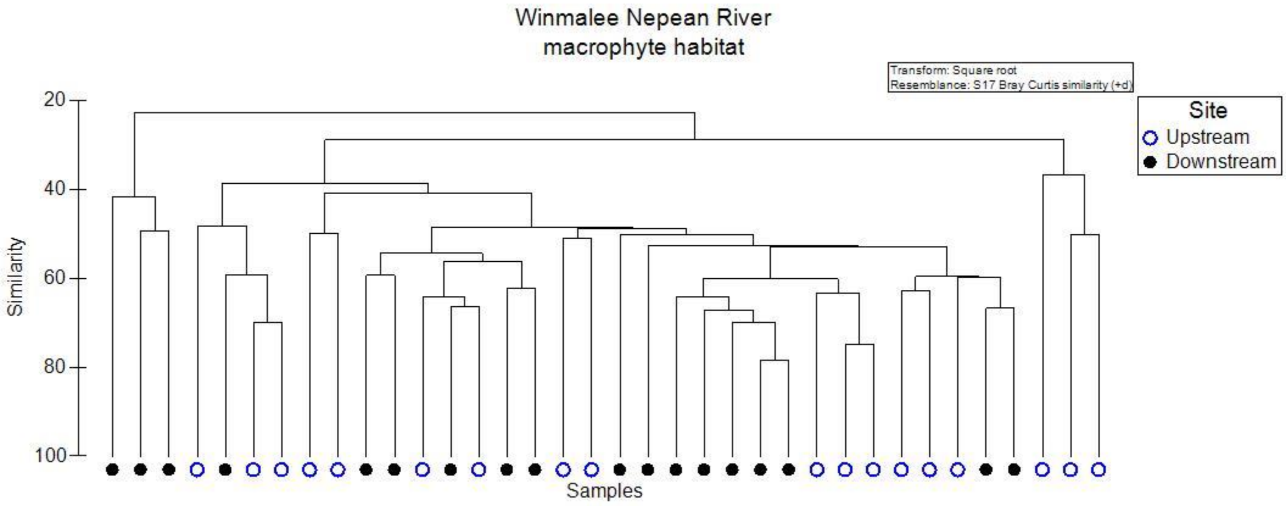


Figure 4-24 Tree diagram of freshwater macroinvertebrate macrophyte habitat community structure of Nepean River upstream and downstream sites of Winmalee plant

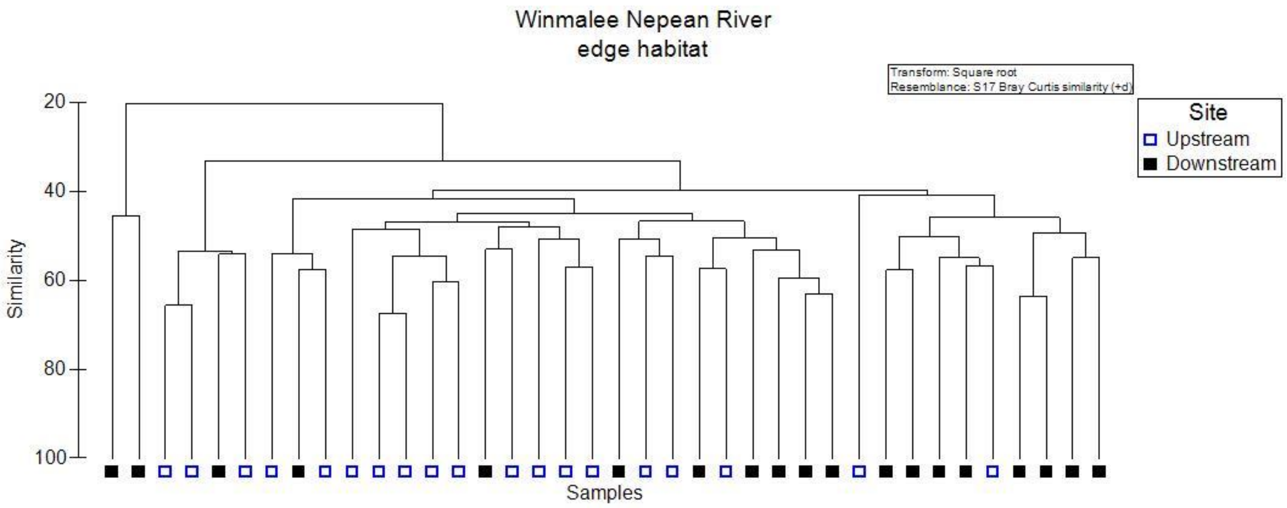


Figure 4-25 Tree diagram of freshwater macroinvertebrate edge habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

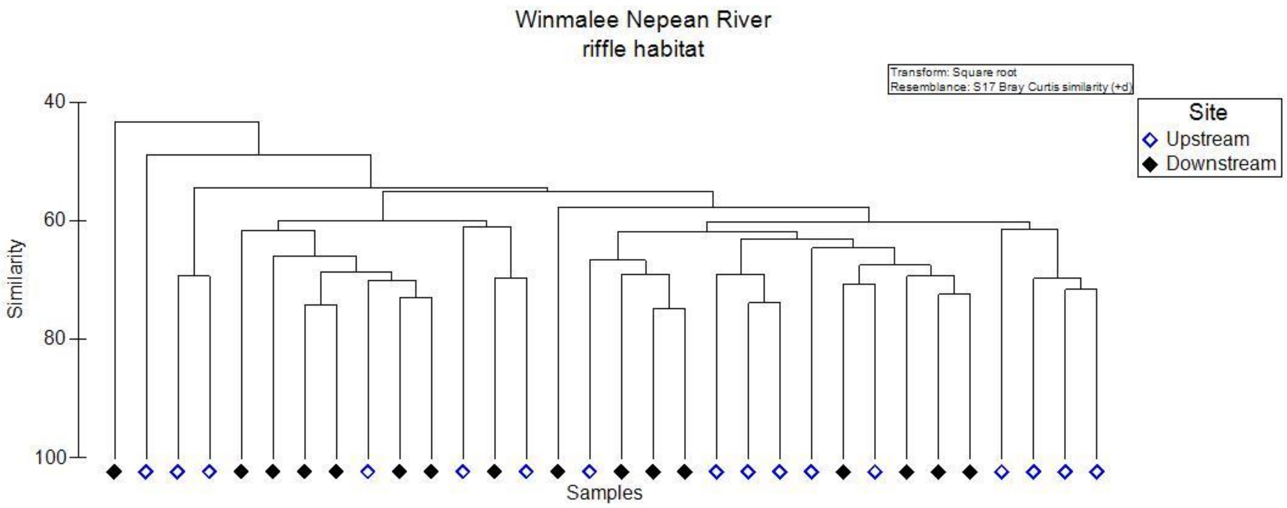


Figure 4-26 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

A PERMANOVA test was run on the model with the single term 'Site'. This model was run for each of the three habitats. Results were non-significant for the macrophyte habitat but significant for the edge and riffle habitats:

- macrophyte habitat (df = 1, MS = 2720.5 Pseudo F = 1.4909 P(perm) = 0.1319)
- edge habitat (df = 1, MS = 4146 Pseudo F = 2.2463 P(perm) = 0.0048)
- riffle habitat (df = 1, MS = 2522.9 Pseudo F = 2.7531 P(perm) = 0.0019)

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) for each habitat of the upstream and downstream sites:

- macrophyte habitat (F = 0.5358, df1 = 1; df2 = 34; P(perm) = 0.5302)
- edge habitat (F = 0.6338; df1 = 1; df2 = 36; P(perm) = 0.4907)
- riffle habitat (F = 0.0050; df1 = 1; df2 = 30; P(perm) = 0.8344)

These non-significant PERMDISP result allowed ANOSIM tests to be run on the factor 'Site' for each of the three habitats. ANOSIM indicated community structure was indistinguishable between the upstream and downstream sites for macrophytes habitat samples (R = 0.04; P = 0.083). The edge and riffle habitats had negligibly small ANOSIM R-values (edge R = 0.12, P = 0.004: riffle R= 0.195, P = 0.001) that indicated barely separable and strongly overlapping community structures of the upstream and downstream sites.

The lack of clear separation of upstream and downstream site samples in the ordination plots, together with intermixed site samples in the tree diagrams and negligibly small ANOSIM R-values suggested the two significant PERMANOVA results are most likely to have detected natural medium scale spatial variability between the upstream and downstream sites in two of the three habitats sampled. Besley and Chessman (2008) demonstrated natural medium scale spatial variation in community structure occurred with as little spatial separation as 0.2 km on the same stream. Out of the Besley and Chessman (2008) study they concluded that the SIGNAL-SG biotic index did not seem to be influenced by natural medium scale spatial variation. They also commented that natural medium scale spatial variation appeared to be responsible for a large part of the multivariate variate ordination patterns. Thus these multivariate results together with SIGNAL-SG biotic index results suggest wastewater discharges did not measurably altered downstream community structure in the Hawkesbury Nepean River.

4.7.4 Unnamed creek at Winmalee

Macroinvertebrate data collected from the unnamed creek downstream of Winmalee were analysed for the monitoring period of 2004-14 less gaps outlined in Table 4-1.

Samples from each habitat, edge and riffle were analysed separately. Both sites were situated downstream of the plant, as this creek did not carry any flow upstream of the plant under dry weather conditions. The first site was located 0.3 km downstream of the plant, while the second downstream site was situated 3 km below the plant in a natural bush land catchment. In the analyses below, sites are labelled as near and far.

The patterns displayed in the three-dimensional nMDS ordination plots and tree diagrams suggested community structure was relatively distinct with little overlap of each site in both habitats (Figure 4-27, Figure 4-28, Figure 4-29 and Figure 4-30). Acceptable stress values were returned for these three-dimensional ordinations plots (edge stress = 0.15 and riffle stress = 0.17).

PERMANOVA tests were run on the model with the single term 'Site'. This model was run for each of the two habitats. Results were significant for both habitats (edge df = 1, MS = 15219 Pseudo F = 9.877 P (perm) = 0.0001; riffle habitat df = 1, MS = 16026 Pseudo F = 14.158 P (perm) = 0.0001).

The PERMDISP analysis indicated a similar pattern of dispersion (spacing between same site samples) in each habitat for the two sites (edge F = 0.3678; df1 = 1; df2 = 38; P (perm) = 0.5622; riffle F = 3.2855; df1 = 1; df2 = 38; P (perm) = 0.0903). That is, community structure at the upstream site varied a similar amount through the monitoring period as did the downstream site.

These non-significant PERMDISP results allowed ANOSIM tests to be run on the factor 'Site'. The level of returned ANOSIM R-values indicated community structure for both habitats was clearly different with little overlap (edge R = 0.608; P = 0.001; riffle R = 0.576; P = 0.001).

As ANOSIM values were returned at levels Besley & Chessman (2008) recorded as representative of natural medium scale spatial variation that could be responsible for the multivariate patterns in the unnamed creek. However, SIGNAL-SG scores from the 3 km downstream (far) site were at levels typical of those recorded for the Hawkesbury Nepean River upstream and downstream of the confluence with the unnamed creek. Hence these multivariate results together with SIGNAL-SG biotic index results suggest wastewater discharges did measurably alter downstream community structure at 0.3 km site. While natural stream processes improved stream health with downstream distance from the Winmalee plant.

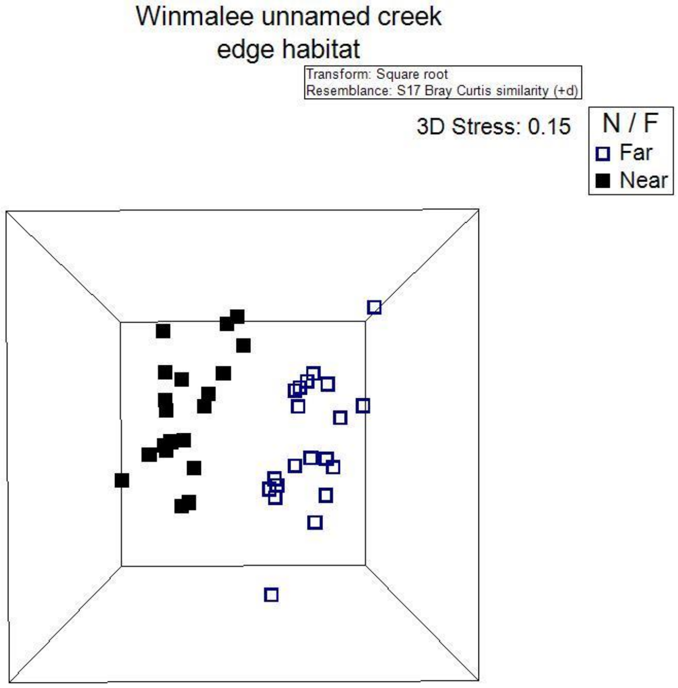


Figure 4-27 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of unnamed creek downstream sites of Winmalee plant

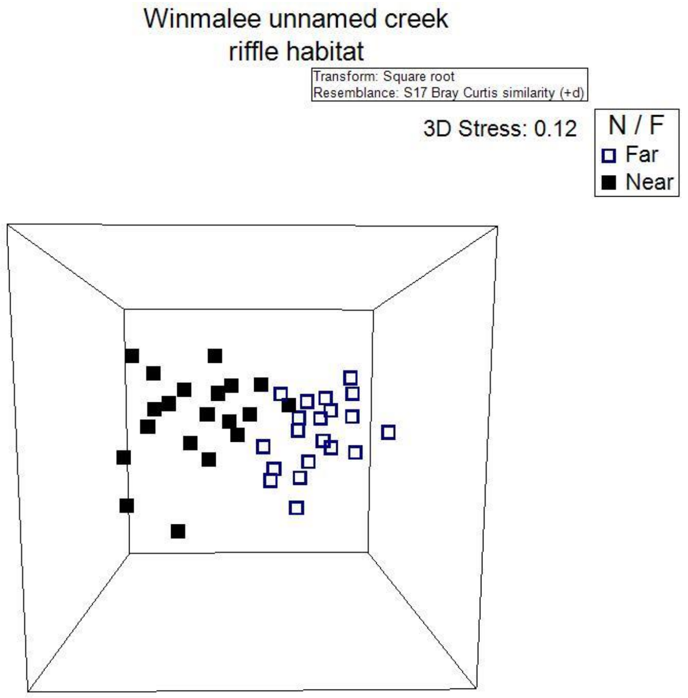


Figure 4-28 Three-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

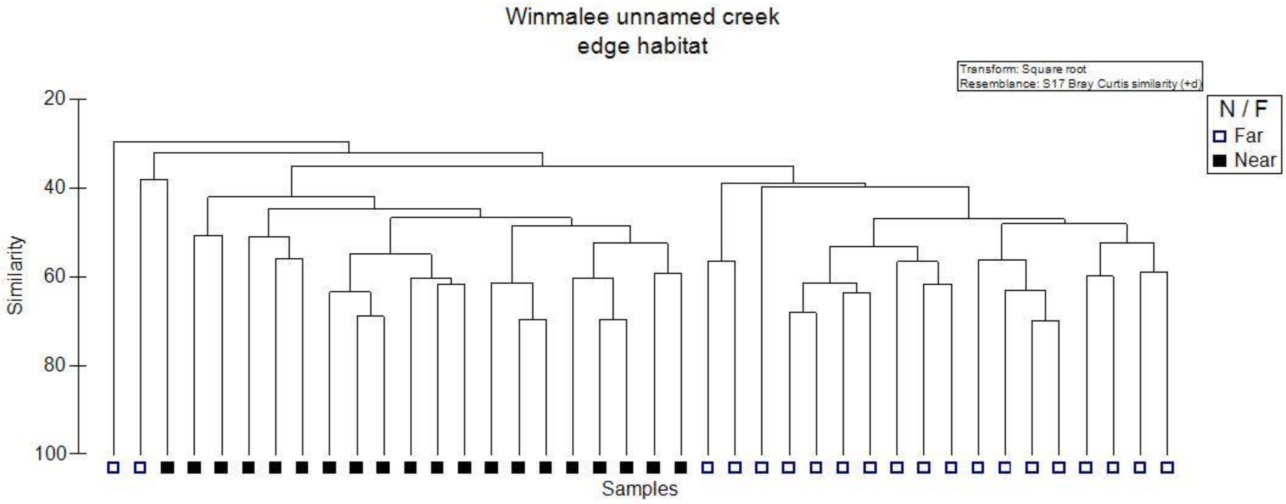


Figure 4-29 Tree diagram of freshwater macroinvertebrate edge habitat community structure of Nepean River upstream and downstream sites of Winmalee plant

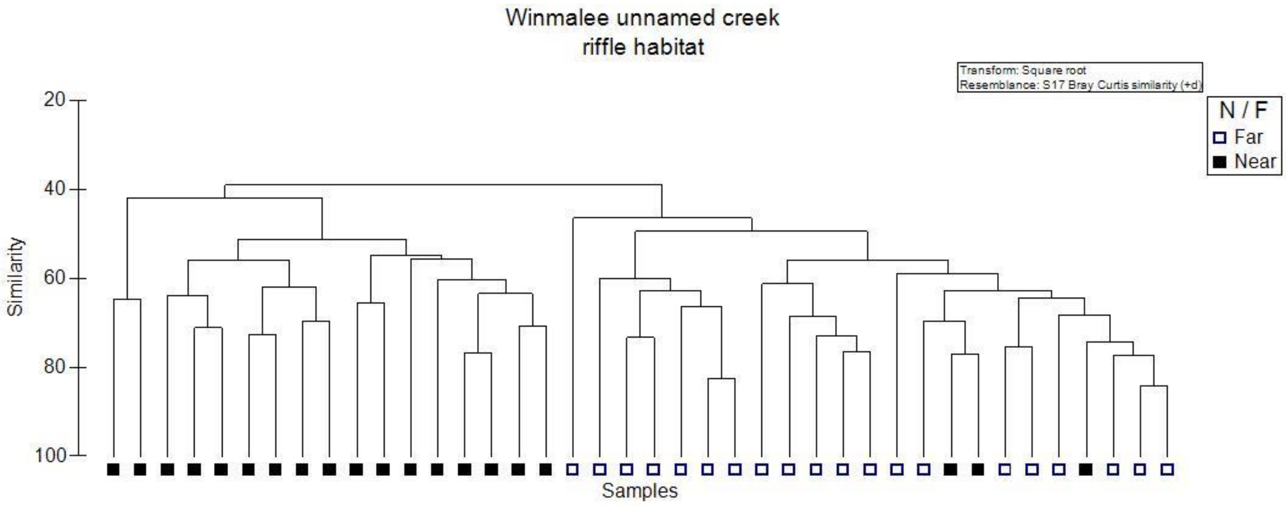


Figure 4-30 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of Hawkesbury Nepean River upstream and downstream sites of Winmalee plant

4.7.5 Calna Creek at Hornsby Heights

Macroinvertebrate data collected from Calna Creek upstream and downstream of the Hornsby Heights plant were analysed for the monitoring period of 1996-2014 less gaps outlined in Table 4-1. Samples from each habitat, edge and riffle were analysed separately.

The patterns displayed in the three-dimensional nMDS ordination plots and tree diagrams suggested community structure recorded at each site had some overlap in each habitat (Figure 4-31, Figure 4-32, Figure 4-33 and Figure 4-34). Acceptable stress values were returned for these three-dimensional ordinations plots (edge stress = 0.19 and riffle stress = 0.14).

PERMANOVA tests were run on the model with the single term 'Site'. This model was run for each of the two habitats. Results were significant for both habitats (edge df = 1, MS = 12522 Pseudo F = 7.2087 P (perm) = 0.0001; riffle habitat df = 1, MS = 24881 Pseudo F = 17.707 P (perm) = 0.0001).

The PERMDISP analysis indicated different patterns of dispersion in each habitat for the two sites (edge F = 32.095; df1 = 1; df2 = 68; P (perm) = 0.0002; riffle F = 7.2897; df1 = 1; df2 = 62; P (perm) = 0.0205). That is, community structure at the upstream site varied by a different amount through the monitoring period to the downstream site. As PERMDISP results were significantly different ANOSIM tests could not be run.

These multivariate results suggested community structure in Calna Creek was being altered by wastewater discharge from the Hornsby Heights plant at different times through the monitoring period. Inspection of SIGNAL-SG temporal plot also reflected intermittent measurable impacts in stream health occurred in Calna Creek.

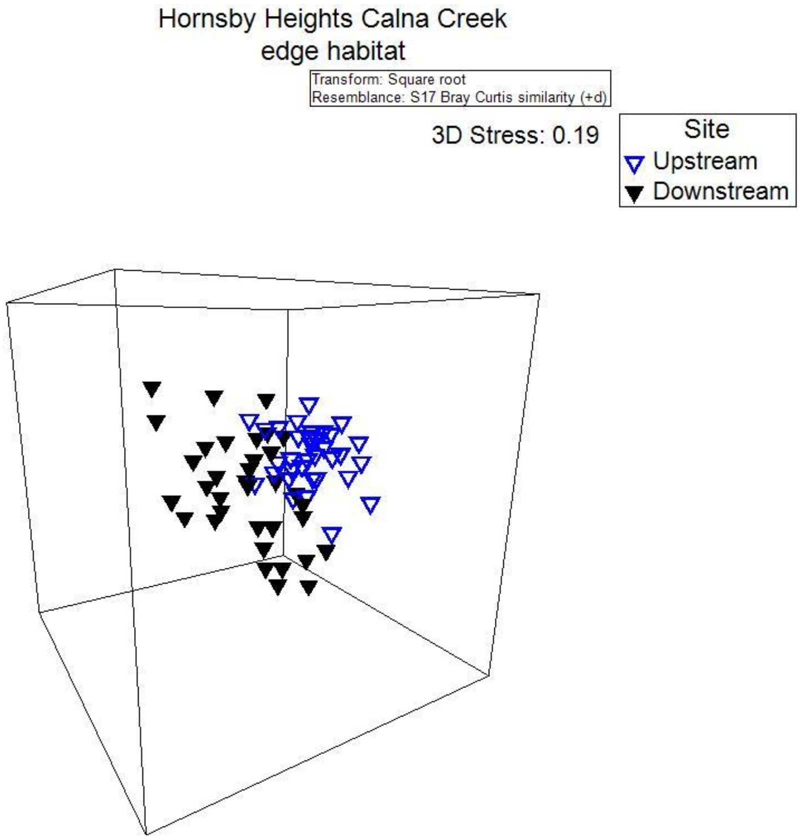


Figure 4-31 Three-dimensional ordination plot of freshwater macroinvertebrate edge habitat community structure of Calna Creek upstream and downstream sites of Hornsby Heights plant

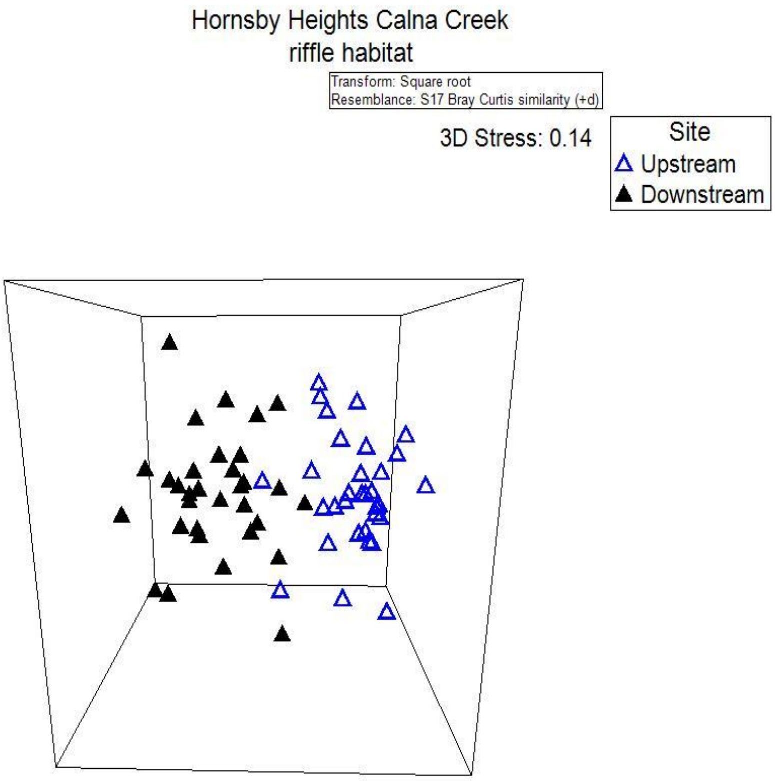


Figure 4-32 Three-dimensional ordination plot of freshwater macroinvertebrate riffle habitat community structure of Calna Creek upstream and downstream sites of Hornsby Heights plant

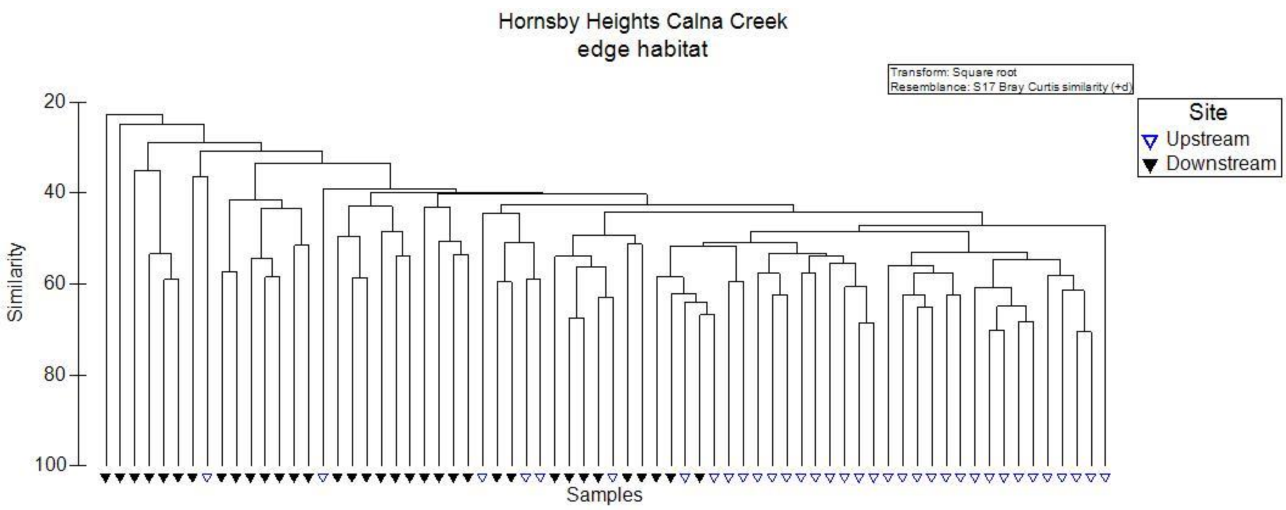


Figure 4-33 Tree diagram of freshwater macroinvertebrate edge habitat community structure of Calna Creek upstream and downstream sites of Hornsby Heights plant

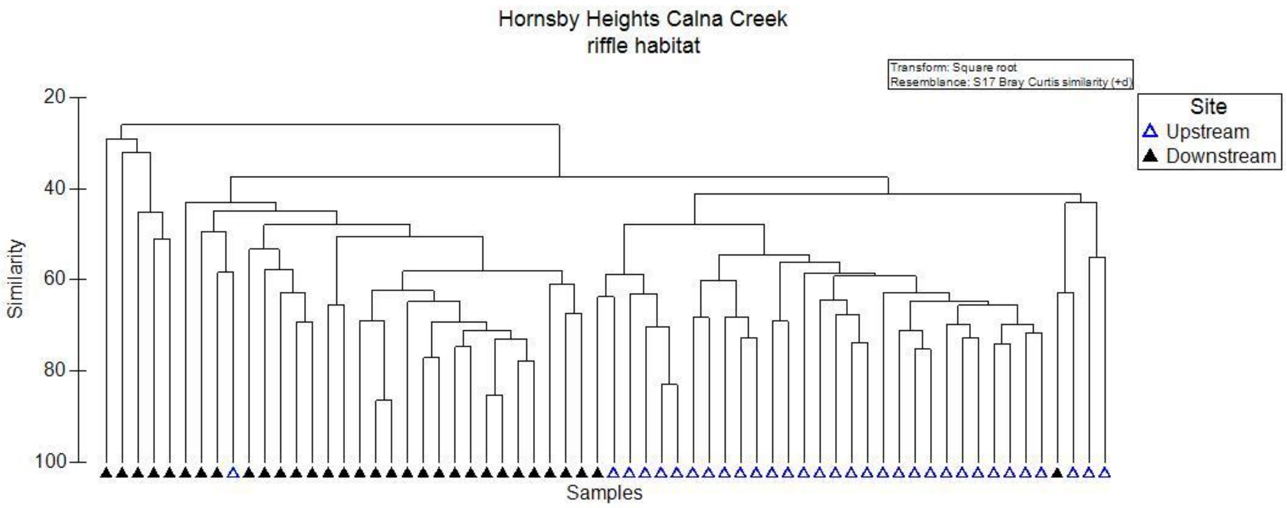


Figure 4-34 Tree diagram of freshwater macroinvertebrate riffle habitat community structure of Calna Creek upstream and downstream sites of Hornsby Heights plant

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6 Appendices

6.1 Appendix A Data analysis methods

Table 6-1 Rainfall stations used for categorising wastewater data as dry or wet weather days

Catchments	Rainfall station (Hydstra code and site name/ description)	Plant
Upper Nepean	568053 Picton plant 568130 West Camden plant (composite)	Picton and West Camden plants
Mid Nepean	567163 Regent Ville Rural Fire Service 567087 St Marys plant 568045 Warragamba or Wallacia plant 568044 Warragamba Water Filtration Plant	Penrith and St Marys plants Glenbrook*, Warragamba* and Wallacia plants
Lower Nepean	567084 Quakers Hill plant 567085 Richmond plant 563069 North Richmond plant 563146 Winmalee plant 567100 Riverstone plant	Quakers Hill and Richmond plants North Richmond, Winmalee and Riverstone plants
Blue Mountains	563062 Blackheath plant 563148 Mount Victoria plant 563059 Katoomba (Cascade Ck, Dam 1) 563061 Wentworth Falls (Bodington)	Blackheath*, Mount Victoria* and Round Corner* plants
Lower Hawkesbury	567076 Castle Hill plant 567102 Dural (WPS14)	Castle Hill and Rouse Hill plants
Berowra	567120 Brooklyn plant 566055 Hornsby Bowling Club 566073 Pymble Bowling Club 566053 Hornsby Heights plant	Brooklyn, West Hornsby and Hornsby Heights plants
South West Sydney	567077 Fairfield plant 567078 Glenfield plant 566049 Liverpool plant	Fairfield plant Glenfield plant Liverpool plant
Cronulla	566078 South Cronulla 566018 Cronulla plant	Cronulla plant
Illawarra	568162 Balgownie Reservoir 568173 Berkeley (Berkeley Sports and Social Club) 568171 Albion Park Bowling Club 568181 Figtree Bowling Club 568188 Kiama Water Tank	Bellambi and Port Kembla plants Shellharbour plant Wollongong and Bombo plants
North Sydney Coast	566089 Manly Croquet Club (formerly Manly Golf Course) 566100 North Head Plant 566051 Warriewood plant (Composite)	North Head and Warriewood plants
Malabar	566026 Malabar plant 567077 Fairfield plant 567078 Glenfield plant	Malabar plant

Catchments	Rainfall station (Hydstra code and site name/ description)	Plant
	566049 Liverpool plant	
Bondi	566032 Paddington (Composite) 566038 Vaucluse Bowling club	Bondi plant

* plant decommissioned but included to calculate historical volume and loads.

Table 6-2 Rainfall stations used for categorising water quality data as dry or wet weather days

Catchments	Rainfall station (Hydstra code and site name/ description)	Water quality monitoring Sites
Upper Nepean	568053 Picton plant 568130 West Camden plant (Composite) 568044 Warragamba Water Filtration Plant	N92, N75 and N67
Mid Nepean	567163 Regentville Rural Fire Service 567087 St Marys plant	N57 and N51
Lower Nepean	567084 Quakers Hill plant 567085 Richmond plant 563069 North Richmond plant 563146 Winmalee plant 567100 Riverstone plant	N48, N44, N39, N35 and NS04
Lower Hawkesbury	567076 Castle Hill plant 567102 Dural (WPS14)	N3001, N26, N18, N2202 and NC11
Berowra	566055 Hornsby Bowling Club 566073 Pymble Bowling Club 566053 Hornsby Heights plant	NB13 and NB11
Port Jackson Lower	566087 Gladesville Bowling Club 566073 Pymble Bowling Club	PJLC and PJTB
Port Jackson Upper	566087 Gladesville Bowling Club 566082 Auburn RSL Bowling Club 566032 Paddington (Composite)	PJ015, PJPR, PJCB2 and PJDFP
Middle Harbour	566089 Manly Golf Course 566100 North head plant 566051 Warriewood plant (Composite)	PJDR, PJSB and PJCB1
Georges River Lower	566026 Marrickville Bowling Club 566020 Enfield (Composite site) 566028 Eastlakes SWC Depot	GR01, CR04, GRRB and GRFB
Georges River Upper	567077 Fairfield plant 567078 Glenfield plant 566049 Liverpool plant	GR19, GR22 and GROB
Port Hacking	566078 South Cronulla BC 566018 Cronulla plant	PHLPB
Lagoons	566051 Warriewood plant (Composite) 566089 Manly Golf Course	All lagoon sites (CC-sites, DW-sites, ML sites and NL_sites)

Table 6-3 Water quality guidelines used for the map based ratings

Water quality variables or Cyanobacteria alert	Main stream Hawkesbury Nepean River sites : Mixed rural use and sandstone plateau (N92, N75, N67, N51, N48, N44, N39, N35, N3001, N26, N2202 and N18)	Main stream Hawkesbury Nepean River sites: Predominantly urban (N57and N42)	Tributary stream of Hawkesbury-Nepean River sites: predominantly urban (NS04 and NC11)	Estuarine and brackish sites of the Hawkesbury Nepean River (NB11 and NB13)	Freshwater sites: Non-Hawkesbury Nepean River catchment (PJLC, PJPR and GR22)	Estuarine or saline sites: Non-Hawkesbury Nepean River catchment(Lagoons and other saline sites)	Guideline references
Total nitrogen (mg/L)	<0.70	<0.50	<1.00	<0.40	-	-	Water quality objectives for nutrients (HRC, 1998)
Total phosphorus (mg/L)	<0.035	<0.030	<0.050	<0.030	-	-	
Chlorophyll *a* (μg/L)	<7.0	<15.0	<20.0	<7.0	<3.0	<4.0	
Green alert	≥ 500 to < 5,000 cells/mL *Microcystis aeruginosa* or other *Microcystis sp.* (when not counted up to species level) or biovolume equivalent > 0.04 to < 0.4 mm^3/L combined total of all cyanobacteria						Cyanobacteria alert levels for recreational water (NHMRC 2008)
Amber alert	≥ 5,000 to < 50,000 cells/mL *Microcystis aeruginosa* or other *Microcystis sp.* (when not counted up to species level) or biovolume equivalent ≥ 0.4 to <4 mm^3/L for combined total biovolume of all cyanobacteria (when toxic species are present) or biovolume equivalent ≥ 0.4 to <10 mm^3/L for combined total biovolume of all cyanobacteria (when toxic species are not present)						
Red alert	≥ 50,000 cells/mL *Microcystis aeruginosa* or other *Microcystis sp.* (when not counted up to species level) or biovolume equivalent ≥ 4 mm^3/L for combined total biovolume of all cyanobacteria (when toxic species are present) or biovolume equivalent ≥ 10 mm^3/L for combined total biovolume of all cyanobacteria (when toxic species are not present)						

6.2 Appendix B Summary of wastewater and recycled water data

Table 6-4 Summary of the toxicity results and EPL limits for ocean discharging plants 2013-14

Plant	Unit of measure	Number of samples	Minimum result	Maximum result	90th percentile limit	90th percentile value	within 90th percentile limits	Average limit	Average value	Within average value limits
Warriewood	% Wastewater/Vol	12	100	100	4	100	yes	6.7	100	yes
North Head	% Wastewater/Vol	12	0.1	4.7	0.13	2.1	yes	0.24	1.4	yes
Bondi	% Wastewater/Vol	12	3.7	20	0.16	20	yes	0.27	8.9	yes
Malabar	% Wastewater/Vol	12	0.4	10	0.1	10	yes	0.19	3.3	yes
Cronulla	% Wastewater/Vol	12	100	100	0.19	100	yes	1.53	100	yes
Shellharbour	% Wastewater/Vol	12	41.2	100	1.87	100	yes	2.09	94.3	yes
Bombo	% Wastewater/Vol	12	66.4	100	1.18	100	yes	2.16	94.5	yes

Table 6-5 Summary of the toxicity results and limits for inland discharging plants 2013-14

Plant	Unit of measure	Number of samples	Minimum result	Maximum result	50th percentile limit	50th percentile value	Within 50th percentile limits
West Camden	% Wastewater/Vol	12	100	100	50	100	yes
Wallacia	% Wastewater/Vol	12	100	100	50	100	yes
Penrith	% Wastewater/Vol	12	100	100	50	100	yes
Winmalee	% Wastewater/Vol	12	100	100	50	100	yes
North Richmond	% Wastewater/Vol	12	100	100	50	100	yes
Richmond	% Wastewater/Vol	7	100	100	50	100	yes
St Marys	% Wastewater/Vol	12	100	100	50	100	yes
Quakers Hill	% Wastewater/Vol	12	100	100	50	100	yes
Riverstone	% Wastewater/Vol	12	100	100	50	100	yes
Castle Hill	% Wastewater/Vol	12	75.2	100	50	100	yes
Rouse Hill	% Wastewater/Vol	12	100	100	50	100	yes
Hornsby Heights	% Wastewater/Vol	12	100	100	50	100	yes
West Hornsby	% Wastewater/Vol	12	100	100	50	100	yes
Brooklyn	% Wastewater/Vol	12	73.5	100	50	100	yes

Other yearly summaries of performance to EPL limits for 2013-14 can be found at http://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/waterquality/epa-reports/index.htm

Table 6-6 Previous ten years of total wastewater discharge volume (ML/year) for all ocean plants

Plant	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
North Head	118,336	122,332	114,415	131,467	137,355	124,459	133,570	143,815	162,071	133,063	123,645	-7.1%
Bondi	49,960	47,932	46,272	48,571	45,108	44,639	44,549	46,165	48,584	47,438	46,009	-3.0%
Malabar System	169,324	166,433	160,970	178,975	184,925	181,283	173,891	187,829	204,793	178,022	175,760	-1.3%
Warriewood	6,220	6,298	5,939	6,651	6,760	6,400	5,811	6,815	8,092	6,844	6,477	-5.4%
Cronulla	20,079	21,375	19,605	25,148	26,857	20,841	18,865	20,643	23,250	20,059	21,094	5.2%
Wollongong	5,663	11,658	16,352	17,403	19,252	18,493	12,291	14,616	17,389	13,178	13,616	3.3%
Bellambi	7,948	6,101	*	*	*	*	356	504	1,018	594	302	-49.1%
Port Kembla	5,726	4,776	1,434	*	*	*	505	790	888	748	496	-33.7%
Shellharbour	4,840	5,346	4,877	7,881	6,555	5,858	6,056	7,031	7,743	6,795	6,552	-3.6%
Bombo	1,534	1,248	1,251	1,537	1,342	1,227	1,327	1,814	1,847	1,705	1,483	-13.0%
All ocean (total)	**389,630**	**393,499**	**371,115**	**417,633**	**428,154**	**403,200**	**397,221**	**430,020**	**475,675**	**408,446**	**395,436**	**-3.2%**

* Converted to stormwater plant and no partial treatment discharges during these years

Table 6-7 Previous ten years of oil and grease loads (tonnes/year) from all ocean plants

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
North Head	dry	3,707.5	3,321.7	3,832.5	3,765.6	3,480.8	2,963.4	3,911.6	3,697.6	3,399.3	3,201.3	3,865.2	
	wet	434.0	731.1	407.0	759.7	1,173.1	1,130.3	933.4	1,002.7	1,523.8	697.4	795.4	
	all	**4,141.6**	**4,052.8**	**4,239.6**	**4,525.4**	**4,653.9**	**4,093.7**	**4,845.0**	**4,700.3**	**4,923.1**	**3,898.6**	**4,660.5**	**20%**
Bondi	dry	1,367.3	1,217.8	1,427.9	1,304.9	1,195.0	1,128.3	1,241.0	1,129.4	1,149.7	1,304.1	1,405.9	
	wet	167.4	221.3	152.5	321.8	328.5	335.6	216.2	309.7	400.8	229.1	191.9	
	all	**1,534.7**	**1,439.1**	**1,580.4**	**1,626.7**	**1,523.4**	**1,463.9**	**1,457.2**	**1,439.1**	**1,550.5**	**1,533.2**	**1,597.8**	**4%**
Malabar System	dry	4,316.8	3,860.9	4,244.6	4,258.8	4,496.2	4,043.3	4,252.1	4,287.4	4,179.1	4,078.5	4,907.3	
	wet	294.6	459.2	368.5	587.3	953.1	639.7	648.2	764.6	1,155.0	676.3	437.1	
	all	**4,611.4**	**4,320.1**	**4,613.1**	**4,846.1**	**5,449.3**	**4,683.0**	**4,900.3**	**5,052.0**	**5,334.2**	**4,754.8**	**5,344.4**	**12%**
Warriewood	dry	9.6	8.3	13.0	12.6	13.5	12.1	2.5	4.3	0.2	0.0	0.0	
	wet	1.2	2.2	3.9	4.1	4.2	3.9	1.2	1.1	14.1	3.7	0.4	
	all	**10.9**	**10.5**	**17.0**	**16.6**	**17.7**	**16.0**	**3.7**	**5.4**	**14.3**	**3.7**	**0.4**	**-90%**
Cronulla	dry	27.6	25.8	41.2	44.7	49.1	38.7	0.0	0.0	0.0	0.0	0.2	
	wet	4.1	9.1	7.8	18.2	18.2	15.5	0.0	0.0	5.9	0.0	0.2	
	all	**31.7**	**34.9**	**49.0**	**62.9**	**67.3**	**54.2**	**0.0**	**0.0**	**5.9**	**0.0**	**0.4**	*****
Wollongong	dry	11.9	24.1	38.1	39.3	35.2	36.1	0.0	2.3	0.0	1.4	0.2	
	wet	0.9	3.3	6.8	19.9	13.1	14.0	7.3	0.1	3.3	0.3	0.7	
	all	**12.8**	**27.4**	**44.9**	**59.2**	**48.3**	**50.1**	**7.3**	**2.5**	**3.3**	**1.7**	**0.9**	**-47%**
Shellharbour	dry	7.2	12.3	10.0	13.8	12.1	11.8	5.8	2.3	0.0	0.0	0.0	
	wet	1.0	2.6	2.2	19.4	5.8	2.9	1.3	0.2	7.9	0.0	0.0	
	all	**8.2**	**14.9**	**12.2**	**33.1**	**18.0**	**14.6**	**7.2**	**2.5**	**7.9**	**0.0**	**0.0**	*****
Bombo	dry	3.9	2.3	2.5	2.4	2.3	2.3	2.3	2.4	0.1	2.9	0.0	
	wet	0.2	0.9	1.0	3.6	1.2	0.8	1.4	0.7	4.3	1.1	3.4	

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
	all	**4.0**	**3.2**	**3.5**	**6.1**	**3.5**	**3.1**	**3.8**	**3.1**	**4.3**	**4.1**	**3.4**	**-17%**
Bellambi	dry	137.0	79.3	*	*	*	*	*	*	3.9	0.0	0.3	
	wet	20.4	14.2	*	*	*	*	6.4	9.1	14.4	10.7	5.2	
	all	**157.4**	**93.5**	*****	*****	*****	*****	**6.4**	**9.1**	**18.3**	**10.7**	**5.4**	**-49%**
Port Kembla	dry	81.4	28.5	*	*	*	*	0.0	0.0	2.4	0.0	1.3	
	wet	11.0	6.5	3.5	*	*	*	9.1	14.2	13.6	13.4	7.6	
	all	**92.4**	**35.0**	**3.5**	*****	*****	*****	**9.1**	**14.2**	**16.0**	**13.5**	**8.9**	**-34%**
All ocean (total)	dry	9,670	8,581	9,610	9,442	9,284	8,236	9,415	9,126	8,735	8,588	10,179	
	wet	935	1,450	953	1,734	2,497	2,143	1,825	2,102	3,143	1,632	1,442	
	all	**10,605**	**10,031**	**10,563**	**11,176**	**11,781**	**10,379**	**11,240**	**11,228**	**11,878**	**10,220**	**11,621**	**14%**

* Converted to stormwater plant and no partial treatment discharges during these years

Table 6-8 Previous ten years of suspended solids loads (tonnes/year) from ocean plants

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
North Head	dry	18,907.0	17,088.5	18,669.9	17,941.0	18,732.3	15,964.0	22,409.0	20,992.2	16,737.9	18,561.1	18,981.8	
	wet	2,653.1	4,815.6	2,170.3	4,655.0	6,701.3	6,591.7	4,987.5	5,244.2	9,538.7	4,237.5	4,025.1	
	all	**21,560.1**	**21,904.2**	**20,840.1**	**22,596.0**	**25,433.7**	**22,555.7**	**27,396.5**	**26,236.4**	**26,276.6**	**22,798.6**	**23,006.9**	**1%**
Bondi	dry	5,436.7	4,683.8	4,384.6	4,394.3	4,154.9	3,464.7	4,148.7	3,763.6	3,892.2	4,504.1	4,287.7	
	wet	733.3	900.1	536.7	1,228.5	1,054.2	936.2	769.0	975.7	1,485.1	1,015.5	553.0	
	all	**6,170.0**	**5,583.9**	**4,921.3**	**5,622.8**	**5,209.1**	**4,400.9**	**4,917.6**	**4,739.3**	**5,377.3**	**5,519.6**	**4,840.7**	**-12%**
Malabar System	dry	21,423.3	20,760.0	20,889.4	22,076.4	22,598.6	21,829.5	23,091.9	22,721.4	23,096.7	24,676.2	23,265.7	
	wet	1,753.3	2,959.8	2,201.8	4,062.1	4,932.5	3,575.8	3,630.0	3,814.4	6,893.7	4,673.5	2,548.1	
	all	**23,176.6**	**23,719.8**	**23,091.2**	**26,138.5**	**27,531.1**	**25,405.3**	**26,721.9**	**26,535.8**	**29,990.4**	**29,349.7**	**25,813.8**	**-12%**
Warriewood	dry	53.6	92.1	83.2	47.4	31.8	38.0	50.0	33.4	67.2	23.0	18.7	
	wet	9.8	27.3	16.9	35.9	16.1	26.0	17.1	33.1	100.8	64.5	12.2	
	all	**63.4**	**119.4**	**100.2**	**83.3**	**47.9**	**63.9**	**67.1**	**66.5**	**168.0**	**87.6**	**30.9**	**-65%**
Cronulla	dry	72.7	34.7	33.9	39.1	61.6	19.8	7.9	7.8	19.3	15.7	16.2	
	wet	9.5	47.9	30.1	73.4	69.8	36.2	54.1	10.0	54.0	109.3	8.9	
	all	**82.2**	**82.6**	**64.0**	**112.5**	**131.3**	**56.0**	**62.0**	**17.8**	**73.3**	**125.1**	**25.1**	**-80%**
Wollongong	dry	58.0	59.6	23.6	23.4	35.7	23.6	8.9	22.3	25.8	11.8	6.7	
	wet	14.6	14.3	24.7	14.7	20.9	17.5	15.4	18.0	71.0	54.4	5.4	
	all	**72.6**	**73.9**	**48.3**	**38.2**	**56.6**	**41.1**	**24.3**	**40.2**	**96.8**	**66.2**	**12.1**	**-82%**
Shellharbour	dry	17.5	21.4	23.1	49.5	16.7	25.1	43.2	24.3	13.6	17.8	46.2	
	wet	4.7	5.2	4.3	40.5	11.0	9.7	16.3	8.6	33.0	19.8	64.7	
	all	**22.2**	**26.7**	**27.4**	**90.1**	**27.7**	**34.8**	**59.5**	**32.9**	**46.6**	**37.6**	**111.0**	**195%**
Bombo	dry	7.1	6.7	3.0	3.1	4.4	3.4	3.6	5.8	3.8	5.0	9.0	

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
	wet	8.9	6.5	1.1	3.0	1.7	2.2	1.8	4.9	15.2	14.9	13.4	
	all	**16.0**	**13.2**	**4.2**	**6.1**	**6.1**	**5.6**	**5.4**	**10.7**	**19.0**	**19.9**	**22.4**	**13%**
Bellambi	dry	500.9	317.9	*	*	*	*	0.0	0.0	17.3	0.0	1.2	
	wet	95.3	82.7	*	*	*	*	28.5	40.3	64.1	47.5	23.0	
	all	**596.2**	**400.6**	*****	*****	*****	*****	**28.5**	**40.3**	**81.5**	**47.5**	**24.2**	**-49%**
Port Kembla	dry	322.6	136.0	*	*	*	*	0.0	0.0	10.7	0.2	5.9	
	wet	60.2	45.2	11.2	*	*	*	40.4	63.2	60.4	59.7	33.7	
	all	**382.8**	**181.2**	**11.2**	*****	*****	*****	**40.4**	**63.2**	**71.1**	**59.9**	**39.7**	**-34%**
All ocean (total)	dry	46,799	43,201	44,111	44,574	45,636	41,368	49,763	47,571	43,884	47,815	46,615	
	wet	5,343	8,905	4,997	10,113	12,808	11,195	9,560	10,212	18,316	10,297	7,288	
	all	**52,142**	**52,106**	**49,108**	**54,687**	**58,444**	**52,563**	**59,323**	**57,783**	**62,200**	**58,112**	**53,903**	**-7%**

* Converted to stormwater plant and no partial treatment discharges during these years

Table 6-9 Previous ten years of volume of reuse water (ML/year) from all ocean plants

Plant	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Wollongong	0	0	0	0	6,634	4,398	6,657	7,088	7,212	7,266	6,703	-8%
Bombo	205	86	184	137	66	111	85	48	53	81	70	-13%
Liverpool	134	181	263	233	55	91	140	163	2,234**	4,667**	2,737**	-41%
All ocean (total)	**339**	**267**	**447**	**370**	**6,755**	**4,600**	**6,882**	**7,300**	**9,499**	**12,014**	**9,511**	**-21%**

** Included volume from Rosehill-Camellia Recycling Water Scheme

Table 6-10 Yearly summary statistics on wastewater discharge volume and quality of ocean plants

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2003-04	North Head	366	324,209	366	36	37	42	49	366	184	185	216	262
2004-05	North Head	365	335,156	365	35	36	42	50	365	184	187	214	303
2005-06	North Head	365	313,466	143	38	39	44	57	143	186	186	222	390
2006-07	North Head	365	360,183	193	38	41	46	71	193	185	185	231	398
2007-08	North Head	366	376,315	85	36	36	44	72	85	189	184	224	271
2008-09	North Head	365	340,985	118	33	35	43	60	118	181	183	221	286
2009-10	North Head	365	365,945	61	36	37	43	56	61	207	202	248	331
2010-11	North Head	365	394,014	60	34	34	43	44	60	189	191	234	261
2011-12	North Head	366	437,916	61	34	36	43	50	61	173	173	215	284
2012-13	North Head	365	364,062	85	31	32	44	48	85	178	185	212	248
2013-14	**North Head**	**365**	**338,750**	**61**	**39**	**40**	**43**	**47**	**61**	**189**	**190**	**230**	**300**
2003-04	Bondi	366	136,877	366	31	31	35	39	366	123	119	159	198
2004-05	Bondi	365	131,321	365	30	30	36	45	365	117	115	147	185
2005-06	Bondi	365	126,772	118	34	36	39	40	118	107	107	123	139
2006-07	Bondi	365	133,072	85	35	35	39	46	85	117	117	153	196
2007-08	Bondi	366	123,583	85	34	35	39	40	85	116	117	139	172
2008-09	Bondi	365	122,298	86	33	34	39	40	86	100	98	122	184
2009-10	Bondi	365	122,051	61	33	34	38	39	61	111	107	127	156
2010-11	Bondi	365	126,479	61	31	31	38	39	61	103	104	118	140
2011-12	Bondi	366	132,073	61	33	33	39	40	61	112	110	138	190
2012-13	Bondi	365	126,578	85	33	36	43	56	85	119	118	145	168
2013-14	**Bondi**	**365**	**123,240**	**61**	**36**	**38**	**39**	**40**	**61**	**107**	**110**	**130**	**160**

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2003-04	Malabar	366	463,715	366	27	27	33	39	366	137	135	162	205
2004-05	Malabar	365	452,134	365	27	26	34	46	365	144	143	169	284
2005-06	Malabar	365	439,434	118	29	29	35	43	118	144	145	164	184
2006-07	Malabar	365	477,068	85	29	30	37	39	85	152	150	182	210
2007-08	Malabar	366	491,093	85	31	32	37	41	85	153	152	179	230
2008-09	Malabar	365	488,616	85	27	27	38	39	85	143	143	169	192
2009-10	Malabar	365	470,021	61	29	29	37	39	61	158	160	181	224
2010-11	Malabar	365	508,216	61	28	28	36	39	61	144	144	177	192
2011-12	Malabar	366	533,833	61	28	28	37	39	61	156	162	194	236
2012-13	Malabar	365	473,272	71	26	25	36	39	71	160	154	194	247
2013-14	**Malabar**	**365**	**478,572**	**61**	**31**	**33**	**38**	**39**	**61**	**149**	**150**	**180**	**200**
2003-04	Fairfield	366	0	1	6	6	6	6	1	50	50	50	50
2004-05	Fairfield	365	2,115	9	5	2	19	19	9	29	16	75	75
2005-06	Fairfield	0	*	4	5	3	12	12	4	43	45	73	73
2006-07	Fairfield	20	97,219	10	5	3	11	14	14	35	32	60	66
2007-08	Fairfield	31	42,324	9	4	3	7	7	13	32	26	53	70
2008-09	Fairfield	23	48,506	12	3	3	3	3	12	23	24	36	38
2009-10	Fairfield	17	51,308	7	<5	<5	5	5	9	35	24	81	81
2010-11	Fairfield	16	46,239	9	<5	<5	13	13	10	25	26	43	45
2011-12	Fairfield	42	84,350	20	<5	<5	5	5	34	30	28	50	63
2012-13	Fairfield	21	90,730	13	<5	<5	7	12	21	36	32	63	77
2013-14	**Fairfield**	**13**	**32,088**	**7**	**<5**	**<5**	**12**	**12**	**7**	**34**	**36**	**67**	**67**
2003-04	Glenfield	366	0	0	*	*	*	*	0	*	*	*	*

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2004-05	Glenfield	365	226	4	3	2	4	4	4	52	48	77	77
2005-06	Glenfield	4	15,439	2	2	2	2	2	3	33	38	49	49
2006-07	Glenfield	20	39,930	9	8	5	22	22	13	35	32	61	68
2007-08	Glenfield	14	42,024	3	5	5	6	6	9	43	41	93	93
2008-09	Glenfield	4	5,842	2	3	3	3	3	2	24	24	35	35
2009-10	Glenfield	6	16,843	3	<5	<5	5	5	4	26	20	36	36
2010-11	Glenfield	14	11,178	6	<5	5	14	14	6	30	18	59	59
2011-12	Glenfield	25	25,784	16	<5	<5	5	8	27	23	21	46	51
2012-13	Glenfield	19	36,251	7	<5	<5	14	14	14	27	25	42	42
2013-14	**Glenfield**	**1**	**262**	*	*	*	*	*	*	*	*	*	*
2003-04	Liverpool	366	185	0	*	*	*	*	0	*	*	*	*
2004-05	Liverpool	365	1,503	6	2	2	6	6	8	21	22	29	29
2005-06	Liverpool	13	39,605	5	2	2	3	3	7	17	15	28	28
2006-07	Liverpool	39	53,901	11	4	3	10	11	21	35	27	62	115
2007-08	Liverpool	46	82,069	14	6	4	12	23	27	50	46	88	126
2008-09	Liverpool	28	64,254	15	27	23	48	51	10	4	3	9	10
2009-10	Liverpool	29	46,910	10	<5	<5	<5	5	15	30	24	59	89
2010-11	Liverpool	29	49,432	11	<5	<5	6	8	14	30	25	55	60
2011-12	Liverpool	70	73,716	30	<5	<5	7	8	66	24	22	40	63
2012-13	Liverpool	38	69,494	15	<5	<5	<5	<5	34	19	16	40	47
2013-14	**Liverpool**	**17**	**39,052**	**6**	**<5**	**<5**	**6**	**6**	**11**	**21**	**16**	**28**	**72**
2003-04	Warriewood	366	17,040	12	2	2	3	3	183	10	7	19	95
2004-05	Warriewood	365	17,256	18	2	2	3	3	184	18	10	46	166

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2005-06	Warriewood	365	16,271	28	3	3	3	8	96	16	11	39	76
2006-07	Warriewood	365	18,221	38	3	3	3	3	85	12	6	23	125
2007-08	Warriewood	366	18,519	27	3	3	3	5	85	7	4	13	29
2008-09	Warriewood	365	17,535	20	3	3	3	3	85	9	6	16	82
2009-10	Warriewood	365	15,920	12	<5	<5	<5	5	61	10	7	17	68
2010-11	Warriewood	365	18,670	12	<5	<5	<5	5	61	7	4	10	77
2011-12	Warriewood	366	20,837	12	<5	<5	5	7	61	16	8	36	145
2012-13	Warriewood	365	18,187	12	<5	<5	<5	<5	85	7	4	12	172
2013-14	**Warriewood**	**365**	**17,688**	**12**	**<5**	**<5**	**<5**	**<5**	**61**	**4**	**3**	**7**	**44**
2003-04	Cronulla	366	55,010	183	2	2	2	4	183	4	4	7	20
2004-05	Cronulla	365	58,562	184	2	2	2	4	184	2	1	4	47
2005-06	Cronulla	365	53,713	96	3	3	3	3	96	2	1	4	33
2006-07	Cronulla	365	68,899	85	3	3	3	3	147	2	1	4	42
2007-08	Cronulla	366	73,580	85	3	3	3	3	85	3	1	5	42
2008-09	Cronulla	365	57,098	85	3	3	3	5	85	2	1	3	34
2009-10	Cronulla	365	51,685	61	<5	<5	<5	<5	61	<2	<2	3	39
2010-11	Cronulla	365	56,556	61	<5	<5	<5	<5	61	<2	<2	2	8
2011-12	Cronulla	366	63,524	61	<5	<5	<5	<5	61	<2	<2	5	32
2012-13	Cronulla	365	54,920	85	<5	<5	<5	<10	85	3	<2	4	47
2013-14	**Cronulla**	**365**	**57,782**	**61**	**<5**	**<5**	**<5**	**<5**	**61**	**3**	**<2**	**5**	**30**
2003-04	Wollongong	366	15,514	12	2	2	4	8	243	11	9	16	306
2004-05	Wollongong	365	31,939	30	2	2	2	19	183	8	5	13	75
2005-06	Wollongong	365	44,800	24	3	3	3	7	96	2	1	4	53

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2006-07	Wollongong	365	47,678	24	4	3	6	15	85	2	1	4	9
2007-08	Wollongong	366	52,746	33	3	3	3	3	85	3	2	5	11
2008-09	Wollongong	365	50,665	24	3	3	3	5	85	2	1	3	17
2009-10	Wollongong	365	33,675	24	<5	<5	<5	5	61	<2	<2	4	17
2010-11	Wollongong	365	40,043	24	<5	<5	<5	5	61	<2	<2	4	21
2011-12	Wollongong	366	47,510	24	<5	<5	<5	5	61	3.967	2	8	21
2012-13	Wollongong	365	54,292	24	<5	<5	<5	5	85	<2	<2	3	45
2013-14	**Wollongong**	**365**	**54,860**	**24**	**<5**	**<5**	**<5**	**7**	**61**	**<2**	**<2**	**2**	**14**
2003-04	Shellharbour	366	13,259	12	2	2	3	3	227	4	4	8	17
2004-05	Shellharbour	365	14,646	12	3	2	7	14	184	5	4	10	39
2005-06	Shellharbour	365	13,361	12	3	3	3	3	96	6	5	11	53
2006-07	Shellharbour	365	21,591	12	4	3	7	10	85	9	7	15	40
2007-08	Shellharbour	366	17,960	21	3	3	3	5	85	4	3	7	16
2008-09	Shellharbour	365	16,050	12	3	3	3	3	85	6	5	10	27
2009-10	Shellharbour	365	16,591	12	<5	<5	5	5	61	9	7	16	73
2010-11	Shellharbour	365	19,263	12	<5	<5	<5	5	61	4	3	8	24
2011-12	Shellharbour	366	21,143	12	<5	<5	<5	17	61	4	3	9	33
2012-13	Shellharbour	365	18,616	12	<5	<5	<5	<5	85	4	3	8	26
2013-14	**Shellharbour**	**365**	**17,890**	**12**	**<5**	**<5**	**<5**	**<5**	**61**	**3**	**3**	**6**	**11**
2003-04	Bombo	366	4,202	12	3	2	4	12	228	6	4	11	61
2004-05	Bombo	365	3,420	16	3	2	4	12	184	7	4	14	67
2005-06	Bombo	365	3,427	14	3	3	3	8	96	3	3	6	13
2006-07	Bombo	365	4,210	12	4	3	3	17	85	4	3	6	12

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2007-08	Bombo	366	3,678	19	3	3	3	5	85	4	3	8	15
2008-09	Bombo	365	3,363	12	3	3	3	3	85	4	2	8	24
2009-10	Bombo	365	3,610	12	<5	<5	5	5	61	3	2	6	12
2010-11	Bombo	365	4,970	12	<5	<5	5	8	61	3	3	4	22
2011-12	Bombo	366	4,756	12	<5	<5	5	5	61	4	4	7	26
2012-13	Bombo	365	4,463	12	<5	<5	9	9	85	5	5	8	41
2013-14	**Bombo**	**365**	**3,926**	**12**	**<5**	**<5**	**<5**	**<5**	**61**	**5**	**4**	**8**	**33**
2003-04	Bellambi	366	21,774	243	21	21	27	31	243	76	75	97	167
2004-05	Bellambi	322	16,715	163	19	18	26	34	163	75	74	96	157
2005-06	Bellambi	0	*	2	13	13	14	14	2	70	70	83	83
2006-07	Bellambi	39	19,725**	0	*	*	*	*	0	*	*	*	*
2007-08	Bellambi	49	19,581**	0	*	*	*	*	0	*	*	*	*
2008-09	Bellambi	38	5,213**	0	*	*	*	*	0	*	*	*	*
2009-10	Bellambi	14	25,424	*	*	*	*	*	*	*	*	*	*
2010-11	Bellambi	19	26,513	*	*	*	*	*	*	*	*	*	*
2011-12	Bellambi	37	27,524	*	*	*	*	*	*	*	*	*	*
2012-13	Bellambi	23	25,805	*	*	*	*	*	*	*	*	*	*
2013-14	**Bellambi**	**14**	**21,590**	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
2003-04	Port Kembla	366	15,689	244	17	16	21	30	244	66	66	80	147
2004-05	Port Kembla	171	13,085	83	16	16	22	97	83	81	66	94	856
2005-06	Port Kembla	68	3,929	1	13	13	13	13	1	42	42	42	42
2006-07	Port Kembla	68	11,923**	0	*	*	*	*	0	*	*	*	*
2007-08	Port Kembla	58	9,007**	0	*	*	*	*	0	*	*	*	*

Year	Plant	Wastewater discharge volume		Oil and grease					Suspended solids				
		No.	mean	No.	mean	median	90th %ile	max	No.	mean	median	90th %ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2008-09	Port Kembla	38	8,924**	0	*	*	*	*	0	*	*	*	*
2009-10	Port Kembla	49	10,297	0	*	*	*	*	*	*	*	*	*
2010-11	Port Kembla	39	20,246	0	*	*	*	*	*	*	*	*	*
2011-12	Port Kembla	45	19,740	0	*	*	*	*	*	*	*	*	*
2012-13	Port Kembla	42	17,814	*	*	*	*	*	*	*	*	*	*
2013-14	**Port Kembla**	**30**	**16,523**	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

* Value not computed

** Included in Wollongong

Normal discharge point's flow and concentrations are listed in this statistics table

Table 6-11 Previous ten years of total wastewater discharge volume (ML/year) for all inland plants

Plant	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Picton	0	10	136	0	76	5	0	220	666	330	134	-59%
West Camden	3,135	3,235	3,453	3,509	3,898	3,115	2,951	3,630	4,172	4,306	3,921	-9%
Warragamba	126	142	151	108	DC	DC	DC	DC	DC	DC	DC	*
Wallacia	NC	NC	NC	164	241	227	211	227.179	372	273	213	-22%
Penrith	8,070	8,268	9,174	8,896	9,515	8,391	8,355	1,526	2,617	1,322	1,843	39%
Glenbrook	1,209	1,211	51	DC	DC	DC	DC	DC	DC	DC	DC	*
Winmalee	5,511	5,080	5,757	5,797	6,703	6,191	6,465	7,339	8,626	7,181	6,373	-11%
Blackheath	334	376	368	394	430	DC	DC	DC	DC	DC	DC	*
Mt Victoria	48	49	60	65	59	41	DC	DC	DC	DC	DC	*
North Richmond	329	329	320	362	340	320	292	317	417	316	305	-4%
Richmond	479	482	298	298	457	432	223	501	774	704	481	-32%
St Marys	12,723	13,011	12,368	13,589	14,658	13,342	12,462	6,090	10,315	6,485	5,486	-15%
Quakers Hill	11,834	12,405	11,633	12,323	13,778	13,773	11,470	7,311	11,153	8,931	8,827	-1%
Riverstone	698	675	573	654	741	666	600	561	771	590	561	-5%
Castle Hill	2,514	2,474	2,238	2,840	2,993	2,267	2,645	2,991	3,673	2,123	2,068	-3%
Rouse Hill	2,596	2,930	2,850	3,674	4,235	3,864	3,513	3,887	5,456	4,461	4,590	3%
Hornsby Heights	1,895	2,023	1,837	2,401	2,490	2,327	2,106	2,250	2,990	2,112	1,917	-9%
West Hornsby	5,524	4,367	4,200	4,858	5,196	4,159	4,520	4,840	5,554	5,052	4,471	-12%
Brooklyn	NC	NC	NC	NC	27	52	75	94	100	85	88	3%
All inland (total)	**57,025**	**57,067**	**55,467**	**59,932**	**65,837**	**59,172**	**55,888**	**41,782**	**57,656**	**44,271**	**41,278**	**-7%**

NC Plant not commissioned

DC Plant decommissioned

* Value not computed

Table 6-12 Previous ten years of total nitrogen loads (tonnes/year) from all inland plants

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Picton	dry	0	0	0.14	0	0.09	0	0	0.43	0.59	0.21	0.37	
	wet	0	0	0.13	0	0.08	0	0	0.19	0.79	0.56	0.05	
	all	**0**	**0.01**	**0.26**	**0**	**0.17**	**0**	**0**	**0.62**	**1.37**	**0.77**	**0.42**	**-45%**
West Camden	dry	44.05	45.74	42.41	39.29	41.69	21.77	10.97	11.21	11.5	14.24	14.87	
	wet	2.74	3.84	5.87	10.36	6.05	1.35	1.4	2.38	3.48	5.15	1.77	
	all	**46.79**	**49.58**	**48.28**	**49.66**	**47.74**	**23.12**	**12.37**	**13.59**	**14.98**	**19.39**	**16.63**	**-14%**
Warragamba	dry	3.11	3.37	3.4	0.65	DC	DC	DC	DC	DC	DC	DC	
	wet	0.36	0.48	0.42	0.07	DC	DC	DC	DC	DC	DC	DC	
	all	**3.47**	**3.85**	**3.82**	**0.72**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**
Wallacia	dry	NC	NC	NC	0.36	0.92	0.61	0.82	0.86	1.07	1.11	0.89	
	wet	NC	NC	NC	0.37	0.43	0.20	0.20	0.25	0.87	0.45	0.14	
	all	**NC**	**NC**	**NC**	**0.73**	**1.35**	**0.81**	**1.02**	**1.11**	**1.93**	**1.55**	**1.03**	**-34%**
Penrith	dry	35.79	32.92	28.19	32.92	31.52	34.39	30.24	4.54	2.54	0.99	4.71	
	wet	4.01	6.56	4.15	7.61	8.27	5.67	4.73	1.39	6.56	2.58	1.42	
	all	**39.80**	**39.48**	**32.34**	**40.53**	**39.79**	**40.06**	**34.97**	**5.93**	**9.10**	**3.57**	**6.13**	**72%**
Glenbrook	dry	33.48	37.24	1.45	DC	DC	DC	DC	DC	DC	DC	DC	
	wet	3.23	4.90	0.19	DC	DC	DC	DC	DC	DC	DC	DC	
	all	**36.72**	**42.14**	**1.64**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**
Winmalee	dry	44.46	40.10	43.64	39.76	51.42	65.27	57.22	55.21	36.95	36.65	35.16	
	wet	4.25	7.06	5.59	7.37	13.53	9.05	13.50	12.88	20.67	9.05	4.44	
	all	**48.70**	**47.16**	**49.23**	**47.13**	**64.95**	**74.32**	**70.72**	**68.09**	**57.63**	**45.70**	**39.61**	**-13%**
Blackheath	dry	8.82	9.51	10.08	8.72	9.10	DC	DC	DC	DC	DC	DC	
	wet	1.18	1.94	1.65	2.19	1.89	DC	DC	DC	DC	DC	DC	
	all	**10.00**	**11.45**	**11.73**	**10.91**	**10.98**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Mt Victoria	dry	0.41	0.34	0.47	0.55	0.58	0.04	DC	DC	DC	DC	DC	
	wet	0.08	0.08	0.07	0.15	0.14	0.00	DC	DC	DC	DC	DC	
	all	**0.49**	**0.42**	**0.54**	**0.70**	**0.72**	**0.04**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**
North Richmond	dry	1.78	1.61	1.63	1.98	1.45	1.40	1.28	1.30	1.43	1.24	1.35	
	wet	0.17	0.28	0.21	0.64	0.55	0.37	0.20	0.30	0.86	0.31	0.25	
	all	**1.94**	**1.89**	**1.84**	**2.62**	**2.01**	**1.77**	**1.48**	**1.60**	**2.29**	**1.55**	**1.60**	**3%**
Richmond	dry	1.82	1.10	0.86	0.11	1.37	1.23	1.36	2.40	3.41	3.72	2.99	
	wet	0.16	0.34	0.10	0.13	0.35	0.33	0.15	0.39	1.57	0.62	0.29	
	all	**1.98**	**1.44**	**0.96**	**0.24**	**1.72**	**1.57**	**1.51**	**2.79**	**4.98**	**4.35**	**3.28**	**-25%**
St Marys	dry	55.44	50.14	54.53	44.70	44.96	38.76	42.99	20.09	26.16	17.57	18.44	
	wet	6.54	9.64	8.35	16.05	16.35	7.82	9.01	4.75	20.42	10.41	6.26	
	all	**61.98**	**59.78**	**62.88**	**60.76**	**61.31**	**46.58**	**52.00**	**24.84**	**46.58**	**27.98**	**24.69**	**-12%**
Quakers Hill	dry	52.24	46.55	43.52	42.31	47.72	51.40	43.32	24.22	27.69	34.70	36.42	
	wet	4.40	9.10	5.77	18.37	16.91	8.86	8.85	5.49	19.89	9.51	8.17	
	all	**56.64**	**55.65**	**49.29**	**60.68**	**64.63**	**60.26**	**52.17**	**29.71**	**47.59**	**44.21**	**44.59**	**1%**
Riverstone	dry	5.81	5.13	4.85	4.72	4.30	3.87	2.49	2.37	2.50	3.25	3.38	
	wet	0.51	0.92	0.61	1.88	1.50	0.64	0.52	0.49	1.57	0.67	0.81	
	all	**6.31**	**6.05**	**5.46**	**6.60**	**5.80**	**4.52**	**3.01**	**2.86**	**4.07**	**3.91**	**4.20**	**7%**
Castle Hill	dry	30.54	31.42	32.91	30.29	33.88	26.62	30.82	26.59	26.56	22.16	22.32	
	wet	3.74	5.30	3.00	9.45	11.58	5.53	7.53	6.27	16.76	5.42	2.67	
	all	**34.28**	**36.73**	**35.91**	**39.75**	**45.46**	**32.15**	**38.35**	**32.86**	**43.32**	**27.58**	**24.99**	**-9%**
Rouse Hill	dry	14.74	14.45	20.27	17.20	23.60	17.98	13.95	15.62	20.09	27.37	26.89	
	wet	2.26	3.40	2.58	6.94	7.86	4.27	3.38	3.98	11.54	5.77	5.07	
	all	**16.99**	**17.85**	**22.85**	**24.14**	**31.46**	**22.25**	**17.33**	**19.61**	**31.63**	**33.15**	**31.96**	**-4%**
West Hornsby	dry	37.49	18.27	21.28	13.58	15.36	11.89	13.64	18.20	12.93	15.91	15.57	

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
	wet	6.94	6.27	2.04	8.31	6.28	4.05	6.29	5.71	10.15	11.52	4.80	
	all	**44.43**	**24.54**	**23.32**	**21.89**	**21.64**	**15.94**	**19.93**	**23.91**	**23.08**	**27.42**	**20.37**	**-26%**
Hornsby Heights	dry	7.98	9.95	7.51	5.51	5.19	7.16	9.12	7.03	4.45	5.88	7.97	
	wet	1.39	3.46	0.70	3.31	2.64	1.87	2.16	2.94	6.08	6.07	1.35	
	all	**9.37**	**13.41**	**8.21**	**8.82**	**7.83**	**9.03**	**11.28**	**9.97**	**10.53**	**11.95**	**9.32**	**-22%**
Brooklyn	dry	NC	NC	NC	NC	0.09	0.47	0.50	0.58	0.20	0.18	0.33	
	wet	NC	NC	NC	NC	0.03	0.09	0.10	0.11	0.10	0.06	0.04	
	all	**NC**	**NC**	**NC**	**NC**	**0.13**	**0.56**	**0.60**	**0.69**	**0.30**	**0.24**	**0.37**	**54%**
All inland (total)	dry	377.94	347.85	317.13	282.66	313.23	282.88	258.72	190.65	178.13	185.18	191.66	
	wet	41.95	63.59	41.43	93.22	94.45	50.11	58.02	47.51	121.29	68.14	37.53	
	all	**419.89**	**411.44**	**358.56**	**375.88**	**407.68**	**332.98**	**316.74**	**238.17**	**299.41**	**253.32**	**229.20**	**-10%**

NC = plant not commissioned

DC= plant decommissioned

*= Value not computed

Table 6-13 Previous ten years of total phosphorus loads (tonnes/year) from all inland plants

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Picton	dry	0	0	0.03	0	0	0	0	0	0.01	0	0.00	
	wet	0	0	0.01	0	0	0	0	0	0.02	0.01	0.00	
	all	**0**	**0.01**	**0.04**	**0**	**0**	**0**	**0**	**0**	**0.02**	**0.01**	**0.00**	**-68%**
West Camden	dry	0.43	0.49	0.25	0.28	0.7	0.42	0.1	0.18	0.24	0.38	0.23	
	wet	0.02	0.07	0.76	0.36	0.21	0.05	0.01	0.04	0.17	0.09	0.03	
	all	**0.45**	**0.55**	**1.01**	**0.64**	**0.9**	**0.47**	**0.11**	**0.22**	**0.41**	**0.47**	**0.27**	**-44%**
Warragamba	dry	0.28	0.2	0.23	0.07	DC	DC	DC	DC	DC	DC	DC	
	wet	0.03	0.05	0.06	0.01	DC	DC	DC	DC	DC	DC	DC	
	all	**0.31**	**0.25**	**0.29**	**0.08**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	*****
Wallacia	dry	NC	NC	NC	0.01	0.05	0.01	0.01	0.01	0.02	0.01	0.01	
	wet	NC	NC	NC	0.03	0.02	0	0	0	0.01	0.01	0.00	
	all	**NC**	**NC**	**NC**	**0.03**	**0.06**	**0.01**	**0.01**	**0.01**	**0.03**	**0.01**	**0.01**	**17%**
Penrith	dry	0.53	0.55	0.58	0.69	1.04	0.84	0.81	0.07	0.07	0.03	0.14	
	wet	0.04	0.09	0.04	0.15	0.29	0.19	0.15	0.03	0.27	0.14	0.04	
	all	**0.57**	**0.64**	**0.61**	**0.83**	**1.34**	**1.03**	**0.96**	**0.1**	**0.33**	**0.18**	**0.18**	**2%**
Glenbrook	dry	0.07	0.08	0	DC	DC	DC	DC	DC	DC	DC	DC	
	wet	0	0.02	0	DC	DC	DC	DC	DC	DC	DC	DC	
	all	**0.08**	**0.1**	**0**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	*****
Winmalee	dry	0.81	1.07	1.75	1.76	1.43	2.27	2.15	2.89	3.05	4.22	2.40	
	wet	0.13	0.34	0.24	0.36	0.61	0.46	1.12	0.74	2.07	1.28	0.41	
	all	**0.93**	**1.41**	**1.99**	**2.12**	**2.04**	**2.73**	**3.27**	**3.63**	**5.11**	**5.5**	**2.81**	**-49%**
Blackheath	dry	0.29	0.5	0.4	0.51	0.66	DC	DC	DC	DC	DC	DC	
	wet	0.04	0.14	0.07	0.18	0.21	DC	DC	DC	DC	DC	DC	
	all	**0.33**	**0.64**	**0.47**	**0.69**	**0.87**	**DC**	**DC**	**DC**	**DC**	**DC**	**DC**	*****

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
Mt Victoria	dry	0.01	0	0.01	0.09	0.01	0	DC	DC	DC	DC	DC	
	wet	0	0	0	0.01	0.01	0	DC	DC	DC	DC	DC	
	all	**0.01**	**0.01**	**0.01**	**0.11**	**0.02**	**0**	**DC**	**DC**	**DC**	**DC**	**DC**	*****
North Richmond	dry	0.04	0.03	0.03	0.03	0.05	0.03	0.02	0.02	0.03	0.01	0.02	
	wet	0.01	0.01	0	0.01	0.02	0.02	0	0	0.03	0.01	0.01	
	all	**0.05**	**0.04**	**0.03**	**0.04**	**0.07**	**0.05**	**0.02**	**0.02**	**0.05**	**0.02**	**0.03**	**32%**
Richmond	dry	0.5	0.17	0.01	0	0.01	0	0.05	0.01	0.01	0.01	0.01	
	wet	0.04	0.06	0	0	0	0	0	0	0.01	0	0.00	
	all	**0.55**	**0.22**	**0.01**	**0**	**0.01**	**0**	**0.05**	**0.01**	**0.02**	**0.01**	**0.01**	**-3%**
St Marys	dry	0.42	0.51	0.37	0.35	0.36	0.35	0.45	0.22	0.54	0.19	0.17	
	wet	0.03	0.14	0.03	0.08	0.13	0.07	0.23	0.07	0.65	0.3	0.31	
	all	**0.45**	**0.65**	**0.4**	**0.43**	**0.49**	**0.42**	**0.68**	**0.29**	**1.19**	**0.49**	**0.48**	**-3%**
Quakers Hill	dry	0.63	0.45	0.4	0.45	0.66	1.55	0.44	0.47	0.34	0.79	0.52	
	wet	0.06	0.25	0.1	0.24	0.37	0.12	0.11	0.16	0.41	0.24	0.27	
	all	**0.69**	**0.7**	**0.5**	**0.68**	**1.03**	**1.67**	**0.55**	**0.63**	**0.75**	**1.04**	**0.79**	**-25%**
Riverstone	dry	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.02	0.03	0.03	0.02	
	wet	0	0.01	0	0.01	0.01	0.01	0.01	0	0.02	0.01	0.01	
	all	**0.01**	**0.02**	**0.01**	**0.02**	**0.02**	**0.04**	**0.05**	**0.02**	**0.06**	**0.03**	**0.03**	**4%**
Castle Hill	dry	0.41	0.51	0.42	0.4	0.29	0.19	0.2	0.32	0.45	0.2	0.27	
	wet	0.06	0.09	0.03	0.1	0.2	0.05	0.27	0.13	0.9	0.25	0.10	
	all	**0.47**	**0.6**	**0.45**	**0.5**	**0.49**	**0.24**	**0.47**	**0.45**	**1.35**	**0.45**	**0.36**	**-19%**
Rouse Hill	dry	0.43	0.42	0.21	0.09	0.08	0.05	0.05	0.04	0.05	0.14	0.10	
	wet	0.05	0.45	0.41	0.05	0.09	0.01	0.01	0.01	0.05	0.05	0.08	
	all	**0.48**	**0.88**	**0.63**	**0.14**	**0.16**	**0.06**	**0.06**	**0.05**	**0.1**	**0.19**	**0.18**	**-4%**
West Hornsby	dry	0.81	0.94	0.49	0.13	0.28	0.28	0.36	0.59	0.46	0.29	0.59	

Plant	Weather	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year
	wet	0.08	0.14	0.07	0.74	0.41	0.26	2.43	0.31	0.89	1.17	0.37	
	all	**0.89**	**1.07**	**0.56**	**0.87**	**0.69**	**0.54**	**2.79**	**0.91**	**1.35**	**1.46**	**0.97**	**-34%**
Hornsby Heights	dry	0.11	0.09	0.12	0.55	0.08	0.1	0.18	0.19	0.23	0.17	0.21	
	wet	0.01	0.22	0.01	0.31	0.07	0.08	0.04	0.04	1.09	1.39	0.20	
	all	**0.12**	**0.3**	**0.13**	**0.86**	**0.16**	**0.18**	**0.22**	**0.23**	**1.32**	**1.56**	**0.41**	**-74%**
Brooklyn	dry	NC	NC	NC	NC	0	0.01	0.01	0.01	0.02	0	0.03	
	wet	NC	NC	NC	NC	0	0	0	0	0.01	0	0.00	
	all	**NC**	**NC**	**NC**	**NC**	**0**	**0.01**	**0.01**	**0.02**	**0.02**	**0.01**	**0.03**	**202%**
All inland (total)	dry	5.78	6.01	5.31	5.41	5.71	6.12	4.87	5.04	5.53	6.49	4.73	
	wet	0.6	2.07	1.84	2.64	2.65	1.32	4.38	1.55	6.6	4.94	1.82	
	all	**6.38**	**8.08**	**7.15**	**8.05**	**8.36**	**7.44**	**9.25**	**6.59**	**12.11**	**11.43**	**6.55**	**-43%**

NC = plant not commissioned

DC= plant decommissioned

*= Value not computed

Table 6-14 Previous ten years of reuse water volume (ML/year) from inland plants

Plant	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	% change last 1 year	% change last 10 years
Picton	430	320	404	355	417	422	466	334	362	357	446	25%	4%
West Camden	0	0	0	0	143	405	627	234	170	221	215	-3%	*
Penrith	1	7	1	3	6	20	20	11	5	13	30	134%	2945%
Richmond	757	539	401	586	224	277	353	185	87	197	415	111%	-45%
St Marys	113	88	107	130	56	68	84	59	46	102	108	6%	-4%
Quakers Hill	74	68	93	129	77	90	98	70	24	0	0	*	-100%
Castle Hill	205	86	184	137	66	111	100	63	22	139	141	1%	-31%
Rouse Hill	1,333	1,356	1,568	1,652	1,398	1,704	2,209	2,250	1,873	2,063	2,137	4%	60%
St Marys AWTP								15,989	13,362	15,142	14,990	-1%	*
All inland (total)	**2,914**	**2,463**	**2,757**	**2,993**	**2,386**	**3,098**	**3,957**	**19,195**	**15,951**	**18,234**	**18,483**	1%	534%

* Value not computed

Table 6-15 Yearly summary statistics on wastewater discharge volume and total nitrogen and total phosphorus concentrations of inland plants

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2003-04	Picton	366	0	58	6.36	6.5	9.3	11.6	58	5.08	5.25	6.5	7.38
2004-05	Picton	365	29	42	3.88	4	5.1	5.7	42	2.89	2.6	4.69	5.68
2005-06	Picton	365	372	64	3.13	3.3	4.6	5.2	64	1.46	1.18	3.61	5.3
2006-07	Picton	365	0	45	5.16	4.82	7.97	12.7	45	2.38	1.65	5.1	6.55
2007-08	Picton	366	208	61	2.5	2.49	4.53	4.9	61	0.59	0.28	1.67	3.44
2008-09	Picton	365	14	35	3.6	2.55	3.22	52.4	35	1.19	0.94	2.28	7.8
2009-10	Picton	365	0	22	2.85	2.93	4.06	4.69	22	2.26	1.26	3.36	9.32
2010-11	Picton	52	4,221	45	2.80	2.86	3.21	3.40	45	0.02	0.02	0.02	0.02
2011-12	Picton	97	6,865	91	2.05	2.00	2.84	3.55	91	0.03	0.02	0.06	0.10
2012-13	Picton	44	7,495	43	2.29	2.76	3.41	3.51	43	0.04	0.03	0.05	0.07
2013-14	**Picton**	**32**	**8,465**	**32**	**3.16**	**3.29**	**3.43**	**3.79**	**32**	**0.02**	**0.02**	**0.03**	**0.06**
2003-04	West Camden	366	8,588	61	14.85	14.2	19.1	33.8	61	0.14	0.11	0.23	0.81
2004-05	West Camden	365	8,862	61	15.46	14.5	19.7	39.8	61	0.17	0.14	0.23	1.58
2005-06	West Camden	365	9,461	61	13.92	13.9	18.1	19.4	61	0.14	0.07	0.15	3.82
2006-07	West Camden	365	9,613	61	13.73	13.8	17	19.7	61	0.13	0.1	0.14	1.77
2007-08	West Camden	366	10,680	61	12.31	12.1	14.6	20	61	0.21	0.15	0.22	2.44
2008-09	West Camden	365	8,534	61	7.09	5.7	13.2	15.2	61	0.16	0.17	0.26	0.33
2009-10	West Camden	365	8,085	60	4.17	4.06	5.40	6.45	60	0.04	0.03	0.06	0.17
2010-11	West Camden	365	9,944	61	3.70	3.72	4.29	7.20	61	0.06	0.05	0.12	0.19
2011-12	West Camden	366	11,399	61	3.68	3.70	4.70	6.80	61	0.09	0.06	0.14	0.58
2012-13	West Camden	365	11,796	61	4.32	4.15	5.08	11.60	61	0.12	0.06	0.27	0.54

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**West Camden**	**365**	**11,622**	**61**	**4.23**	**4.19**	**5.45**	**6.18**	**61**	**0.07**	**0.06**	**0.14**	**0.19**
2003-04	Warragamba	366	345	61	27.87	27.7	33.1	39	61	2.46	2.14	4.03	4.54
2004-05	Warragamba	365	390	61	30.7	31	39.5	45.6	61	1.84	1.71	2.45	3.22
2005-06	Warragamba	365	413	61	29.25	30.3	38.9	43.1	61	1.98	1.86	2.99	5.43
2006-07	Warragamba	76	296	12	31.83	32.8	36.2	36.3	12	3.92	3.65	5.6	7.15
2007-08	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2008-09	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2009-10	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2010-11	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2011-12	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2012-13	Warragamba	0	*	0	*	*	*	*	0	*	*	*	*
2013-14	**Warragamba**	**0**	*****	**0**	*****	*****	*****	*****	**0**	*****	*****	*****	*****
2003-04	Wallacia	0	*	0	*	*	*	*	0	*	*	*	*
2004-05	Wallacia	0	*	0	*	*	*	*	0	*	*	*	*
2005-06	Wallacia	0	*	0	*	*	*	*	0	*	*	*	*
2006-07	Wallacia	308	452	51	4.28	2.7	10.8	13.6	51	0.14	0.04	0.47	0.69
2007-08	Wallacia	366	660	61	5.6	4.51	10.7	16.4	61	0.29	0.17	0.78	1.08
2008-09	Wallacia	365	622	61	3.46	2.93	6.25	8.55	61	0.03	0.02	0.07	0.24
2009-10	Wallacia	365	579	60	4.76	4.63	6.50	118	60	0.04	0.03	0.07	0.14
2010-11	Wallacia	365	622	61	4.84	4.97	6.50	9.8	61	0.03	0.03	0.04	0.21
2011-12	Wallacia	366	1017	61	5.09	4.98	6.15	12.6	61	0.07	0.04	0.13	0.33
2012-13	Wallacia	365	748	61	5.88	5.10	7.85	14.60	61	0.05	0.03	0.08	0.58

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**Wallacia**	**365**	**647**	**61**	**4.85**	**4.64**	**6.35**	**9.65**	**61**	**0.06**	**0.02**	**0.07**	**1.21**
2003-04	Glenbrook	366	3,304	61	30.46	29.8	35.8	41.9	61	0.06	0.06	0.11	0.21
2004-05	Glenbrook	365	3,317	61	35.66	36.6	43.3	49.7	61	0.08	0.07	0.16	0.23
2005-06	Glenbrook	62	824	6	36.98	39.95	43.1	43.1	6	0.05	0.04	0.12	0.12
2006-07	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2007-08	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2008-09	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2009-10	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2010-11	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2011-12	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2012-13	Glenbrook	0	*	0	*	*	*	*	0	*	*	*	*
2013-14	**Glenbrook**	**0**	*****	**0**	*****	*****	*****	*****	**0**	*****	*****	*****	*****
2003-04	Penrith	366	22,111	61	4.95	4.8	6.9	11.3	61	0.07	0.05	0.11	0.8
2004-05	Penrith	365	22,652	61	4.71	4.4	7	9.3	61	0.08	0.06	0.13	0.25
2005-06	Penrith	365	25,133	61	3.5	3.4	4.8	7.3	61	0.07	0.06	0.14	0.29
2006-07	Penrith	365	24,373	66	4.51	4.25	6.1	11.6	66	0.09	0.07	0.18	0.4
2007-08	Penrith	366	26,067	61	4.15	3.99	5.35	9.6	61	0.13	0.09	0.24	0.75
2008-09	Penrith	365	22,990	61	4.73	4.61	5.5	8.95	61	0.12	0.09	0.2	0.78
2009-10	Penrith	365	22,892	60	4.27	4.15	5.50	7.00	60	0.12	0.08	0.21	0.71
2010-11	Penrith	365	4,182	61	3.87	3.64	5.10	7.05	61	0.06	0.05	0.09	0.16
2011-12	Penrith	366	7,150	61	3.40	3.38	4.72	5.65	61	0.11	0.08	0.19	0.42
2012-13	Penrith	365	3,622	61	2.72	2.68	3.39	5.60	61	0.11	0.08	0.17	0.83

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**Penrith**	**365**	**22,527**	**61**	**3.32**	**3.28**	**4.52**	**5.43**	**61**	**0.10**	**0.07**	**0.13**	**0.94**
2003-04	Winmalee	366	15,098	61	8.86	8.5	10.8	14.2	61	0.17	0.14	0.29	0.42
2004-05	Winmalee	365	13,917	61	9.52	9.6	11.3	13.1	61	0.26	0.28	0.37	0.45
2005-06	Winmalee	365	15,772	61	8.68	9	10.5	12.2	61	0.35	0.34	0.49	0.67
2006-07	Winmalee	365	15,881	61	8.32	8.29	9.8	11.3	61	0.37	0.39	0.47	0.52
2007-08	Winmalee	366	18,365	63	10.18	9.65	14.2	17.7	63	0.29	0.27	0.36	0.7
2008-09	Winmalee	365	16,961	62	12.36	12.35	14.5	18.4	61	0.44	0.4	0.64	1.04
2009-10	Winmalee	365	17,712	60	10.98	10.80	13.20	16.20	60	0.42	0.43	0.53	0.59
2010-11	Winmalee	365	20,107	61	9.30	8.90	12.00	13.60	61	0.48	0.41	0.74	1.04
2011-12	Winmalee	366	23,250	61	6.80	6.25	9.95	13.90	61	0.548	0.6	0.95	1.12
2012-13	Winmalee	365	19,674	61	6.30	6.20	7.80	8.80	61	0.76	0.73	1.12	1.22
2013-14	**Winmalee**	**365**	**17,731**	**61**	**6.28**	**6.2**	**7.85**	**10.2**	**61**	**0.44**	**0.44**	**0.58**	**0.68**
2003-04	Blackheath	366	915	61	30.01	29.6	34.1	40.9	61	1	0.99	1.29	1.9
2004-05	Blackheath	365	1,030	61	31.2	30.4	40.4	45.7	61	1.81	1.69	2.58	8.85
2005-06	Blackheath	364	1,008	61	32.69	32.2	42.2	44.9	61	1.3	1.33	1.85	1.97
2006-07	Blackheath	365	1,078	61	29.76	31.4	34.4	35.9	61	1.77	1.72	2.17	2.27
2007-08	Blackheath	360	1,178	60	27.22	28.9	32.4	34.8	60	2.05	2.01	2.42	2.74
2008-09	Blackheath	0	*	0	*	*	*	*	0	*	*	*	*
2009-10	Blackheath	0	*	0	*	*	*	*	0	*	*	*	*
2010-11	Blackheath	0	*	0	*	*	*	*	0	*	*	*	*
2011-12	Blackheath	0	*	0	*	*	*	*	0	*	*	*	*
2012-13	Blackheath	0	*	0	*	*	*	*	0	*	*	*	*

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**Blackheath**	**0**	*****	**0**	*****	*****	*****	*****	**0**	*****	*****	*****	*****
2003-04	Mt.Victoria	366	131	61	9.93	9	13.7	37.6	61	0.19	0.17	0.34	0.52
2004-05	Mt.Victoria	365	135	61	8.52	7.5	11.7	25.8	61	0.13	0.11	0.22	0.37
2005-06	Mt.Victoria	365	163	61	8.96	8.8	11.7	14.9	61	0.14	0.13	0.22	0.55
2006-07	Mt.Victoria	364	177	61	11.45	8.82	12.9	156	61	2.36	0.16	0.44	129
2007-08	Mt.Victoria	366	162	61	11.75	10.8	16.2	36.4	61	0.34	0.18	0.64	2.1
2008-09	Mt.Victoria	45	113	7	8.43	9.2	11.3	11.3	7	0.23	0.17	0.63	0.63
2009-10	Mt.Victoria	0	*	0	*	*	*	*	0	*	*	*	*
2010-11	Mt.Victoria	0	*	0	*	*	*	*	0	*	*	*	*
2011-12	Mt.Victoria	0	*	0	*	*	*	*	0	*	*	*	*
2012-13	Mt.Victoria	0	*	0	*	*	*	*	0	*	*	*	*
2013-14	**Mt.Victoria**	**0**	*****	*****	*****	*****	*****	*****	**0**	*****	*****	*****	*****
2003-04	North Richmond	366	903	61	5.87	5.9	7.2	8.8	61	0.15	0.12	0.26	0.52
2004-05	North Richmond	365	902	61	5.76	5.5	7.9	9.1	61	0.12	0.11	0.17	0.44
2005-06	North Richmond	365	878	61	5.62	5.7	7.4	9.4	61	0.1	0.08	0.22	0.28
2006-07	North Richmond	365	991	61	6.91	6.23	9.8	19.5	61	0.12	0.1	0.2	0.63
2007-08	North Richmond	366	931	61	5.77	5.3	8.6	9.65	61	0.19	0.15	0.31	0.63
2008-09	North Richmond	365	876	61	5.37	5.35	6.6	7.75	61	0.13	0.11	0.21	0.36
2009-10	North Richmond	365	801	60	5.09	5.00	6.40	7.10	60	0.08	0.07	0.10	0.34
2010-11	North Richmond	365	868	61	4.96	4.93	6.00	8.00	61	0.08	0.07	0.11	0.26
2011-12	North Richmond	366	1139	61	5.45	5.45	6.45	7.60	61	0.11	0.10	0.17	0.45
2012-13	North Richmond	365	866	61	4.77	4.79	5.50	6.70	61	0.06	0.05	0.08	0.21

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**North Richmond**	**365**	**835**	**61**	**5.23**	**5.2**	**6.07**	**6.6**	**61**	**0.08**	**0.08**	**0.12**	**0.2**
2003-04	Richmond	48	1,311	61	31.5	31.9	37.1	40.6	61	8.65	8.63	9.64	10.4
2004-05	Richmond	125	1,321	123	15.15	5.7	36.6	47.7	123	3.12	0.09	9.33	10.2
2005-06	Richmond	286	818	140	4.18	4	5.5	7.3	140	0.04	0.01	0.08	1.2
2006-07	Richmond	73	816	68	4.26	3.97	5.79	8.46	68	0.02	0.02	0.03	0.07
2007-08	Richmond	312	1,253	92	4.44	4.24	5.45	8.2	92	0.02	0.02	0.03	0.11
2008-09	Richmond	273	1,182	84	4.72	4.62	5.3	7.45	83	0.01	0.01	0.02	0.03
2009-10	Richmond	365	612	23	6.79	5.00	6.00	47.00	23	0.24	0.01	0.02	5.30
2010-11	Richmond	365	1,371	38	5.49	5.35	6.45	9.50	38	0.01	0.01	0.02	0.02
2011-12	Richmond	366	2,115	61	6.21	6.00	7.60	9.95	61	0.02	0.02	0.03	0.05
2012-13	Richmond	365	1,930	52	6.33	6.30	7.30	8.30	52	0.02	0.02	0.03	0.04
2013-14	**Richmond**	**365**	**1,319**	**61**	**6.59**	**6.42**	**7.6**	**12.2**	**61**	**0.02**	**0.02**	**0.03**	**0.04**
2003-04	St Marys	366	34,858	61	4.85	4.6	6.3	8.2	61	0.04	0.03	0.07	0.12
2004-05	St Marys	365	35,647	61	4.56	4.38	6.29	6.81	61	0.05	0.04	0.08	0.15
2005-06	St Marys	365	33,886	61	5.05	4.76	6.34	12.9	61	0.03	0.03	0.05	0.13
2006-07	St Marys	365	37,231	66	4.29	4.15	5.66	10	66	0.03	0.03	0.06	0.08
2007-08	St Marys	366	40,159	61	3.99	3.73	4.89	8.2	61	0.03	0.03	0.05	0.06
2008-09	St Marys	365	36,552	61	3.42	3.33	4.54	6.25	61	0.03	0.03	0.05	0.09
2009-10	St Marys	365	34,142	61	4.00	3.47	6.30	9.75	61	0.04	0.03	0.06	0.11
2010-11	St Marys	365	16,684	61	4.00	4.02	4.94	6.00	61	0.04	0.03	0.06	0.12
2011-12	St Marys	366	26,881	61	4.07	3.84	5.30	6.20	61	0.03	0.02	0.04	0.07
2012-13	St Marys	365	17,766	61	4.04	3.93	4.93	7.00	61	0.04	0.03	0.07	0.24

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**St Marys**	**365**	**14,934**	**61**	**4.10**	**4.07**	**5.01**	**6.53**	**61**	**0.05**	**0.03**	**0.05**	**0.88**
2003-04	Quakers Hill	366	32,422	61	4.77	4.8	5.5	8.9	61	0.06	0.04	0.1	0.31
2004-05	Quakers Hill	365	33,985	61	4.45	4.46	5.42	6.33	61	0.05	0.04	0.07	0.46
2005-06	Quakers Hill	365	31,871	61	4.21	4.18	4.92	6.72	61	0.04	0.04	0.07	0.13
2006-07	Quakers Hill	365	33,761	66	4.59	4.23	5.94	13.7	66	0.05	0.04	0.08	0.12
2007-08	Quakers Hill	366	37,748	61	4.62	4.58	5.65	7.25	61	0.07	0.05	0.11	0.35
2008-09	Quakers Hill	365	37,735	60	4.28	4.27	5.1	24.5	60	0.04	0.03	0.07	16.3
2009-10	Quakers Hill	365	31,425	61	4.51	4.30	5.40	9.40	61	0.05	0.04	0.08	0.21
2010-11	Quakers Hill	365	20,029	61	4.032	4.06	4.81	5.2	61	0.075	0.05	0.142	0.59
2011-12	Quakers Hill	366	30,473	61	4.137	4	5.1	5.6	61	0.062	0.046	0.107	0.298
2012-13	Quakers Hill	365	24,470	61	4.78	4.61	6.10	8.35	61	0.11	0.08	0.18	0.44
2013-14	**Quakers Hill**	**365**	**24,183**	**61**	**4.93**	**4.85**	**6.08**	**7.15**	**61**	**0.08**	**0.06**	**0.14**	**0.24**
2003-04	Riverstone	366	1,913	61	9.06	9	10.8	12.7	61	0.02	0.01	0.04	0.08
2004-05	Riverstone	365	1,849	61	9.05	8.98	10.6	15.8	61	0.02	0.02	0.03	0.08
2005-06	Riverstone	365	1,569	61	9.49	9.51	11.1	12.5	61	0.02	0.02	0.04	0.1
2006-07	Riverstone	365	1,792	61	9.73	9.13	11.3	19.4	61	0.02	0.02	0.03	0.07
2007-08	Riverstone	366	2,030	61	8.04	7.95	9.45	11.4	61	0.03	0.02	0.05	0.12
2008-09	Riverstone	365	1,824	61	6.87	6.6	9.4	11.2	61	0.06	0.05	0.11	0.22
2009-10	Riverstone	365	1,644	61	5.01	4.95	5.60	7.20	61	0.08	0.04	0.18	0.58
2010-11	Riverstone	365	1,537	61	5.09	5.00	5.65	8.15	61	0.04	0.03	0.06	0.09
2011-12	Riverstone	366	2,105	61	5.29	5.20	6.15	10.20	61	0.08	0.05	0.13	0.80
2012-13	Riverstone	365	1,617	61	6.73	6.70	8.20	14.00	61	0.05	0.04	0.10	0.37

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**Riverstone**	**365**	**1,536**	**61**	**7.11**	**6.9**	**9.06**	**12.4**	**61**	**0.05**	**0.03**	**0.10**	**0.47**
2003-04	Castle Hill	366	6,888	61	13.66	13.7	16.3	16.9	61	0.18	0.15	0.33	1
2004-05	Castle Hill	365	6,778	61	15.1	15.6	17.5	19.7	61	0.23	0.17	0.44	1.24
2005-06	Castle Hill	365	6,132	61	16.09	16.4	17.9	19	61	0.2	0.13	0.35	1.32
2006-07	Castle Hill	365	7,781	61	15.16	15.6	17	19.1	61	0.17	0.07	0.25	2.24
2007-08	Castle Hill	366	8,200	61	16.24	16.4	19.2	22	61	0.16	0.12	0.26	1.52
2008-09	Castle Hill	365	6,210	61	14.59	14.4	17	19.8	61	0.11	0.08	0.2	0.42
2009-10	Castle Hill	365	7,246	61	14.82	14.80	17.70	19.00	61.00	0.08	0.05	0.16	0.29
2010-11	Castle Hill	365	8,193	61	11.06	11.00	12.80	16.20	61.00	0.11	0.08	0.19	0.65
2011-12	Castle Hill	366	10,035	61	12.29	12.00	15.50	19.60	61.00	0.15	0.11	0.27	1.06
2012-13	Castle Hill	365	5,816	61	13.69	13.30	16.40	24.80	61	0.12	0.08	0.17	1.72
2013-14	**Castle Hill**	**365**	**5,666**	**61**	**12.4**	**12.4**	**14.7**	**16.6**	**61**	**0.14**	**0.12**	**0.24**	**0.43**
2003-04	Rouse Hill	366	7,112	61	6.48	6.3	8.6	9.7	61	0.18	0.09	0.23	3.31
2004-05	Rouse Hill	365	8,028	62	6.02	5.57	9.07	12.2	62	0.22	0.17	0.33	1.5
2005-06	Rouse Hill	365	7,809	61	8.03	8.06	10.2	13.2	61	0.13	0.07	0.18	2.4
2006-07	Rouse Hill	365	10,066	61	6.56	6.29	8.33	9.67	61	0.03	0.03	0.06	0.08
2007-08	Rouse Hill	366	11,604	61	7.73	8.25	9.95	11.5	61	0.03	0.03	0.04	0.29
2008-09	Rouse Hill	365	10,585	61	5.78	5.45	7.45	10.4	61	0.02	0.01	0.02	0.04
2009-10	Rouse Hill	365	9,626	61	4.83	4.78	5.90	7.00	61	0.02	0.02	0.02	0.06
2010-11	Rouse Hill	365	10,650	61	5.08	4.95	5.95	6.35	61	0.01	0.01	0.02	0.02
2011-12	Rouse Hill	366	14,908	61	5.82	5.60	7.90	8.80	61	0.02	0.01	0.02	0.06
2012-13	Rouse Hill	365	12,222	61	7.62	7.50	9.75	11.20	61	0.04	0.03	0.06	0.26

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90^{th}%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**Rouse Hill**	**365**	**12,577**	**61**	**6.89**	**6.65**	**8.3**	**9.33**	**61**	**0.03**	**0.02**	**0.04**	**0.24**
2003-04	Hornsby Heights	366	5,191	61	4.95	4.9	7.8	11.3	61	0.07	0.05	0.13	0.86
2004-05	Hornsby Heights	365	5,542	62	6.48	6.5	9.78	13.3	62	0.1	0.04	0.14	2.02
2005-06	Hornsby Heights	365	5,032	61	4.46	4.21	7.99	9.04	61	0.07	0.04	0.13	0.42
2006-07	Hornsby Heights	365	6,577	60	2.85	2	6.66	9.92	60	0.08	0.04	0.05	1.31
2007-08	Hornsby Heights	366	6,821	61	3	2.73	4.92	6.5	61	0.05	0.04	0.08	0.26
2008-09	Hornsby Heights	365	6,374	61	3.89	3.07	7.75	10.8	61	0.07	0.04	0.11	0.45
2009-10	Hornsby Heights	365	5,769	61	5.29	4.85	9.50	15.90	61	0.10	0.05	0.17	1.20
2010-11	Hornsby Heights	365	6,165	61	4.11	3.85	7.30	9.55	61	0.09	0.03	0.07	1.81
2011-12	Hornsby Heights	366	8,170	61	2.94	2.40	5.60	9.30	61	0.25	0.08	0.47	2.43
2012-13	Hornsby Heights	365	5,787	61	4.28	3.06	9.20	16.10	61	0.28	0.08	0.41	5.51
2013-14	**Hornsby Heights**	**365**	**5,253**	**61**	**4.86**	**4.31**	**9.11**	**11.4**	**61**	**0.15**	**0.07**	**0.27**	**1.76**
2003-04	West Hornsby	366	15,133	61	8.02	8	13	17.1	61	0.16	0.08	0.3	1.35
2004-05	West Hornsby	365	11,966	61	5.53	4.41	8.38	25.9	61	0.17	0.06	0.16	5.9
2005-06	West Hornsby	365	11,508	93	5.57	5.38	6.98	14.2	93	0.13	0.06	0.31	1.1
2006-07	West Hornsby	365	13,309	77	4.06	3.95	5.29	10.6	77	0.08	0.03	0.09	1.29
2007-08	West Hornsby	366	14,236	61	4.17	4.34	5.85	6.85	61	0.1	0.05	0.20	0.68
2008-09	West Hornsby	365	11,396	61	3.77	3.7	4.8	10.90	61	0.12	0.06	0.23	1.50
2009-10	West Hornsby	365	12,383	61	3.98	3.66	5.25	17.40	61	0.28	0.06	0.23	11.10
2010-11	West Hornsby	365	13,260	61	4.70	4.85	6.25	10.70	61	0.15	0.07	0.38	0.93
2011-12	West Hornsby	366	15,100	61	6.80	6.25	9.95	13.90	61	0.55	0.60	0.95	1.12
2012-13	West Hornsby	365	13,840	61	4.58	4.46	6.45	9.10	61	0.12	0.07	0.27	1.20

Year	Plant	Wastewater discharge volume		Total nitrogen					Total phosphorus				
		No.	mean	No.	mean	median	90th%ile	max	No.	mean	median	90th%ile	max
			KL/day		mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L
2013-14	**West Hornsby**	**365**	**12,248**	**61**	**4.36**	**4.13**	**6.58**	**7.75**	**61**	**0.19**	**0.07**	**0.35**	**2.05**
2003-04	Brooklyn	0	*	0	*	*	*	*	0	*	*	*	*
2004-05	Brooklyn	0	*	0	*	*	*	*	0	*	*	*	*
2005-06	Brooklyn	0	*	0	*	*	*	*	0	*	*	*	*
2006-07	Brooklyn	0	*	0	*	*	*	*	0	*	*	*	*
2007-08	Brooklyn	192	73	35	8.92	7.7	16	22	35	0.27	0.12	0.75	2.11
2008-09	Brooklyn	365	143	58	10.62	9.8	16.2	26.2	58	0.19	0.15	0.30	0.95
2009-10	Brooklyn	365	205	61	8.03	6.70	12.20	27.80	61	0.11	0.08	0.23	0.36
2010-11	Brooklyn	365	257	61	7.27	5.03	14.50	43.90	61	0.19	0.10	0.22	2.37
2011-12	Brooklyn	366	273	61	3.34	2.62	4.59	20.20	61	0.21	0.09	0.47	1.34
2012-13	Brooklyn	365	234	61	2.71	2.53	3.57	13.30	61	0.06	0.03	0.11	0.87
2013-14	**Brooklyn**	**365**	**241**	**61**	**4.12**	**3.72**	**5.55**	**15.1**	**61**	**0.37**	**0.08**	**1.32**	**3.7**

*= Value not computed

Normal discharge point's flow and concentrations are listed in this statistics table

6.3 Appendix C Beach Suitability Grades

Table 6-16 Beach Suitability Grades of Sydney beaches as adopted from OEH (2012-13 and 2013-14)*

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach Suitability Grade
Northern Sydney	Palm Beach	Very good	Low	Category A	Very good
	Whale Beach	Very good	Low	Category A	Very good
	Avalon Beach	Very good	Low	Category A	Very good
	Bilgola Beach	Good	Low	Category A	Very good
	Newport Beach	Good	Low	Category A	Very good
	Bungan Beach	Good	Low	Category A	Very good
	Mona Vale Beach	Good	Low	Category A	Very good
	Warriewood Beach	Good	Moderate	Category A	Good
	Turimetta Beach	Good	Moderate	Category A	Good
	North Narrabeen Beach	Good	Moderate	Category A	Good
	Narrabeen Lagoon (Birdwood Park)	Poor	Moderate	Category B	Good
	Collaroy Beach	Good	Moderate	Category A	Good
	Long Reef Beach	Good	Moderate	Category A	Good
	Dee Why Beach	Good	Low	Category A	Very good
	North Curl Curl Beach	Good	Moderate	Category B	Good
	South Curl Curl Beach	Good	Low	Category A	Very good
	Freshwater Beach	Good	Moderate	Category B	Good
	Queenscliff Beach	Good	Moderate	Category B	Good
	North Steyne	Good	Low	Category B	Good
	South Steyne	Good	Moderate	Category B	Good
	Shelly Beach (Manly)	Good	Low	Category A	Very good
Central Sydney	Bondi Beach	Good	Moderate	Category B	Good
	Tamarama Beach	Good	Moderate	Category B	Good
	Bronte Beach	Good	Moderate	Category B	Good
	Clovelly Beach	Good	Low	Category A	Very good
	Gordons Bay	Good	Moderate	Category B	Good
	Coogee Beach	Good	Moderate	Category B	Good
	Maroubra Beach	Very good	Low	Category B	Good
	South Maroubra	Good	Moderate	Category B	Good
	Malabar Beach	Good	Moderate	Category B	Good
	Little Bay	Good	Moderate	Category B	Good

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach Suitability Grade
Southern Sydney	Boat Harbour	Poor	Moderate	Category C	Poor
	Greenhills	Very good	Low	Category A	Very good
	Wanda Beach	Good	Low	Category A	Very good
	Elouera Beach	Good	Low	Category A	Very good
	North Cronulla Beach	Good	Low	Category A	Very good
	South Cronulla Beach	Good	Low	Category B	Good
	Shelly Beach (Sutherland)	Good	Low	Category A	Very good
	Oak Park	Very good	Low	Category A	Very good

Table 6-17 Beach Suitability Grades of Illawarra beaches as adopted from OEH (2013-13 and 2013-14)*

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach Suitability Grade
Wollongong City Council	Stanwell Park Beach	Very good	Low	Category A	Very good
	Coledale Beach	Very good	Low	Category A	Very good
	Austinmer Beach	Very good	Low	Category A	Very good
	Thirroul Beach	Very good	Moderate	Category A	Good
	Bulli Beach	Good	Moderate	Category A	Good
	Woonona Beach	Very good	Low	Category A	Very good
	Bellambi Beach	Good	Moderate	Category A	Good
	Corrimal Beach	Good	Moderate	Category B	Good
	North Wollongong Beach	Good	Moderate	Category A	Good
	Wollongong City Beach	Very good	Low	Category A	Very good
	Coniston Beach	Very good	Low	Category A	Very good
	Fishermans Beach	Very good	Low	Category A	Very good
	Port Kembla Beach	Good	Moderate	Category A	Good
Shellharbour City Council	Entrance Lagoon Beach	Poor	Moderate	Category C	Poor
	Warilla Beach	Very good	Low	Category A	Very good
	Shellharbour Beach	Very good	Low	Category A	Very good
	Boyd's Jones Beach	Very good	Low	Category A	Very good
Kiama Municipal	Bombo Beach	Good	Moderate	Category A	Good

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach Suitability Grade
Council	Surf Beach, Kiama	Good	Moderate	Category B	Good
	Werri Beach	Very good	Low	Category A	Very good

Table 6-18 Beach Suitability Grades of Sydney harbours and estuaries as adopted from OEH (2013-14)*

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach suitability grade
Pittwater	Barrenjoey Beach	Good	Low	Category B	Good
	Great Mackerel Beach	Good	Low	Category B	Good
	The Basin	Good	Low	Category A	Very good
	Paradise Beach Baths	Good	Low	Category B	Good
	Taylors Point baths	Good	Moderate	Category B	Good
	Clareville Beach	Good	Moderate	Category B	Good
	North Scotland Island	Good	Moderate	Category B	Good
	Elvina Bay	Good	Low	Category B	Good
	South Scotland Island	Good	Moderate	Category A	Good
	Bayview Baths	Good	Moderate	Category C	Poor
Sydney Harbours	Davidson Reserve	Poor	High	Category C	Poor
	Gurney Cresent Baths	Poor	High	Category B	Fair
	Manly Cove	Good	Moderate	Category B	Good
	Fairlight Beach	Good	Moderate	Category A	Good
	Little Manly Cove	Good	Moderate	Category B	Good
	Northbridge Baths	Poor	High	Category C	Poor
	Clontarf Pool	Fair	High	Category B	Fair
	Forty Baskets Pool	Good	Moderate	Category A	Good
	Chinamans Beach	Good	Moderate	Category B	Good
	Edwards Beach	Good	Moderate	Category A	Good
	Balmoral Baths	Good	Moderate	Category B	Good
	Tambourine Bay	Poor	Moderate	Category C	Poor
	Woodford Bay	Good	Moderate	Category B	Good
	Woolwich Baths	Fair	Moderate	Category B	Good
	Greenwich Baths	Good	Moderate	Category B	Good

Region	Site name	2012-13	2013-14		
		Beach Suitability Grade	Sanitary inspection category	Microbial assessment category	Beach suitability grade
	Hayes St Beach	Good	Moderate	Category B	Good
	Cabarita Beach	Good	Moderate	Category B	Good
	Chiswick Baths	Good	Moderate	Category B	Good
	Dawn Fraser Pool	Good	Moderate	Category B	Good
	Clifton Gardens	Good	Moderate	Category B	Good
	Watsons Bay	Good	Low	Category A	Very good
	Parsley Bay	Good	Moderate	Category B	Good
	Nielsen Park	Very good	Low	Category A	Very good
	Redleaf Pool	Good	Moderate	Category B	Good
	Rose Bay Beach	Good	Moderate	Category C	Poor
Botany Bay and Lower Georges River	Kyeemagh Baths	Fair	Moderate	Category B	Good
	Brighton Le Sands	Good	Moderate	Category B	Good
	Monterey Baths	Good	Moderate	Category B	Good
	Ramsgate Baths	Good	Moderate	Category B	Good
	Dolls Point Baths	Good	Moderate	Category B	Good
	Sandringham Baths	Good	Moderate	Category A	Good
	Foreshores Beach	Very poor	High	Category D	Very poor
	Yarra Bay	Good	Moderate	Category B	Good
	Frenchmans Bay	Good	Moderate	Category B	Good
	Congwong Bay	Good	Low	Category A	Very good
	Silver Beach	Good	Moderate	Category B	Good
	Jew Fish Bay Baths	Good	Moderate	Category B	Good
	Como Baths	Good	Moderate	Category B	Good
	Oatley Bay Baths	Poor	Moderate	Category B	Good
	Carss Point Baths	Fair	Moderate	Category B	Good
Port Hacking	Gymea Bay Baths	Poor	High	Category C	Poor
	Lilli Pilli Baths	Good	Moderate	Category B	Good
	Gunnamatta Bay Baths	Good	Moderate	Category B	Good
	Horderns Beach	Poor	Moderate	Category B	Good
	Jibbon Beach	Very good	Low	Category A	Very good

* OEH (2013-14) http://www.environment.nsw.gov.au/beach/ar1213/; and http://www.environment.nsw.gov.au/beach/ar1314/index.htm

Table 6-19 Beach Suitability Grades summary and comparison with 2012-13 grades

Region	Number of sites 2013-14					Total number of sites	Comparison with 2012-13		
	Very good	Good	Fair	Poor	Very poor		Stable	Improved	Deteriorated
Northern Sydney	10	11	0	0	0	21	13	8	0
Central Sydney	1	9	0	0	0	10	8	1	1
Southern Sydney	6	1	0	1	0	8	4	4	0
Total Sydney beaches	17	21	0	1	0	39	25	13	1
Wollongong	7	6	0	0	0	13	12	0	1
Shellharbour	3	0	0	1	0	4	4	0	0
Kiama	1	2	0	0	0	3	3	0	0
Total Illawarra beaches	11	8	0	1	0	20	19	0	1
Pittwater	1	8	0	1	0	10	8	1	1
Sydney Harbours	2	17	2	4	0	25	21	3	1
Botany and Port Hacking	2	16	0	1	1	20	15	5	0
Total Sydney estuary/harbours	5	41	2	6	1	55	44	9	2
Grand total	**33**	**70**	**2**	**8**	**1**	**114**	**88**	**22**	**4**
As a percent of total sites	**29%**	**61%**	**2%**	**7%**	**1%**		**77%**	**19%**	**4%**

6.4 Appendix D SIMPER 2008 to 2013 - intertidal assemblages

Group Control 1-2008 Average similarity: 47.34

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
False limpets and rock limpets (Patellogastropoda)	2.70	19.67	2.34	41.56	41.56
Barnacles (Cirripedia)	2.06	14.44	1.94	30.50	72.05
Red Algae (Rhodophyta)	1.29	4.67	0.65	9.86	81.91
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.92	2.57	0.43	5.43	87.34
Green Algae (Ulvaceae)	0.78	2.02	0.43	4.26	91.60
Oyster borer (Muricidae Morula marginalba)	0.52	1.00	0.34	2.11	93.71
Brown algae (Phaeophyta)	0.55	0.85	0.26	1.80	95.51
Nerite (Nertidae Nerita)	0.35	0.80	0.26	1.70	97.21
Conniwinks (Lottorinidae Bembicium)	0.43	0.80	0.26	1.68	98.89
Zebra top shell (Trochidae Austrocochlea)	0.24	0.36	0.18	0.76	99.65
Periwinkles (Littorinidae Nodilittorina)	0.29	0.17	0.10	0.35	100.00

Group Control 1-2009
Average similarity: 68.90

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	2.97	18.90	2.48	27.43	27.43
False limpets and rock limpets (Patellogastropoda)	2.99	18.76	2.19	27.23	54.66
Conniwinks (Lottorinidae Bembicium)	2.04	14.42	2.31	20.93	75.59
Nerite (Nertidae Nerita)	1.93	13.17	4.66	19.12	94.70
Zebra top shell (Trochidae Austrocochlea)	0.61	1.52	0.43	2.20	96.90
Oyster borer (Muricidae Morula marginalba)	0.43	0.84	0.35	1.22	98.12
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.43	0.78	0.26	1.13	99.26
Brown algae (Phaeophyta)	0.39	0.40	0.18	0.59	99.84
Periwinkles (Littorinidae Nodilittorina)	0.22	0.11	0.10	0.16	100.00

Group Control 1-2010
Average similarity: 47.08

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	2.54	14.67	1.10	31.15	31.15
Green Algae (Ulvaceae)	2.05	8.78	0.73	18.65	49.80
False limpets and rock limpets (Patellogastropoda)	1.70	7.93	0.89	16.84	66.63
Conniwinks (Lottorinidae Bembicium)	1.16	6.12	0.91	13.00	79.63
Nerite (Nertidae Nerita)	0.94	4.72	0.94	10.02	89.65
Brown algae (Phaeophyta)	0.82	1.73	0.34	3.68	93.33
Periwinkles (Littorinidae Nodilittorina)	0.67	1.16	0.25	2.47	95.80
Red Algae (Rhodophyta)	0.75	1.07	0.26	2.28	98.07
Oyster borer (Muricidae Morula marginalba)	0.31	0.62	0.26	1.32	99.39
Zebra top shell (Trochidae Austrocochlea)	0.26	0.29	0.18	0.61	100.00

Group Control 1-2011
Average similarity: 66.51

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
False limpets and rock limpets (Patellogastropoda)	2.68	15.72	3.83	23.64	23.64
Barnacles (Cirripedia)	3.01	15.61	2.14	23.47	47.11
Conniwinks (Lottorinidae Bembicium)	1.64	8.79	1.48	13.22	60.33
Red Algae (Rhodophyta)	1.92	7.35	0.95	11.05	71.37
Oyster borer (Muricidae Morula marginalba)	1.17	6.26	1.55	9.41	80.78
Nerite (Nertidae Nerita)	1.09	4.43	0.92	6.66	87.43
Brown algae (Phaeophyta)	1.34	3.75	0.63	5.64	93.08
Green Algae (Ulvaceae)	1.09	3.23	0.65	4.85	97.93
Zebra top shell (Trochidae Austrocochlea)	0.47	0.74	0.34	1.12	99.05
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.45	0.63	0.26	0.95	100.00

Group Control 1-2013
Average similarity: 60.30

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	4.42	25.97	2.74	43.06	43.06
False limpets and rock limpets (Patellogastropoda)	2.12	13.44	3.78	22.29	65.36
Conniwinks (Lottorinidae Bembicium)	1.43	5.73	0.93	9.49	74.85
Oyster borer (Muricidae Morula marginalba)	1.12	4.22	0.94	7.00	81.86
Brown algae (Phaeophyta)	1.57	4.03	0.53	6.68	88.54
Red Algae (Rhodophyta)	1.25	2.72	0.44	4.51	93.05
Nerite (Nertidae Nerita)	0.72	2.27	0.66	3.77	96.82
Green Algae (Ulvaceae)	0.79	1.05	0.34	1.74	98.56
Periwinkles (Littorinidae Nodilittorina)	0.47	0.65	0.25	1.07	99.64
Zebra top shell (Trochidae Austrocochlea)	0.26	0.22	0.18	0.36	100.00

Group Outfall-2008
Average similarity: 66.24

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	2.56	15.89	3.00	23.99	23.99
Red Algae (Rhodophyta)	2.64	14.59	2.06	22.02	46.01
Conniwinks (Lottorinidae Bembicium)	2.24	11.21	1.15	16.93	62.94
Nerite (Nertidae Nerita)	1.72	10.56	2.28	15.94	78.88
False limpets and rock limpets (Patellogastropoda)	1.36	7.17	1.42	10.83	89.70
Green Algae (Ulvaceae)	1.66	5.06	0.64	7.64	97.34
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.45	0.66	0.26	1.00	98.34
Oyster borer (Muricidae Morula marginalba)	0.29	0.47	0.26	0.71	99.05
Periwinkles (Littorinidae Nodilittorina)	0.41	0.39	0.17	0.59	99.64
Zebra top shell (Trochidae Austrocochlea)	0.24	0.24	0.18	0.36	100.00

Group Outfall-2009

Average similarity: 65.11

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
False limpets and rock limpets (Patellogastropoda)	2.78	19.93	3.89	30.60	30.60
Barnacles (Cirripedia)	2.89	17.71	2.11	27.20	57.81
Green Algae (Ulvaceae)	2.31	13.51	2.12	20.75	78.55
Nerite (Nertidae Nerita)	1.24	5.54	0.95	8.50	87.06
Red Algae (Rhodophyta)	1.24	3.92	0.65	6.02	93.08
Conniwinks (Lottorinidae Bembicium)	0.78	1.86	0.44	2.85	95.93
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.59	1.28	0.35	1.97	97.90
Periwinkles (Littorinidae Nodilittorina)	0.70	1.16	0.26	1.78	99.68
Brown algae (Phaeophyta)	0.21	0.11	0.10	0.17	99.84
Oyster borer (Muricidae Morula marginalba)	0.25	0.10	0.10	0.16	100.00

Group Outfall-2010
Average similarity: 68.26

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	2.85	14.06	1.76	20.59	20.59
Nerite (Nertidae Nerita)	2.09	13.99	6.48	20.49	41.08
False limpets and rock limpets (Patellogastropoda)	2.10	13.84	7.72	20.28	61.37
Conniwinks (Lottorinidae Bembicium)	2.18	12.46	1.78	18.25	79.61
Green Algae (Ulvaceae)	2.14	11.20	1.49	16.41	96.03
Periwinkles (Littorinidae Nodilittorina)	0.65	1.30	0.31	1.90	97.93
Red Algae (Rhodophyta)	0.49	0.67	0.26	0.98	98.91
Oyster borer (Muricidae Morula marginalba)	0.34	0.48	0.26	0.70	99.61
Zebra top shell (Trochidae Austrocochlea)	0.31	0.27	0.18	0.39	100.00

Group Outfall-2011
Average similarity: 64.55

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	4.25	20.63	2.21	31.96	31.96
False limpets and rock limpets (Patellogastropoda)	2.93	14.59	3.03	22.61	54.57
Red Algae (Rhodophyta)	2.59	11.10	1.27	17.20	71.77
Nerite (Nertidae Nerita)	1.80	8.58	2.12	13.29	85.06
Brown algae (Phaeophyta)	1.09	2.84	0.66	4.40	89.46
Oyster borer (Muricidae Morula marginalba)	0.79	2.79	0.80	4.32	93.78
Conniwinks (Lottorinidae Bembicium)	1.13	2.48	0.51	3.83	97.62
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.55	1.00	0.35	1.54	99.16
Green Algae (Ulvaceae)	0.67	0.46	0.18	0.71	99.87
Zebra top shell (Trochidae Austrocochlea)	0.21	0.09	0.10	0.13	100.00

Group Outfall-2013
Average similarity: 59.11

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	3.74	22.53	2.42	38.11	38.11
Green Algae (Ulvaceae)	3.10	13.68	1.16	23.13	61.24
Nerite (Nertidae Nerita)	1.44	6.39	1.21	10.81	72.05
False limpets and rock limpets (Patellogastropoda)	1.39	6.34	1.51	10.72	82.77
Conniwinks (Lottorinidae Bembicium)	1.64	6.02	0.95	10.19	92.96
Oyster borer (Muricidae Morula marginalba)	0.64	2.02	0.66	3.42	96.38
Red Algae (Rhodophyta)	0.83	1.30	0.35	2.20	98.58
Periwinkles (Littorinidae Nodilittorina)	0.33	0.43	0.10	0.73	99.31
Zebra top shell (Trochidae Austrocochlea)	0.37	0.41	0.26	0.69	100.00

Group Control 2-2008
Average similarity: 62.11

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Brown algae (Phaeophyta)	3.15	20.59	1.94	33.16	33.16
Conniwinks (Lottorinidae Bembicium)	1.65	10.99	2.79	17.69	50.85
Zebra top shell (Trochidae Austrocochlea)	1.63	10.68	3.88	17.19	68.04
False limpets and rock limpets (Patellogastropoda)	1.55	9.41	2.06	15.15	83.19
Barnacles (Cirripedia)	2.12	4.57	0.46	7.36	90.55
Nerite (Nertidae Nerita)	0.87	3.42	0.65	5.51	96.06
Red Algae (Rhodophyta)	0.81	1.78	0.35	2.86	98.92
Oyster borer (Muricidae Morula marginalba)	0.36	0.52	0.26	0.84	99.75
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.29	0.15	0.10	0.25	100.00

Group Control 2-2009
Average similarity: 69.71

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	7.62	29.90	1.57	42.89	42.89
Brown algae (Phaeophyta)	2.75	12.41	2.73	17.80	60.69
False limpets and rock limpets (Patellogastropoda)	1.54	6.98	2.35	10.01	70.70
Conniwinks (Lottorinidae Bembicium)	1.68	5.86	1.43	8.40	79.10
Zebra top shell (Trochidae Austrocochlea)	1.39	5.32	1.45	7.64	86.74
Nerite (Nertidae Nerita)	1.28	5.10	1.56	7.32	94.06
Tube worm (Serpilidae *Galeolaria caespitosa*)	0.82	1.89	0.53	2.72	96.77
Red Algae (Rhodophyta)	0.78	1.61	0.43	2.31	99.08
Oyster borer (Muricidae Morula marginalba)	0.39	0.55	0.35	0.78	99.87
Green Algae (Ulvaceae)	0.21	0.09	0.10	0.13	100.00

Group Control 2-2010
Average similarity: 61.06

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	7.09	26.72	1.16	43.76	43.76
Brown algae (Phaeophyta)	2.75	14.74	1.20	24.13	67.89
Red Algae (Rhodophyta)	1.28	6.72	1.08	11.00	78.89
False limpets and rock limpets (Patellogastropoda)	1.31	5.86	1.57	9.61	88.49
Conniwinks (Lottorinidae Bembicium)	1.09	3.06	0.76	5.02	93.51
Zebra top shell (Trochidae Austrocochlea)	0.91	2.98	0.64	4.88	98.39
Nerite (Nertidae Nerita)	0.43	0.63	0.35	1.04	99.43
Oyster borer (Muricidae Morula marginalba)	0.30	0.35	0.26	0.57	100.00

Group Control 2-2011
Average similarity: 62.02

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	7.78	29.85	1.44	48.13	48.13
Brown algae (Phaeophyta)	2.39	8.15	0.78	13.14	61.27
Tube worm (Serpilidae *Galeolaria caespitosa*)	1.39	6.50	1.49	10.47	71.75
False limpets and rock limpets (Patellogastropoda)	1.47	5.80	1.51	9.34	81.09
Zebra top shell (Trochidae Austrocochlea)	1.17	3.70	0.94	5.97	87.06
Conniwinks (Lottorinidae Bembicium)	1.12	3.34	0.94	5.39	92.45
Red Algae (Rhodophyta)	1.05	2.59	0.51	4.17	96.62
Nerite (Nertidae Nerita)	0.73	1.73	0.65	2.79	99.40
Oyster borer (Muricidae Morula marginalba)	0.37	0.37	0.26	0.60	100.00

Group Control 2-2013
Average similarity: 78.05

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Barnacles (Cirripedia)	**10.04**	**44.40**	**6.33**	**56.89**	**56.89**
False limpets and rock limpets (Patellogastropoda)	1.57	6.68	.33	8.55	65.44
Conniwinks (Lottorinidae Bembicium)	1.69	5.89	1.52	7.55	72.99
Brown algae (Phaeophyta)	1.79	5.63	1.20	7.21	80.21
Zebra top shell (Trochidae Austrocochlea)	1.32	3.90	1.16	4.99	85.20
Red Algae (Rhodophyta)	1.36	3.81	0.95	4.88	90.08
Oyster borer (Muricidae Morula marginalba)	1.09	3.80	1.56	4.87	94.95
Nerite (Nertidae Nerita)	1.19	3.66	1.18	4.69	99.64
Green Algae (Ulvaceae)	0.34	0.20	0.18	0.25	99.89
Tube worm (Serpilidae Galeolaria caespitosa)	0.21	0.09	0.10	0.11	100.00

6.5 Appendix E PERMDISP 2008 to 2011 and 2013 – factor 'Site-Time'

```
Distance-based test for homogeneity of multivariate dispersions
Transform: Fourth root
Resemblance: S17 Bray Curtis similarity (+d)
Group factor: Site-Time
Number of permutations: 9999
Number of groups: 15
Number of samples: 210
```

DEVIATIONS FROM CENTROID

```
F: 3.5299  df1: 14  df2: 195
P(perm): 0.0009
```

PAIRWISE COMPARISONS

Groups	t	P(perm)
(Control 1-2008,Control 2-2008)	2.9296	9.9E-3
(Control 1-2008,Outfall-2008)	3.468	4.5E-3
(Control 1-2008,Control 1-2009)	4.211	1.6E-3
(Control 1-2008,Control 2-2009)	3.3561	8.2E-3
(Control 1-2008,Outfall-2009)	3.3059	1E-2
(Control 1-2008,Control 1-2010)	6.2881E-2	0.9579
(Control 1-2008,Control 2-2010)	1.6496	0.1592
(Control 1-2008,Outfall-2010)	4.0759	1.5E-3
(Control 1-2008,Control 1-2011)	3.8264	2.1E-3
(Control 1-2008,Control 2-2011)	1.8629	0.1064
(Control 1-2008,Outfall-2011)	2.8372	2.51E-2
(Control 1-2008,Control 1-2013)	2.3674	5.16E-2
(Control 1-2008,Control 2-2013)	6.4119	1E-4
(Control 1-2008,Outfall-2013)	1.4319	0.2839
(Control 2-2008,Outfall-2008)	1.0716	0.3089
(Control 2-2008,Control 1-2009)	1.9005	7.53E-2
(Control 2-2008,Control 2-2009)	1.4652	0.1838
(Control 2-2008,Outfall-2009)	0.71296	0.4787
(Control 2-2008,Control 1-2010)	2.7316	1.66E-2
(Control 2-2008,Control 2-2010)	0.17156	0.8694
(Control 2-2008,Outfall-2010)	1.6679	0.1095
(Control 2-2008,Control 1-2011)	1.2754	0.209
(Control 2-2008,Control 2-2011)	2.0906E-2	0.9844
(Control 2-2008,Outfall-2011)	0.50427	0.6289
(Control 2-2008,Control 1-2013)	1.028	0.2933
(Control 2-2008,Control 2-2013)	4.6037	2E-4
(Control 2-2008,Outfall-2013)	0.39977	0.7702
(Outfall-2008,Control 1-2009)	0.65637	0.5448
(Outfall-2008,Control 2-2009)	0.63486	0.5601
(Outfall-2008,Outfall-2009)	0.38629	0.7173
(Outfall-2008,Control 1-2010)	3.2747	5E-3
(Outfall-2008,Control 2-2010)	0.78848	0.4707
(Outfall-2008,Outfall-2010)	0.41138	0.6959
(Outfall-2008,Control 1-2011)	3.2322E-2	0.9759
(Outfall-2008,Control 2-2011)	0.67417	0.5465
(Outfall-2008,Outfall-2011)	0.40904	0.7041
(Outfall-2008,Control 1-2013)	1.9633	5.97E-2
(Outfall-2008,Control 2-2013)	2.712	1.31E-2
(Outfall-2008,Outfall-2013)	1.0007	0.4668
(Control 1-2009,Control 2-2009)	0.1526	0.8962
(Control 1-2009,Outfall-2009)	1.1089	0.2985

(Control 1-2009,Control 1-2010)	3.9429	1.1E-3
(Control 1-2009,Control 2-2010)	1.2349	0.3061
(Control 1-2009,Outfall-2010)	0.27835	0.793
(Control 1-2009,Control 1-2011)	0.70192	0.4864
(Control 1-2009,Control 2-2011)	1.1396	0.3782
(Control 1-2009,Outfall-2011)	1.0246	0.358
(Control 1-2009,Control 1-2013)	2.9268	9.5E-3
(Control 1-2009,Control 2-2013)	2.1037	4.69E-2
(Control 1-2009,Outfall-2013)	1.4487	0.3199
(Control 2-2009,Outfall-2009)	0.9492	0.3713
(Control 2-2009,Control 1-2010)	3.2458	6.4E-3
(Control 2-2009,Control 2-2010)	1.1739	0.3672
(Control 2-2009,Outfall-2010)	0.35378	0.7549
(Control 2-2009,Control 1-2011)	0.64991	0.5721
(Control 2-2009,Control 2-2011)	1.0839	0.4039
(Control 2-2009,Outfall-2011)	0.92961	0.4499
(Control 2-2009,Control 1-2013)	2.0895	8.37E-2
(Control 2-2009,Control 2-2013)	1.2825	0.2373
(Control 2-2009,Outfall-2013)	1.3588	0.3151
(Outfall-2009,Control 1-2010)	3.1025	8.9E-3
(Outfall-2009,Control 2-2010)	0.55974	0.6055
(Outfall-2009,Outfall-2010)	0.86263	0.4336
(Outfall-2009,Control 1-2011)	0.47057	0.6419
(Outfall-2009,Control 2-2011)	0.43219	0.6877
(Outfall-2009,Outfall-2011)	7.9115E-2	0.9374
(Outfall-2009,Control 1-2013)	1.6754	0.1042
(Outfall-2009,Control 2-2013)	3.4097	2.5E-3
(Outfall-2009,Outfall-2013)	0.77901	0.5869
(Control 1-2010,Control 2-2010)	1.634	0.1513
(Control 1-2010,Outfall-2010)	3.8049	3E-3
(Control 1-2010,Control 1-2011)	3.562	1.5E-3
(Control 1-2010,Control 2-2011)	1.8352	0.1246
(Control 1-2010,Outfall-2011)	2.713	1.65E-2
(Control 1-2010,Control 1-2013)	2.2017	4.3E-2
(Control 1-2010,Control 2-2013)	5.8917	1E-4
(Control 1-2010,Outfall-2013)	1.425	0.3075
(Control 2-2010,Outfall-2010)	1.0795	0.3411
(Control 2-2010,Control 1-2011)	0.84489	0.4483
(Control 2-2010,Control 2-2011)	0.11819	0.9237
(Control 2-2010,Outfall-2011)	0.471	0.6847
(Control 2-2010,Control 1-2013)	0.30661	0.7845
(Control 2-2010,Control 2-2013)	2.5187	1.74E-2
(Control 2-2010,Outfall-2013)	0.17415	0.8923
(Outfall-2010,Control 1-2011)	0.42961	0.6645
(Outfall-2010,Control 2-2011)	0.97623	0.4067
(Outfall-2010,Outfall-2011)	0.80923	0.4587
(Outfall-2010,Control 1-2013)	2.7322	1.17E-2
(Outfall-2010,Control 2-2013)	2.5057	2.65E-2
(Outfall-2010,Outfall-2013)	1.2968	0.3678
(Control 1-2011,Control 2-2011)	0.72937	0.5299
(Control 1-2011,Outfall-2011)	0.47548	0.654
(Control 1-2011,Control 1-2013)	2.3675	2.45E-2
(Control 1-2011,Control 2-2013)	3.091	6E-3
(Control 1-2011,Outfall-2013)	1.0662	0.4364
(Control 2-2011,Outfall-2011)	0.34709	0.7793
(Control 2-2011,Control 1-2013)	0.48689	0.6747
(Control 2-2011,Control 2-2013)	2.4863	2.61E-2
(Control 2-2011,Outfall-2013)	0.29679	0.8406
(Outfall-2011,Control 1-2013)	1.2549	0.24

(Outfall-2011,Control 2-2013)	2.8991	7E-3
(Outfall-2011,Outfall-2013)	0.67687	0.6157
(Control 1-2013,Control 2-2013)	6.1574	1E-4
(Control 1-2013,Outfall-2013)	6.9654E-2	0.9619
(Control 2-2013,Outfall-2013)	2.7336	7.9E-2

MEANS AND STANDARD ERRORS

Group	Size	Average	SE
Control 1-2008	14	33.018	2.4742
Control 2-2008	14	24.439	1.5662
Outfall-2008	14	21.551	2.1935
Control 1-2009	14	19.599	2.0083
Control 2-2009	14	19.001	3.3649
Outfall-2009	14	22.676	1.9145
Control 1-2010	14	33.254	2.8213
Control 2-2010	14	25.185	4.0529
Outfall-2010	14	20.364	1.8754
Control 1-2011	14	21.461	1.7325
Control 2-2011	14	24.526	3.8286
Outfall-2011	14	22.928	2.5544
Control 1-2013	14	26.483	1.2241
Control 2-2013	14	14.241	1.5667
Outfall-2013	14	26.186	4.0794

6.6 Appendix F Summary of ocean receiving water data 2013-14

Table 6-20 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various metals

North Head		Chemical concentration (µg/L)							
		aluminium	cadmium	chromium	copper	mercury	lead	selenium	zinc
Undiluted wastewater average value		561	0.2	3.8	104	0.24	2.6	<5	109
Guideline 95th %ile for protection of marine species		ID	5.5	27.4	1.3	0.4	4.4	ID	15
Dilution exceeded 98% of time	72:1	7.8	0.003	0.05	1.4	0.003	0.04	0.07	1.5
Dilution exceeded 10% of time	690:1	0.81	0.0003	0.01	0.15	0.0004	0.004	0.01	0.16

ID means= 'insufficient data' for ANZECC to form a guideline

Table 6-21 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals

North Head		Chemical concentration (µg/L)								
		aldrin	DDE	DDT	dieldrin	endosulphan	heptachlor	lindane	chlordane	chlorpyrifos
Undiluted wastewater average value		<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.01	<0.05
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	0.01	ID	ID	ID	0.009
Dilution exceeded 98% of time	72:1	0.0004	0.0004	0.0004	0.0004	0.0004	0.00007	0.0004	0.0004	0.0007
Dilution exceeded 10% of time	690:1	0.00001	0.00001	0.00001	0.00001	0.00001	0.000001	0.00001	0.00001	0.00007

Table 6-22 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals (continued)

North Head		Chemical concentration (µg/L)					
		diazinon	malathion	parathion	nonyl phenol ethoxylate	polychlorinated biphenols	hydrogen sulphide
Undiluted wastewater average value		<0.1	<0.05	<0.1	161	<0.1	130
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	ID	ID
Dilution exceeded 98% of time	72:1	0.004	0.0007	0.004	2.2	0.0004	1.8
Dilution exceeded 10% of time	690:1	0.00014	0.00007	0.00014	0.23	0.00014	0.19

Table 6-23 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various metals

Bondi		Chemical concentration (μg/L)							
		aluminium	cadmium	chromium	copper	mercury	lead	selenium	zinc
Undiluted wastewater average value		306	0.1	1.1	120	0.07	3.6	<5	106
Guideline 95th %ile for protection of marine species		ID	5.5	27.4	1.3	0.4	4.4	ID	15
Dilution exceeded 98% of time	89:1	3.4	0.001	0.01	1.3	0.001	0.04	0.06	1.2
Dilution exceeded 10% of time	943:1	0.32	0.0001	0.001	0.13	0.0001	0.004	0.01	0.11

ID means= 'insufficient data' for ANZECC to form a guideline

Table 6-24 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals

Bondi		Chemical concentration (μg/L)								
		aldrin	DDE	DDT	dieldrin	endosulphan	heptachlor	lindane	chlordane	chlorpyrifos
Undiluted wastewater average value		<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.01	<0.05
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	0.01	ID	ID	ID	0.009
Dilution exceeded 98% of time	89:1	0.0001	0.0001	0.0001	0.0001	0.0001	0.00006	0.0001	0.0001	0.0006
Dilution exceeded 10% of time	943:1	0.00001	0.00001	0.00001	0.00001	0.00001	0.000001	0.00001	0.00001	0.00005

Table 6-25 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals (continued)

Bondi		Chemical concentration (μg/L)					
		diazinon	malathion	parathion	nonyl phenol ethoxylate	polychlorinated biphenols	hydrogen sulphide
Undiluted wastewater average value		<0.1	<0.05	<0.1	120	<0.1	120
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	ID	ID
Dilution exceeded 98% of time	89:1	0.001	0.0006	0.001	1.3	0.0001	1.3
Dilution exceeded 10% of time	943:1	0.00011	0.00005	0.00011	0.13	0.00011	0.13

Table 6-26 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various metals

Malabar		Chemical concentration (µg/L)							
		aluminium	cadmium	chromium	copper	mercury	lead	selenium	zinc
Undiluted wastewater average value		459	0.2	9.3	80	0.05	3.3	<5	102
Guideline 95th %ile for protection of marine species		ID	5.5	27.4	1.3	0.4	4.4	ID	15
Dilution exceeded 98% of time	56:1	8.2	0.004	0.17	1.4	0.001	0.06	0.09	1.8
Dilution exceeded 10% of time	478:1	0.96	0.0004	0.02	0.17	0.0001	0.01	0.01	0.21

ID means= 'insufficient data' for ANZECC to form a guideline

Table 6-27 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals

Malabar		Chemical concentration (µg/L)								
		aldrin	DDE	DDT	dieldrin	endosulphan	heptachlor	lindane	chlordane	chlorpyrifos
Undiluted wastewater average value		<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.01	<0.05
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	0.01	ID	ID	ID	0.009
Dilution exceeded 98% of time	56:1	0.0002	0.0002	0.0002	0.0002	0.0002	0.00009	0.0002	0.0002	0.0009
Dilution exceeded 10% of time	478:1	0.00002	0.00002	0.00002	0.00002	0.00002	0.000001	0.00002	0.00002	0.00010

Table 6-28 Average 2013-2014 wastewater concentrations, ANZECC (2000) guideline values, and modelled dilution concentrations for various chemicals (continued)

Malabar		Chemical concentration (µg/L)					
		diazinon	malathion	parathion	nonyl phenol ethoxylate	polychlorinated biphenols	hydrogen sulphide
Undiluted wastewater average value		<0.1	<0.05	<0.1	301	<0.1	169
Guideline 95th %ile for protection of marine species		ID	ID	ID	ID	ID	ID
Dilution exceeded 98% of time	56:1	0.002	0.0009	0.002	5.4	0.0015	3.0
Dilution exceeded 10% of time	478:1	0.00021	0.00010	0.00021	0.63	0.00021	0.35

6.7 Appendix G Summary of estuarine and lagoon water quality data

Table 6-29 Yearly summary statistics on chlorophyll *a*, of urban river and estuarine monitoring sites (2013-14)

Site code	Site name	Stats	Chlorophyll *a* (µg/L)	
			Dry weather	Wet weather
CR04	Alexandria Canal	No of Obs	12	0
		Minimum	2.4	.
		10th%ile	3.3	.
		Median	14.7	.
		Mean	16.8	.
		90th%ile	35.9	.
		Maximum	45.5	.
		Std Dev	12.9	.
GR01	Cooks River (d/s Muddy Creek)	No of Obs	12	0
		Minimum	1.7	.
		10th%ile	1.9	.
		Median	3.3	.
		Mean	7.7	.
		90th%ile	14.5	.
		Maximum	24.3	.
		Std Dev	7.4	.
GR19	Upper Georges River, d/s of Harris Creek	No of Obs	12	0
		Minimum	1	.
		10th%ile	1.2	.
		Median	3.4	.
		Mean	3.6	.
		90th%ile	7.9	.
		Maximum	8.1	.
		Std Dev	2.4	.
GR22	Liverpool Weir	No of Obs	12	0
		Minimum	2.3	.
		10th%ile	2.5	.
		Median	8.8	.
		Mean	10.7	.
		90th%ile	22.7	.
		Maximum	40.5	.
		Std Dev	10.9	.
GRFB	Frenchmans Bay	No of Obs	12	1
		Minimum	0.7	.
		10th%ile	1.9	.
		Median/Value	2.9	1.5
		Mean	6.5	.
		90th%ile	4.8	.

Site code	Site name	Stats	Chlorophyll *a* (µg/L)	
			Dry weather	Wet weather
		Maximum	47.9	.
		Std Dev	13.1	.
GROB	Oatley Baths	No of Obs	13	0
		Minimum	1.7	.
		10^{th}%ile	2.1	.
		Median	4.4	.
		Mean	4.3	.
		90^{th}%ile	6.9	.
		Maximum	7	.
		Std Dev	1.8	.
GRRB	Ramsgate Baths	No of Obs	12	1
		Minimum	1	.
		10^{th}%ile	1.7	.
		Median/Value	2.6	1.9
		Mean	3.3	.
		90^{th}%ile	5.2	.
		Maximum	8.1	.
		Std Dev	2	.
PHLPB	Lilli Pilli Baths	No of Obs	12	1
		Minimum	1.1	.
		10^{th}%ile	1.5	.
		Median/Value	2.1	1.3
		Mean	2.2	.
		90^{th}%ile	2.7	.
		Maximum	4.1	.
		Std Dev	0.8	.
PJ015	Parramatta River at Ermington	No of Obs	11	1
		Minimum	6.7	.
		10^{th}%ile	7.2	.
		Median/Value	14.3	2.9
		Mean	16.2	.
		90^{th}%ile	26.6	.
		Maximum	43.4	.
		Std Dev	10.7	.
PJCB1	Chinamans Beach	No of Obs	11	1
		Minimum	1.2	.
		10^{th}%ile	1.4	.
		Median/Value	2.5	0.8
		Mean	2.6	.
		90^{th}%ile	3.7	.
		Maximum	4.5	.
		Std Dev	1	.
PJCB2	Cabarita Beach	No of Obs	11	1

Site code	Site name	Stats	Chlorophyll *a* (µg/L)	
			Dry weather	Wet weather
		Minimum	1.2	.
		10th%ile	1.6	.
		Median/Value	5.6	2.9
		Mean	5.6	.
		90th%ile	7.6	.
		Maximum	13	.
		Std Dev	3.2	.
PJDFP	Dawn Fraser Pool	No of Obs	11	1
		Minimum	1.4	.
		10th%ile	1.8	.
		Median/Value	3	1.3
		Mean	3	.
		90th%ile	3.5	.
		Maximum	6.2	.
		Std Dev	1.3	.
PJDR	Davidsons Reserve	No of Obs	11	1
		Minimum	0.9	.
		10th%ile	1	.
		Median/Value	2.4	0.4
		Mean	2.7	.
		90th%ile	4.2	.
		Maximum	6.6	.
		Std Dev	1.7	.
PJLC	Lane Cove River Weir	No of Obs	11	1
		Minimum	3.1	.
		10th%ile	10.4	.
		Median/Value	15	6.6
		Mean	19	.
		90th%ile	41.2	.
		Maximum	43.6	.
		Std Dev	12.6	.
PJPR	Parramatta River Weir	No of Obs	11	1
		Minimum	1.8	.
		10th%ile	3.9	.
		Median/Value	20.1	14
		Mean	23.8	.
		90th%ile	41.9	.
		Maximum	47.1	.
		Std Dev	15.8	.
PJTB	Lane Cove River (nr Tambourine Bay)	No of Obs	11	1
		Minimum	1.3	.
		10th%ile	2.2	.
		Median/Value	3.6	0.3

Site code	Site name	Stats	Chlorophyll *a* (µg/L)	
			Dry weather	Wet weather
		Mean	4	.
		90th%ile	6.7	.
		Maximum	6.9	.
		Std Dev	1.7	.

Table 6-30 Water quality ratings based on chlorophyll *a* and percent samples with the guideline for the estuarine sites (2012-13 and 2013-14)

Site code	Site name	Percent samples within guideline (%)		Map score		Water quality ratings	
		2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
CR04	Alexandria Canal	0	17	3	3	Poor	Poor
GR01	Cooks River (d/s Muddy Creek)	45	58	2	2	Fair	Fair
GR19	Upper Georges River, d/s of Harris Creek	27	75	3	1	Poor	Good
GR22	Liverpool Weir	9	25	3	3	Poor	Poor
GRFB	Frenchmans Bay	90	83	1	1	Good	Good
GROB	Oatley Baths	90	46	1	2	Good	Fair
GRRB	Ramsgate Baths	97	67	1	2	Good	Fair
PHLPB	Lilli Pilli Baths	100	92	1	1	Good	Good
PJ015	Parramatta River at Ermington	9	0	3	3	Poor	Poor
PJCB1	Chinamans Beach	100	91	1	1	Good	Good
PJCB2	Cabarita Beach	91	27	1	3	Good	Poor
PJDFP	Dawn Fraser Pool	97	91	1	1	Good	Good
PJDR	Davidsons Reserve	93	82	1	1	Good	Good
PJLC	Lane Cove River Weir	9	0	3	3	Poor	Poor
PJPR	Parramatta River Weir	0	9	3	3	Poor	Poor
PJTB	Lane Cove River (nr Tambourine Bay)	83	58	1	2	Good	Fair

Table 6-31 Yearly summary statistics on lagoon monitoring data (2013-14)

Site code	Site name	Stat	Conductivity (µS/cm)		Chlorophyll *a* (µg/L)	
			Weather		Weather	
			Dry	Wet	Dry	Wet
CC01	Curl Curl Lagoon	No of Obs	8	3	8	3
		Minimum	11,500	26,500	1.7	1.1
		10^{th}%ile	11,500	26,500	1.7	1.1
		Median	22,350	28,600	4.6	1.5
		Mean	24,175	31,800	33.5	2.2
		90^{th}%ile	48,100	40,300	192.0	4.0
		Maximum	48,100	40,300	192.0	4.0
		Std Dev	11,610	7,436	65.9	1.6
DW01	Dee Why Lagoon	No of Obs	10	3	10.0	3.0
		Minimum	14,400	20,300	0.6	2.2
		10^{th}%ile	14,600	20,300	1.0	2.2
		Median	29,950	40,200	5.4	3.1
		Mean	31,600	38,233	6.9	3.2
		90^{th}%ile	50,150	54,200	17.5	4.4
		Maximum	51,500	54,200	18.8	4.4
		Std Dev	12,287	17,035	6.3	1.1
ML01	Mouth Manly Lagoon	No of Obs	10	3	10	3
		Minimum	8,200	3,600	2.6	2.4
		10^{th}%ile	18,150	3,600	3.6	2.4
		Median	44,050	4,600	7.9	2.7
		Mean	38,520	13,767	8.9	3.6
		90^{th}%ile	50,600	33,100	17.6	5.8
		Maximum	50,900	33,100	19.8	5.8
		Std Dev	13,459	16,751	5.2	1.9
ML03	Upper Manly Lagoon	No of Obs	10	3	10	3
		Minimum	897	194	0.8	1.1
		10^{th}%ile	1,047	194	1.2	1.1
		Median	13,800	567	16.0	4.4
		Mean	14,649	3,320	17.4	3.5
		90^{th}%ile	29,350	9,200	36.6	5.0
		Maximum	32,800	9,200	38.1	5.0
		Std Dev	10,892	5,095	13.6	2.1
NL01	East Narrabeen Lagoon	No of Obs	9	3	10	3
		Minimum	42,800	38,200	0.8	0.5
		10^{th}%ile	42,800	38,200	1.1	0.5
		Median	51,900	52,900	1.5	1.1
		Mean	51,100	48,400	2.5	1.4
		90^{th}%ile	54,500	54,100	6.5	2.5
		Maximum	54,500	54,100	8.2	2.5
		Std Dev	3,341	8,854	2.3	1.0

Site code	Site name	Stat	Conductivity (µS/cm)		Chlorophyll *a* (µg/L)	
			Weather		Weather	
			Dry	Wet	Dry	Wet
NL06	West Narrabeen Lagoon	No of Obs	10	3	10	3
		Minimum	27,700	7,600	1.4	3.2
		10^{th}%ile	30,350	7,600	1.9	3.2
		Median	48,800	46,800	12.4	7.7
		Mean	45,380	33,767	12.5	8.4
		90^{th}%ile	52,850	46,900	27.8	14.2
		Maximum	53,700	46,900	34.9	14.2
		Std Dev	8,716	22,661	10.1	5.5
WL83	Wattamolla Lagoon	No of Obs	10	3	10	3
		Minimum	14,100	25,900	0.4	0.3
		10^{th}%ile	14,200	25,900	0.4	0.3
		Median	24,700	32,200	1.0	1.3
		Mean	26,730	32,000	1.1	1.0
		90^{th}%ile	42,700	37,900	2.1	1.4
		Maximum	50,600	37,900	2.3	1.4
		Std Dev	10,604	6,002	0.6	0.6

Table 6-32 Water quality ratings based on chlorophyll a and percent samples within the guideline values for the lagoon sites (2012-13 and 2013-14)

Site code	Site name	Percent samples within guidelines (%)		Map score		Water quality ratings	
		2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
CC01	Curl Curl Lagoon	27	38	3	3	Poor	Poor
DW01	Dee Why Lagoon	36	50	3	2	Poor	Fair
ML01	Mouth Manly Lagoon	36	10	3	3	Poor	Poor
ML03	Upper Manly Lagoon	9	20	3	3	Poor	Poor
NL01	East Narrabeen Lagoon	91	80	1	1	Good	Good
NL06	West Narrabeen Lagoon	27	30	3	3	Poor	Poor
WL83	Wattamolla Lagoon	91	100	1	1	Good	Good

6.8 Appendix H Summary of Hawkesbury Nepean River data

Table 6-33 Yearly summary of Hawkesbury Nepean River receiving water quality (2013-14)

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
N92	Hawkesbury Nepean River at Maldon Weir, Reference site	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	0	0
			Minimum	7.4	10.9	6.1	70.5	84.0	0.8	0.26	0.01	0.07	0.003	0.007	0.6	.	.
			10th%ile	7.6	11.2	6.8	78.4	107.0	1.1	0.28	0.01	0.08	0.003	0.008	0.8	.	.
			Median	7.8	18.4	9.1	99.1	198.0	1.7	0.36	0.01	0.14	0.004	0.009	1.8	.	.
			Mean	7.9	17.9	9.1	95.9	212.4	2.0	0.40	0.01	0.20	0.005	0.009	2.0	.	.
			90th%ile	8.3	23.6	10.8	105.7	360.0	4.3	0.66	0.02	0.46	0.007	0.014	3.7	.	.
			Maximum	8.5	24.2	11.2	113.1	422.0	4.9	0.66	0.03	0.49	0.009	0.015	4.4	.	.
			Std dev	0.3	4.6	1.5	10.2	91.1	1.1	0.13	0.01	0.14	0.002	0.002	1.1	.	.
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	0	0
			Value	7.1	20.8	9.3	104.4	88.0	4.0	0.36	0.01	0.14	0.004	0.009	1.0	.	.
N75	Hawkesbury Nepean River at Sharpes Weir, d/s of West Camden plant	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	5	5
			Minimum	7.0	11.2	7.3	88.0	118.0	2.5	0.36	0.01	0.07	0.004	0.011	1.2	0.001	0
			10th%ile	7.1	12.3	7.6	90.7	157.0	2.8	0.40	0.01	0.08	0.005	0.013	2.0	0.001	0
			Median	7.6	20.1	9.4	103.5	216.0	4.0	0.48	0.01	0.21	0.006	0.016	6.3	0.018	0
			Mean	7.5	19.7	9.4	102.5	221.5	5.0	0.51	0.01	0.25	0.006	0.017	5.8	0.024	0
			90th%ile	7.9	26.0	10.8	113.4	294.0	10.0	0.73	0.02	0.47	0.007	0.023	10.0	0.054	0
			Maximum	8.1	26.8	11.2	114.3	301.0	12.0	0.75	0.03	0.52	0.010	0.025	12.2	0.054	0
			Std dev	0.3	5.3	1.2	7.7	48.4	2.7	0.12	0.01	0.14	0.001	0.004	2.8	0.025	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	0	0
			Value	6.9	20.6	8.5	95.2	125.0	15.0	0.60	0.04	0.25	0.010	0.026	1.9	.	.
N67	Hawkesbury Nepean River at Wallacia Bridge, u/s of Warragamba River	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	11	11
			Minimum	7.0	10.7	8.1	80.0	139.0	2.9	0.45	0.01	0.12	0.004	0.013	1.4	0.002	0
			10th%ile	7.3	11.6	8.1	88.3	174.0	2.9	0.47	0.01	0.16	0.004	0.013	3.0	0.003	0
			Median	7.6	20.4	9.6	108.7	294.0	5.1	0.60	0.01	0.26	0.006	0.018	7.8	0.017	0
			Mean	7.6	20.5	9.6	107.5	278.1	6.7	0.62	0.01	0.34	0.007	0.021	8.3	0.069	0

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm³/L	CBtoxcnt cells/mL
			90th%ile	7.9	27.4	10.8	123.9	357.0	14.0	0.91	0.03	0.68	0.013	0.038	15.6	0.073	0
			Maximum	8.1	27.6	12.0	124.8	393.0	23.0	0.92	0.03	0.77	0.020	0.047	20.6	0.496	0
			Std dev	0.3	5.9	1.1	12.6	64.5	4.9	0.16	0.01	0.20	0.004	0.009	4.6	0.144	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	0	0
			Value	6.9	20.1	8.0	88.6	126.0	390.0	1.28	0.05	0.46	0.134	0.503	1.70	.	.
N57	Hawkesbury Nepean River at Penrith Weir, u/s of Penrith plant	Dry	No of Obs	16	16	16	16	16	16	16	16	16	16	16	16	8	8
			Minimum	6.9	12.9	6.9	79.7	128.0	2.6	0.31	0.01	0.01	0.004	0.011	2.4	0.000	0
			10th%ile	7.0	13.3	7.3	81.5	153.0	3.1	0.33	0.01	0.01	0.004	0.011	2.6	0.000	0
			Median	7.6	19.6	9.0	99.0	214.0	3.9	0.52	0.01	0.22	0.005	0.015	7.0	0.022	0
			Mean	7.5	19.2	9.1	98.8	226.6	4.7	0.48	0.01	0.18	0.005	0.016	8.5	0.031	0
			90th%ile	7.9	24.6	10.8	117.7	319.0	7.7	0.63	0.02	0.33	0.008	0.023	16.4	0.105	0
			Maximum	8.1	26.6	11.1	119.4	342.0	11.0	0.67	0.02	0.40	0.008	0.033	19.6	0.105	0
			Std dev	0.3	4.5	1.5	11.5	63.5	2.1	0.11	0.01	0.13	0.001	0.005	5.2	0.036	0
		Wet	No of Obs	2	2	2	2	2	2	2	2	2	2	2	2	2	2
			Minimum	7.3	25.1	5.9	72.2	263.0	2.7	0.33	0.01	0.01	0.004	0.014	10.1	0.087	0
			10th%ile	7.3	25.1	5.9	72.2	263.0	2.7	0.33	0.01	0.01	0.004	0.014	10.1	0.087	0
			Median	7.4	25.6	6.3	77.4	276.5	3.0	0.34	0.01	0.01	0.004	0.015	11.0	0.216	764
			Mean	7.4	25.6	6.3	77.4	276.5	3.0	0.34	0.01	0.01	0.004	0.015	11.0	0.216	764
			90th%ile	7.4	26.0	6.6	82.5	290.0	3.3	0.34	0.01	0.02	0.004	0.015	11.9	0.344	1,528
			Maximum	7.4	26.0	6.6	82.5	290.0	3.3	0.34	0.01	0.02	0.004	0.015	11.9	0.344	1,528
			Std dev	0.1	0.6	0.5	7.3	19.1	0.4	0.01	0.00	0.01	0.000	0.001	1.3	0.182	1,080
N51	Hawkesbury Nepean River opposite Fitzgerald Creek, d/s of Penrith plant	Dry	No of Obs	16	16	16	16	16	16	16	16	16	16	16	16	9	9
			Minimum	7.1	12.2	7.6	88.7	134.0	4.2	0.32	0.01	0.01	0.004	0.012	2.4	0.000	0
			10th%ile	7.2	13.7	7.7	89.8	159.0	5.0	0.33	0.01	0.03	0.004	0.013	2.9	0.000	0
			Median	7.6	19.7	9.4	101.8	211.0	5.7	0.53	0.01	0.23	0.005	0.019	7.1	0.033	0
			Mean	7.5	19.5	9.2	100.3	212.4	6.0	0.47	0.01	0.19	0.006	0.019	8.0	0.044	0
			90th%ile	7.8	25.7	10.8	107.3	289.0	6.7	0.61	0.01	0.33	0.008	0.027	18.0	0.099	0
			Maximum	7.9	27.3	11.0	108.0	321.0	11.0	0.64	0.02	0.37	0.015	0.028	19.9	0.099	0

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
			Std dev	0.2	4.6	1.1	6.2	51.4	1.5	0.11	0.00	0.12	0.003	0.004	4.8	0.034	0
		Wet	No of Obs	2	2	2	2	2	2	2	2	2	2	2	2	2	2
			Minimum	7.4	25.5	7.0	87.4	246.0	6.4	0.35	0.01	0.01	0.004	0.021	13.9	0.032	0
			10th%ile	7.4	25.5	7.0	87.4	246.0	6.4	0.35	0.01	0.01	0.004	0.021	13.9	0.032	0
			Median	7.5	25.9	7.5	92.6	267.0	6.7	0.39	0.01	0.06	0.005	0.023	16.2	0.099	0
			Mean	7.5	25.9	7.5	92.6	267.0	6.7	0.39	0.01	0.06	0.005	0.023	16.2	0.099	0
			90th%ile	7.6	26.2	7.9	97.7	288.0	6.9	0.43	0.01	0.10	0.006	0.025	18.4	0.166	0
			Maximum	7.6	26.2	7.9	97.7	288.0	6.9	0.43	0.01	0.10	0.006	0.025	18.4	0.166	0
			Std dev	0.2	0.5	0.6	7.3	29.7	0.4	0.06	0.00	0.06	0.001	0.002	3.2	0.095	0
N48	Hawkesbury Nepean River at Smith Street, u/s of Winmalee plant	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	11	11
			Minimum	7.1	12.6	5.7	71.3	154.0	2.6	0.30	0.01	0.01	0.004	0.014	2.4	0.000	0
			10th%ile	7.1	13.4	5.8	71.6	156.0	2.9	0.31	0.01	0.01	0.005	0.017	3.6	0.002	0
			Median	7.5	21.1	8.9	94.9	215.0	5.0	0.51	0.01	0.17	0.006	0.020	7.9	0.050	0
			Mean	7.5	20.3	8.7	96.0	218.8	5.3	0.46	0.01	0.15	0.006	0.021	8.8	0.057	8
			90th%ile	7.8	26.8	10.9	114.6	308.0	9.3	0.59	0.03	0.30	0.010	0.028	16.2	0.153	15
			Maximum	7.8	26.9	11.0	122.3	316.0	9.8	0.60	0.03	0.31	0.011	0.034	22.6	0.170	73
			Std dev	0.3	4.7	1.8	14.0	52.4	2.2	0.11	0.01	0.12	0.002	0.005	5.1	0.060	22
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.1	25.2	6.2	76.0	215.0	3.6	0.37	0.02	0.01	0.006	0.030	17.2	0.041	0
N44	Hawkesbury Nepean River at Yarramundi Bridge, d/s of Winmalee plant	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	13	13
			Minimum	7.1	13.4	6.4	79.6	158.0	2.8	0.40	0.01	0.03	0.006	0.015	2.9	0.000	0
			10th%ile	7.2	13.6	7.3	86.2	166.0	2.9	0.48	0.01	0.04	0.007	0.018	4.1	0.000	0
			Median	7.5	20.5	8.7	95.6	226.0	4.8	0.56	0.02	0.24	0.008	0.030	10.8	0.014	0
			Mean	7.6	20.3	8.8	97.0	229.6	5.0	0.60	0.02	0.25	0.009	0.029	11.7	0.174	0
			90th%ile	8.0	26.4	11.3	113.6	309.0	7.9	0.79	0.05	0.51	0.012	0.037	20.9	0.504	0
			Maximum	8.3	26.6	11.3	119.6	334.0	8.0	0.87	0.06	0.61	0.014	0.038	23.1	0.917	0
			Std dev	0.3	4.6	1.5	9.9	52.5	1.6	0.12	0.02	0.17	0.002	0.006	6.0	0.272	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
			Value	7.2	24.8	5.8	70.4	263.0	4.8	0.66	0.06	0.21	0.008	0.036	22.4	0.128	0
N42	Hawkesbury Nepean River at North Richmond, d/s of Grose River	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	15	15
			Minimum	6.9	13.0	5.7	72.6	135.0	3.1	0.39	0.01	0.04	0.005	0.021	2.7	0.001	0
			10th%ile	7.0	13.0	7.3	85.2	159.0	3.8	0.45	0.01	0.04	0.006	0.021	4.4	0.013	0
			Median	7.3	20.8	9.1	97.5	185.0	5.6	0.56	0.01	0.21	0.008	0.027	13.8	0.032	0
			Mean	7.4	20.1	8.9	97.6	204.4	7.0	0.56	0.02	0.22	0.007	0.028	14.5	0.155	23
			90th%ile	7.7	27.4	11.0	115.6	276.0	14.0	0.69	0.05	0.43	0.010	0.035	26.9	0.396	0
			Maximum	7.8	27.4	11.0	118.4	305.0	15.0	0.74	0.05	0.49	0.010	0.036	31.6	0.840	349
			Std dev	0.2	5.2	1.6	11.5	46.5	3.7	0.09	0.01	0.14	0.001	0.004	7.8	0.226	90
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.2	25.4	6.4	78.4	263.0	5.7	0.57	0.05	0.11	0.007	0.032	20.70	0.270	141
N39	Hawkesbury Nepean River at Freemans Reach, d/s of North Richmond plant	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	12	12
			Minimum	6.8	13.3	7.3	87.2	133.0	2.7	0.35	0.01	0.01	0.004	0.017	2.0	0.002	0
			10th%ile	7.0	14.2	7.8	89.1	155.0	2.8	0.43	0.01	0.03	0.005	0.018	3.2	0.004	0
			Median	7.5	20.8	9.8	102.3	201.0	5.3	0.56	0.02	0.19	0.007	0.025	13.1	0.164	0
			Mean	7.5	21.1	9.3	104.3	210.7	7.2	0.55	0.02	0.20	0.006	0.026	12.9	0.395	41
			90th%ile	8.5	27.6	10.8	125.8	304.0	18.0	0.71	0.05	0.41	0.008	0.037	23.4	0.830	143
			Maximum	8.6	28.2	11.0	127.3	312.0	19.0	0.72	0.06	0.53	0.013	0.039	26.7	1.609	274
			Std dev	0.5	5.1	1.2	12.5	51.2	5.0	0.11	0.01	0.14	0.002	0.007	7.6	0.486	86
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.3	23.6	8.7	103.7	210.0	8.2	0.53	0.01	0.17	0.009	0.037	18.5	0.007	0
NS04	Lower South Creek at Fitzroy Bridge, Windsor	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	10	10
			Minimum	7.0	11.7	3.6	42.2	417.0	24.0	1.41	0.01	0.80	0.015	0.062	2.5	0.000	0
			10th%ile	7.1	12.5	3.7	43.1	568.0	29.0	1.47	0.01	0.83	0.019	0.069	3.6	0.000	0
			Median	7.4	20.1	5.5	62.0	996.0	44.0	2.37	0.10	1.55	0.027	0.106	10.3	0.000	0
			Mean	7.4	19.2	5.9	63.1	936.6	52.6	2.36	0.12	1.46	0.043	0.119	21.7	0.196	0
			90th%ile	7.9	25.6	8.6	80.6	1242.0	120.0	3.50	0.26	2.13	0.065	0.156	86.9	0.979	0
			Maximum	7.9	25.9	10.1	104.1	1310.0	130.0	3.53	0.37	2.20	0.263	0.407	94.6	1.495	0

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
			Std dev	0.3	5.0	2.0	16.6	255.7	29.6	0.69	0.10	0.51	0.058	0.078	27.7	0.479	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.2	20.8	5.5	61.7	468.0	200.0	2.67	0.17	1.73	0.107	0.242	7.1	0.000	0
N35	Hawkesbury Nepean River at Wilberforce, d/s of South Creek	Dry	No of Obs	18	18	18	18	18	18	18	18	18	18	18	18	15	15
			Minimum	6.8	12.5	5.6	69.3	171.0	6.3	0.46	0.01	0.01	0.005	0.022	2.4	0.015	0
			10^{th}%ile	6.9	13.1	6.0	70.1	192.0	8.6	0.48	0.01	0.01	0.006	0.026	6.9	0.017	0
			Median	7.4	20.9	8.2	90.3	295.5	14.0	0.69	0.02	0.28	0.008	0.044	27.5	0.216	0
			Mean	7.3	20.2	8.1	89.0	303.6	14.2	0.67	0.02	0.25	0.009	0.045	27.9	0.332	761
			90^{th}%ile	7.6	26.5	10.3	104.5	417.0	25.0	0.85	0.04	0.56	0.020	0.067	48.7	1.010	2,814
			Maximum	7.7	27.4	10.5	105.1	502.0	26.0	0.94	0.06	0.63	0.021	0.074	51.2	1.243	4,213
			Std dev	0.3	5.1	1.6	11.1	85.9	5.4	0.15	0.01	0.18	0.005	0.015	13.6	0.371	1,356
		Wet	No of Obs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NC11	Lower Cattai Creek at Cattai Ridge Road	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	14	14
			Minimum	6.8	10.8	2.6	30.9	352.0	9.6	0.64	0.02	0.14	0.006	0.023	2.3	0.000	0
			10^{th}%ile	6.9	12.1	3.0	35.2	370.0	14.0	0.77	0.02	0.17	0.007	0.030	3.4	0.000	0
			Median	7.3	19.0	6.0	64.8	621.0	20.0	1.55	0.04	1.10	0.010	0.043	9.4	0.013	0
			Mean	7.4	18.7	6.0	64.0	576.8	20.8	1.94	0.04	1.36	0.011	0.044	15.4	0.032	199
			90^{th}%ile	7.8	25.4	8.1	81.8	706.0	35.0	3.05	0.08	2.20	0.024	0.071	30.7	0.068	422
			Maximum	7.9	26.0	8.2	91.9	712.0	41.0	3.65	0.14	3.20	0.030	0.074	32.8	0.231	2,128
			Std dev	0.3	5.2	1.8	16.9	125.5	8.0	0.86	0.03	0.84	0.006	0.014	10.1	0.061	567
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	0	0
			Value	7.1	20.5	6.0	67.6	374.0	150.0	1.67	0.05	1.11	0.034	0.121	2.8	0	0
N3001	Hawkesbury Nepean River off Cattai SRA, d/s of Cattai Creek	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	16	16
			Minimum	6.9	12.4	5.7	68.0	192.0	5.6	0.44	0.01	0.01	0.005	0.024	2.0	0.001	0
			10^{th}%ile	6.9	13.4	6.0	69.8	227.0	7.1	0.47	0.01	0.01	0.005	0.024	8.0	0.017	0
			Median	7.5	19.9	8.7	93.9	313.0	10.0	0.68	0.01	0.31	0.007	0.039	24.1	0.114	0
			Mean	7.4	20.0	8.5	92.8	311.7	14.1	0.68	0.02	0.26	0.010	0.041	23.9	0.376	2,223
			90^{th}%ile	7.7	27.0	10.7	107.9	407.0	24.0	0.91	0.07	0.50	0.027	0.071	35.3	1.038	9,586

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
			Maximum	7.8	27.0	10.9	111.0	452.0	42.0	1.09	0.08	0.77	0.028	0.079	47.6	1.609	15,577
			Std dev	0.3	5.1	1.6	12.7	68.8	8.8	0.18	0.02	0.21	0.007	0.016	11.0	0.492	4,709
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.6	25.2	9.1	111.9	257.0	16.0	0.51	0.01	0.01	0.006	0.053	78.4	0.081	349
N26	Hawkesbury Nepean River at Sackville, d/s of Cattai Creek	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	16	16
			Minimum	7.0	13.4	6.2	73.0	179.0	5.4	0.40	0.01	0.01	0.004	0.020	1.7	0.000	0
			10th%ile	7.1	13.4	6.3	79.0	196.0	5.7	0.46	0.01	0.01	0.005	0.020	8.7	0.026	0
			Median	7.7	20.2	9.0	97.9	304.0	8.4	0.59	0.01	0.16	0.006	0.033	27.4	0.593	2,741
			Mean	7.7	20.2	8.9	97.8	281.1	10.7	0.60	0.01	0.17	0.008	0.034	26.6	1.272	5,483
			90th%ile	8.0	26.6	10.6	108.1	346.0	18.0	0.85	0.04	0.41	0.019	0.058	37.5	2.825	14,857
			Maximum	8.4	26.9	11.2	117.4	394.0	28.0	0.99	0.04	0.50	0.019	0.063	38.3	7.127	40,737
			Std dev	0.4	4.9	1.5	11.5	62.3	6.1	0.14	0.01	0.15	0.004	0.013	9.5	1.825	10,109
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	8.4	25.5	9.2	113.1	424.0	8.4	0.40	0.01	0.01	0.006	0.038	21.4	1.235	7,308
N2202	Lower Colo River at Putty Road, Reference Site	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	0	0
			Minimum	6.6	10.3	6.3	75.8	98.0	0.9	0.15	0.01	0.03	0.001	0.002	0.4	.	.
			10th%ile	6.7	11.8	6.3	76.2	102.0	1.1	0.16	0.01	0.03	0.002	0.003	0.5	.	.
			Median	7.5	20.2	8.6	90.4	156.0	1.4	0.21	0.01	0.07	0.003	0.006	1.8	.	.
			Mean	7.4	19.0	8.4	90.0	141.2	1.9	0.20	0.01	0.08	0.003	0.006	1.8	.	.
			90th%ile	7.9	24.9	10.7	99.2	165.0	3.8	0.25	0.01	0.15	0.006	0.009	3.8	.	.
			Maximum	8.1	25.5	10.8	108.7	168.0	3.9	0.26	0.01	0.17	0.006	0.011	4.0	.	.
			Std dev	0.4	5.4	1.6	9.6	24.1	0.9	0.04	0.00	0.04	0.001	0.002	1.2	.	.
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	0	0
			Value	7.3	20.3	7.9	88.3	108.0	14.0	0.35	0.01	0.10	0.005	0.016	1.8	.	.
N18	Hawkesbury Nepean River at Leets Vale, d/s of Colo River	Dry	No of Obs	16	16	16	16	16	16	16	16	16	16	16	16	15	15
			Minimum	6.9	13.4	4.6	58.7	189.0	3.4	0.27	0.01	0.01	0.003	0.011	4.0	0.000	0
			10th%ile	7.1	13.8	5.7	71.7	202.0	4.3	0.28	0.01	0.01	0.004	0.015	8.7	0.000	0
			Median	7.5	21.0	8.6	91.5	1827.0	7.8	0.38	0.01	0.05	0.005	0.022	14.2	0.034	0

Site code	Site name	Weather	Date or Stats	pH	Temp °C	DO mg/L	DOsat %	Cond µS/cm	Turb NTU	TN mg/L	Amm mg/L	NOx mg/L	FTP mg/L	TP mg/L	Chla µg/L	CBtotbv mm^3/L	CBtoxcnt cells/mL
			Mean	7.4	20.6	8.3	92.2	2418.4	8.6	0.41	0.01	0.08	0.006	0.024	17.8	0.175	2,639
			90th%ile	7.7	26.6	9.8	106.9	5200.0	16.0	0.59	0.04	0.27	0.009	0.038	31.9	0.545	10,393
			Maximum	8.0	26.6	10.5	117.0	11400.0	18.0	0.62	0.07	0.28	0.010	0.039	44.5	1.013	18,380
			Std dev	0.3	4.7	1.6	13.7	2865.2	4.2	0.10	0.02	0.09	0.002	0.008	10.2	0.293	5,372
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.5	25.4	7.1	88.8	2873.0	5.5	0.35	0.01	0.01	0.007	0.032	25.8	0.246	1,611
NB11	Berowra Creek off Square Bay/Oaky Point	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	8	8
			Minimum	7.4	14.2	5.9	84.6	9700.0	4.0	0.21	0.01	0.01	0.005	0.012	3.6	0.000	0
			10th%ile	7.5	14.2	6.2	84.7	28200.0	4.3	0.22	0.01	0.01	0.007	0.013	3.8	0.000	0
			Median	7.7	20.9	7.7	96.9	40900.0	6.3	0.30	0.01	0.01	0.011	0.022	5.3	0.000	0
			Mean	7.8	20.6	7.6	96.4	37700.0	6.1	0.32	0.01	0.04	0.012	0.022	7.0	0.001	0
			90th%ile	8.2	26.4	9.7	107.9	45700.0	8.7	0.47	0.01	0.17	0.016	0.032	12.5	0.006	0
			Maximum	8.4	26.8	10.1	113.3	46600.0	11.0	0.62	0.03	0.24	0.029	0.035	13.8	0.006	0
			Std dev	0.3	4.6	1.3	7.7	8739.1	1.7	0.10	0.00	0.07	0.005	0.007	3.2	0.002	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.6	25.8	6.2	89.9	43100.0	9.4	0.27	0.01	0.01	0.011	0.022	10.1	0.010	0
NB13	Berowra Creek at Calabash Bay/ Cunio Point	Dry	No of Obs	17	17	17	17	17	17	17	17	17	17	17	17	8	8
			Minimum	7.3	14.0	5.0	71.1	6900.0	1.0	0.22	0.01	0.01	0.005	0.011	1.8	0.000	0
			10th%ile	7.4	14.1	5.4	71.4	25900.0	1.1	0.24	0.01	0.01	0.009	0.016	2.9	0.000	0
			Median	7.7	21.3	7.5	99.9	38800.0	1.6	0.37	0.01	0.01	0.018	0.028	5.5	0.000	0
			Mean	7.7	20.7	7.7	97.6	35823.5	2.2	0.37	0.02	0.06	0.017	0.030	7.7	2.546	0
			90th%ile	8.1	26.8	10.0	125.6	42900.0	3.7	0.50	0.07	0.17	0.029	0.049	16.8	20.280	0
			Maximum	8.4	27.0	10.5	140.9	44000.0	7.4	0.73	0.07	0.28	0.031	0.054	18.1	20.280	0
			Std dev	0.3	4.7	1.6	19.2	8966.2	1.6	0.12	0.02	0.08	0.008	0.012	5.4	7.166	0
		Wet	No of Obs	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Value	7.6	25.3	6.9	98.5	41800.0	2.0	0.35	0.01	0.01	0.020	0.062	10.5	0.000	0

Table 6-34 Water quality ratings for three key variables and percentage samples within guidelines for the Hawkesbury Nepean River (2003-04 to 2013-14)

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
N92	2003-04	11	9	82%	Good	11	10	91%	Good	11	6	55%	Fair
N92	2004-05	10	8	80%	Good	10	9	90%	Good	10	7	70%	Fair
N92	2005-06	9	8	89%	Good	9	8	89%	Good	9	8	89%	Good
N92	2006-07	10	5	50%	Fair	10	5	50%	Fair	10	7	70%	Fair
N92	2007-08	12	8	67%	Fair	12	11	92%	Good	12	5	42%	Fair
N92	2008-09	18	17	94%	Good	18	17	94%	Good	18	12	67%	Fair
N92	2009-10	14	14	100%	Good	14	14	100%	Good	14	12	86%	Good
N92	2010-11	15	15	100%	Good	15	15	100%	Good	15	13	87%	Good
N92	2011-12	14	14	100%	Good	14	14	100%	Good	14	13	93%	Good
N92	2012-13	16	16	100%	Good	16	16	100%	Good	16	16	100%	Good
N92	**2013-14**	**17**	**17**	**100%**	**Good**	**17**	**17**	**100%**	**Good**	**17**	**17**	**100%**	Good
N75	2003-04	11	0	0%	Poor	11	9	82%	Good	11	6	55%	Fair
N75	2004-05	10	0	0%	Poor	10	9	90%	Good	10	8	80%	Good
N75	2005-06	7	0	0%	Poor	7	3	43%	Fair	7	1	14%	Poor
N75	2006-07	9	0	0%	Poor	9	9	100%	Good	9	4	44%	Fair
N75	2007-08	12	1	8%	Poor	12	3	25%	Poor	12	1	8%	Poor
N75	2008-09	17	3	18%	Poor	17	12	71%	Fair	17	2	12%	Poor
N75	2009-10	14	5	36%	Poor	14	14	100%	Good	14	7	50%	Fair
N75	2010-11	16	15	94%	Good	16	16	100%	Good	16	6	38%	Poor
N75	2011-12	14	14	100%	Good	14	14	100%	Good	14	9	64%	Fair
N75	2012-13	16	13	81%	Good	16	15	94%	Good	16	9	56%	Fair
N75	**2013-14**	**17**	**15**	**88%**	**Good**	**17**	**17**	**100%**	**Good**	**17**	**12**	**71%**	Fair
N67	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N67	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
N67	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N67	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N67	2007-08	2	0	0%	Poor	2	2	100%	Good	2	2	100%	Good
N67	2008-09	17	9	53%	Fair	17	16	94%	Good	17	7	41%	Fair
N67	2009-10	15	10	67%	Fair	15	14	93%	Good	15	11	73%	Fair
N67	2010-11	16	11	69%	Fair	16	13	81%	Good	16	8	50%	Fair
N67	2011-12	14	11	79%	Good	14	13	93%	Good	14	4	29%	Poor
N67	2012-13	16	8	50%	Fair	16	15	94%	Good	16	8	50%	Fair
N67	**2013-14**	**17**	**12**	**71%**	**Fair**	**17**	**15**	**88%**	**Good**	**17**	**7**	**41%**	Fair
N57	2003-04	11	8	73%	Fair	11	11	100%	Good	11	11	100%	Good
N57	2004-05	10	10	100%	Good	10	10	100%	Good	10	10	100%	Good
N57	2005-06	7	6	86%	Good	7	7	100%	Good	7	7	100%	Good
N57	2006-07	13	12	92%	Good	13	13	100%	Good	13	13	100%	Good
N57	2007-08	13	7	54%	Fair	13	10	77%	Good	13	12	92%	Good
N57	2008-09	18	13	72%	Fair	18	18	100%	Good	18	18	100%	Good
N57	2009-10	14	13	93%	Good	14	14	100%	Good	14	14	100%	Good
N57	2010-11	15	10	67%	Fair	15	15	100%	Good	15	15	100%	Good
N57	2011-12	15	10	67%	Fair	15	13	87%	Good	15	13	87%	Good
N57	2012-13	16	8	50%	Fair	16	15	94%	Good	16	12	75%	Good
N57	**2013-14**	**16**	**7**	**44%**	**Fair**	**16**	**15**	**94%**	**Good**	**16**	**13**	**81%**	**Good**
N51	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N51	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N51	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N51	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N51	2007-08	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N51	2008-09	18	12	67%	Fair	18	18	100%	Good	18	16	89%	Good

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
N51	2009-10	14	14	100%	Good	14	14	100%	Good	14	13	93%	Good
N51	2010-11	15	14	93%	Good	15	14	93%	Good	15	14	93%	Good
N51	2011-12	15	15	100%	Good	15	15	100%	Good	15	10	67%	Fair
N51	2012-13	15	14	93%	Good	15	14	93%	Good	15	2	13%	Poor
N51	**2013-14**	**16**	**16**	**100%**	**Good**	**16**	**16**	**100%**	**Good**	**16**	**8**	**50%**	**Fair**
N48	2003-04	11	7	64%	Fair	11	10	91%	Good	11	9	82%	Good
N48	2004-05	11	7	64%	Fair	11	11	100%	Good	11	10	91%	Good
N48	2005-06	7	3	43%	Fair	7	4	57%	Fair	7	1	14%	Poor
N48	2006-07	12	9	75%	Good	12	11	92%	Good	12	8	67%	Fair
N48	2007-08	7	3	43%	Fair	7	4	57%	Fair	7	2	29%	Poor
N48	2008-09	17	13	76%	Good	17	17	100%	Good	17	11	65%	Fair
N48	2009-10	14	14	100%	Good	14	14	100%	Good	14	12	86%	Good
N48	2010-11	17	16	94%	Good	17	16	94%	Good	17	14	82%	Good
N48	2011-12	16	16	100%	Good	16	14	88%	Good	16	7	44%	Fair
N48	2012-13	16	15	94%	Good	16	14	88%	Good	16	3	19%	Poor
N48	**2013-14**	**17**	**17**	**100%**	**Good**	**17**	**17**	**100%**	**Good**	**17**	**8**	**47%**	**Fair**
N44	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N44	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N44	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N44	2006-07	0	0	nc	nc	1	1	nc	nc	1	1	nc	nc
N44	2007-08	0	0	nc	nc	1	1	nc	nc	1	1	nc	nc
N44	2008-09	18	3	17%	Poor	18	17	94%	Good	18	16	89%	Good
N44	2009-10	14	4	29%	Poor	14	14	100%	Good	14	13	93%	Good
N44	2010-11	17	12	71%	Fair	17	17	100%	Good	17	15	88%	Good
N44	2011-12	16	14	88%	Good	16	11	69%	Fair	16	12	75%	Good

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
N44	2012-13	16	12	75%	Good	16	6	38%	Poor	16	1	6%	Poor
N44	**2013-14**	**17**	**13**	**76%**	**Good**	**17**	**15**	**88%**	**Good**	**17**	**5**	**29%**	**Poor**
N42	2003-04	11	6	55%	Fair	11	11	100%	Good	11	11	100%	Good
N42	2004-05	11	4	36%	Poor	11	11	100%	Good	11	11	100%	Good
N42	2005-06	7	5	71%	Fair	7	7	100%	Good	7	7	100%	Good
N42	2006-07	12	5	42%	Fair	12	11	92%	Good	12	12	100%	Good
N42	2007-08	12	2	17%	Poor	12	9	75%	Good	12	8	67%	Fair
N42	2008-09	18	6	33%	Poor	18	18	100%	Good	18	18	100%	Good
N42	2009-10	14	6	43%	Fair	14	13	93%	Good	14	14	100%	Good
N42	2010-11	17	10	59%	Fair	17	17	100%	Good	17	17	100%	Good
N42	2011-12	15	9	60%	Fair	15	10	67%	Fair	15	13	87%	Good
N42	2012-13	17	2	12%	Poor	17	7	41%	Fair	17	6	35%	Poor
N42	**2013-14**	**17**	**5**	**29%**	**Poor**	**17**	**13**	**76%**	**Good**	**17**	**10**	**59%**	**Fair**
N39	2003-04	11	8	73%	Fair	11	11	100%	Good	11	6	55%	Fair
N39	2004-05	11	8	73%	Fair	11	11	100%	Good	11	10	91%	Good
N39	2005-06	5	5	100%	Good	5	5	100%	Good	5	0	0%	Poor
N39	2006-07	12	9	75%	Good	12	12	100%	Good	12	10	83%	Good
N39	2007-08	6	3	50%	Fair	6	6	100%	Good	6	4	67%	Fair
N39	2008-09	14	10	71%	Fair	14	14	100%	Good	14	12	86%	Good
N39	2009-10	14	11	79%	Good	14	14	100%	Good	14	14	100%	Good
N39	2010-11	17	17	100%	Good	17	17	100%	Good	17	16	94%	Good
N39	2011-12	14	12	86%	Good	14	12	86%	Good	14	9	64%	Fair
N39	2012-13	17	15	88%	Good	17	14	82%	Good	17	4	24%	Poor
N39	**2013-14**	**17**	**15**	**88%**	**Good**	**17**	**15**	**88%**	**Good**	**17**	**5**	**29%**	**Poor**
NS04	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
NS04	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NS04	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NS04	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NS04	2007-08	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NS04	2008-09	14	0	0%	Poor	14	0	0%	Poor	14	12	86%	Good
NS04	2009-10	14	0	0%	Poor	14	0	0%	Poor	14	13	93%	Good
NS04	2010-11	16	0	0%	Poor	16	0	0%	Poor	16	15	94%	Good
NS04	2011-12	14	0	0%	Poor	14	0	0%	Poor	14	13	93%	Good
NS04	2012-13	17	1	6%	Poor	17	0	0%	Poor	17	11	65%	Fair
NS04	**2013-14**	**17**	**0**	**0%**	**Poor**	**17**	**0**	**0%**	**Poor**	**17**	**13**	**76%**	**Good**
N35	2003-04	11	3	27%	Poor	11	4	36%	Poor	11	1	9%	Poor
N35	2004-05	11	2	18%	Poor	11	4	36%	Poor	11	0	0%	Poor
N35	2005-06	7	2	29%	Poor	7	2	29%	Poor	7	0	0%	Poor
N35	2006-07	11	0	0%	Poor	11	4	36%	Poor	11	1	9%	Poor
N35	2007-08	12	1	8%	Poor	12	2	17%	Poor	12	0	0%	Poor
N35	2008-09	16	3	19%	Poor	16	5	31%	Poor	16	2	13%	Poor
N35	2009-10	15	5	33%	Poor	15	4	27%	Poor	15	1	7%	Poor
N35	2010-11	16	10	63%	Fair	16	5	31%	Poor	16	3	19%	Poor
N35	2011-12	13	8	62%	Fair	13	3	23%	Poor	13	2	15%	Poor
N35	2012-13	15	8	53%	Fair	15	1	7%	Poor	15	0	0%	Poor
N35	**2013-14**	**18**	**9**	**50%**	**Fair**	**18**	**6**	**33%**	**Poor**	**18**	**2**	**11%**	**Poor**
NC11	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NC11	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NC11	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NC11	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
NC11	2007-08	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
NC11	2008-09	12	2	17%	Poor	12	6	50%	Fair	12	9	75%	Good
NC11	2009-10	14	4	29%	Poor	14	12	86%	Good	14	10	71%	Fair
NC11	2010-11	15	3	20%	Poor	15	13	87%	Good	15	15	100%	Good
NC11	2011-12	12	1	8%	Poor	12	5	42%	Fair	12	12	100%	Good
NC11	2012-13	17	0	0%	Poor	17	11	65%	Fair	17	11	65%	Fair
NC11	**2013-14**	**17**	**2**	**12%**	**Poor**	**17**	**14**	**82%**	**Good**	**17**	**10**	**59%**	**Fair**
N3001	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N3001	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N3001	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N3001	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N3001	2007-08	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N3001	2008-09	14	4	29%	Poor	14	5	36%	Poor	14	1	7%	Poor
N3001	2009-10	14	4	29%	Poor	14	7	50%	Fair	14	0	0%	Poor
N3001	2010-11	17	7	41%	Fair	17	8	47%	Fair	17	1	6%	Poor
N3001	2011-12	13	6	46%	Fair	13	1	8%	Poor	13	2	15%	Poor
N3001	2012-13	15	6	40%	Fair	15	2	13%	Poor	15	0	0%	Poor
N3001	**2013-14**	**17**	**9**	**53%**	**Fair**	**17**	**7**	**41%**	**Fair**	**17**	**1**	**6%**	**Poor**
N26	2003-04	11	6	55%	Fair	11	6	55%	Fair	11	0	0%	Poor
N26	2004-05	10	6	60%	Fair	10	3	30%	Poor	10	0	0%	Poor
N26	2005-06	7	6	86%	Good	7	4	57%	Fair	7	0	0%	Poor
N26	2006-07	10	3	30%	Poor	10	4	40%	Fair	10	1	10%	Poor
N26	2007-08	11	1	9%	Poor	11	2	18%	Poor	11	2	18%	Poor
N26	2008-09	14	4	29%	Poor	14	4	29%	Poor	14	1	7%	Poor
N26	2009-10	14	7	50%	Fair	14	5	36%	Poor	14	0	0%	Poor
N26	2010-11	17	9	53%	Fair	17	10	59%	Fair	17	0	0%	Poor

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
N26	2011-12	13	5	38%	Poor	13	1	8%	Poor	13	2	15%	Poor
N26	2012-13	15	12	80%	Good	15	9	60%	Fair	15	0	0%	Poor
N26	**2013-14**	**17**	**15**	**88%**	**Good**	**17**	**12**	**71%**	**Fair**	**17**	**1**	**6%**	**Poor**
N2202	2003-04	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N2202	2004-05	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N2202	2005-06	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N2202	2006-07	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N2202	2007-08	0	0	nc	nc	0	0	nc	nc	0	0	nc	nc
N2202	2008-09	12	12	100%	Good	12	12	100%	Good	12	12	100%	Good
N2202	2009-10	14	14	100%	Good	14	14	100%	Good	14	14	100%	Good
N2202	2010-11	16	16	100%	Good	16	16	100%	Good	16	16	100%	Good
N2202	2011-12	12	12	100%	Good	12	12	100%	Good	12	12	100%	Good
N2202	2012-13	17	17	100%	Good	17	17	100%	Good	17	17	100%	Good
N2202	**2013-14**	**17**	**17**	**100%**	**Good**	**17**	**17**	**100%**	**Good**	**17**	**17**	**100%**	**Good**
N18	2003-04	11	10	91%	Good	11	9	82%	Good	11	7	64%	Fair
N18	2004-05	10	9	90%	Good	10	8	80%	Good	10	3	30%	Poor
N18	2005-06	7	6	86%	Good	7	7	100%	Good	7	3	43%	Fair
N18	2006-07	10	10	100%	Good	10	10	100%	Good	10	4	40%	Fair
N18	2007-08	11	5	45%	Fair	11	3	27%	Poor	11	4	36%	Poor
N18	2008-09	14	14	100%	Good	14	11	79%	Good	14	1	7%	Poor
N18	2009-10	14	14	100%	Good	14	12	86%	Good	14	1	7%	Poor
N18	2010-11	17	16	94%	Good	17	16	94%	Good	17	0	0%	Poor
N18	2011-12	13	12	92%	Good	13	7	54%	Fair	13	1	8%	Poor
N18	2012-13	15	12	80%	Good	15	13	87%	Good	15	3	20%	Poor
N18	**2013-14**	**16**	**16**	**100%**	**Good**	**16**	**14**	**88%**	**Good**	**16**	**1**	**6%**	**Poor**

Site code	year	Total nitrogen				Total phosphorus				Chlorophyll-*a*			
		Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings	Number of samples		% within guideline	Ratings
		Total	Within guideline			Total	Within guideline			Total	Within guideline		
NB11	2003-04	10	10	100%	Good	10	8	80%	Good	10	6	60%	Fair
NB11	2004-05	11	11	100%	Good	11	7	64%	Fair	11	7	64%	Fair
NB11	2005-06	9	9	100%	Good	9	8	89%	Good	9	7	78%	Good
NB11	2006-07	9	9	100%	Good	9	7	78%	Good	9	6	67%	Fair
NB11	2007-08	11	6	55%	Fair	11	9	82%	Good	11	6	55%	Fair
NB11	2008-09	16	14	88%	Good	16	15	94%	Good	16	14	88%	Good
NB11	2009-10	17	15	88%	Good	17	15	88%	Good	17	14	82%	Good
NB11	2010-11	16	14	88%	Good	16	16	100%	Good	16	12	75%	Good
NB11	2011-12	12	7	58%	Fair	12	10	83%	Good	12	5	42%	Fair
NB11	2012-13	15	14	93%	Good	15	14	93%	Good	15	11	73%	Fair
NB11	**2013-14**	**17**	**15**	**88%**	**Good**	**17**	**14**	**82%**	**Good**	**17**	**10**	**59%**	**Fair**
NB13	2003-04	10	10	100%	Good	10	7	70%	Fair	10	6	60%	Fair
NB13	2004-05	11	11	100%	Good	11	9	82%	Good	11	6	55%	Fair
NB13	2005-06	9	7	78%	Good	9	5	56%	Fair	9	6	67%	Fair
NB13	2006-07	9	9	100%	Good	9	7	78%	Good	9	6	67%	Fair
NB13	2007-08	11	4	36%	Poor	11	8	73%	Fair	11	8	73%	Fair
NB13	2008-09	16	12	75%	Good	16	13	81%	Good	16	13	81%	Good
NB13	2009-10	17	11	65%	Fair	17	13	76%	Good	17	11	65%	Fair
NB13	2010-11	16	10	63%	Fair	16	12	75%	Good	16	8	50%	Fair
NB13	2011-12	12	5	42%	Fair	12	8	67%	Fair	12	6	50%	Fair
NB13	2012-13	15	12	80%	Good	15	11	73%	Fair	15	10	67%	Fair
NB13	**2013-14**	**17**	**13**	**76%**	**Good**	**17**	**9**	**53%**	**Fair**	**17**	**9**	**53%**	**Fair**

nc : not computed

Table 6-35 Water quality ratings based on cyanobacteria alert levels (2008-09 to 2013-14)

Site code	Year	Total number of samples						% sample with no alert*	Ratings
		Samples collected	Samples counted for algae	Green alert	Amber alert	Red alert	Total alert		
N92	2008-09	18	7	0	2	0	2	89%	Good
N92	2009-10	14	2	1	1	0	2	86%	Good
N92	2010-11	15	2	0	0	0	0	100%	Good
N92	2011-12	14	1	0	0	0	0	100%	Good
N92	2012-13	16	0	0	0	0	0	100%	Good
N92	**2013-14**	**17**	**0**	**0**	**0**	**0**	**0**	**100%**	**Good**
N75	2008-09	17	17	2	0	0	2	88%	Good
N75	2009-10	14	8	2	0	0	2	86%	Good
N75	2010-11	16	10	0	0	0	0	100%	Good
N75	2011-12	14	6	2	0	0	2	86%	Good
N75	2012-13	16	8	1	0	0	1	94%	Good
N75	**2013-14**	**17**	**5**	**2**	**0**	**0**	**2**	**88%**	**Good**
N67	2008-09	17	11	2	1	0	3	82%	Good
N67	2009-10	15	4	0	0	0	0	100%	Good
N67	2010-11	16	8	0	0	0	0	100%	Good
N67	2011-12	14	10	2	0	0	2	86%	Good
N67	2012-13	16	10	4	0	0	4	75%	Good
N67	**2013-14**	**17**	**11**	**2**	**1**	**0**	**3**	**82%**	**Good**
N57	2008-09	18	3	0	0	0	0	100%	Good
N57	2009-10	14	0	0	0	0	0	100%	Good
N57	2010-11	15	3	2	0	0	2	87%	Good
N57	2011-12	15	8	1	0	0	1	93%	Good
N57	2012-13	16	12	4	0	0	4	75%	Good
N57	**2013-14**	**16**	**8**	**3**	**0**	**0**	**3**	**81%**	**Good**
N51	2008-09	18	5	0	0	0	0	100%	Good
N51	2009-10	14	1	0	0	0	0	100%	Good
N51	2010-11	15	1	0	0	0	0	100%	Good
N51	2011-12	15	6	2	0	0	2	87%	Good
N51	2012-13	15	14	4	1	0	5	67%	Fair
N51	**2013-14**	**16**	**9**	**4**	**0**	**0**	**4**	**75%**	**Good**
N48	2008-09	17	7	2	0	0	2	88%	Good
N48	2009-10	14	2	0	0	0	0	100%	Good
N48	2010-11	17	3	2	0	0	2	88%	Good
N48	2011-12	16	9	1	2	0	3	81%	Good
N48	2012-13	16	13	6	0	0	6	63%	Fair
N48	**2013-14**	**17**	**11**	**6**	**0**	**0**	**6**	**65%**	**Fair**
N44	2008-09	18	3	0	0	0	0	100%	Good
N44	2009-10	14	1	0	0	0	0	100%	Good
N44	2010-11	17	2	0	0	0	0	100%	Good
N44	2011-12	16	4	1	1	0	2	88%	Good
N44	2012-13	16	15	8	2	0	10	38%	Poor

Site code	Year	Total number of samples						% sample with no alert*	Ratings
		Samples collected	Samples counted for algae	Green alert	Amber alert	Red alert	Total alert		
N44	**2013-14**	**17**	**13**	**4**	**2**	**0**	**6**	**65%**	**Fair**
N42	2008-09	18	3	0	0	0	0	100%	Good
N42	2009-10	14	3	1	0	0	1	93%	Good
N42	2010-11	17	4	0	0	0	0	100%	Good
N42	2011-12	15	7	1	0	0	1	93%	Good
N42	2012-13	17	15	5	3	0	8	53%	Fair
N42	**2013-14**	**17**	**15**	**6**	**1**	**0**	**7**	**59%**	**Fair**
N39	2008-09	14	2	0	0	0	0	100%	Good
N39	2009-10	14	2	1	0	0	1	93%	Good
N39	2010-11	17	1	0	0	0	0	100%	Good
N39	2011-12	14	7	3	0	0	3	79%	Good
N39	2012-13	17	14	8	3	0	11	35%	Poor
N39	**2013-14**	**17**	**12**	**5**	**4**	**0**	**9**	**47%**	**Fair**
NS04	2008-09	14	7	1	0	0	1	93%	Good
NS04	2009-10	14	6	0	0	0	0	100%	Good
NS04	2010-11	16	6	0	0	0	0	100%	Good
NS04	2011-12	14	7	0	0	0	0	100%	Good
NS04	2012-13	17	12	0	0	0	0	100%	Good
NS04	**2013-14**	**17**	**10**	**0**	**2**	**0**	**2**	**88%**	**Good**
N35	2008-09	16	14	4	1	0	5	69%	Fair
N35	2009-10	15	15	6	1	0	7	53%	Fair
N35	2010-11	16	13	2	0	0	2	88%	Good
N35	2011-12	13	11	3	0	0	3	77%	Good
N35	2012-13	15	15	7	1	0	8	47%	Fair
N35	**2013-14**	**18**	**15**	**5**	**6**	**0**	**11**	**39%**	**Poor**
NC11	2008-09	12	8	2	1	0	3	75%	Good
NC11	2009-10	14	11	5	2	0	7	50%	Fair
NC11	2010-11	15	8	2	0	0	2	87%	Good
NC11	2011-12	12	6	0	0	0	0	100%	Good
NC11	2012-13	17	10	2	2	0	4	76%	Good
NC11	**2013-14**	**17**	**14**	**3**	**0**	**0**	**3**	**82%**	**Good**
N3001	2008-09	14	13	4	2	0	6	57%	Fair
N3001	2009-10	14	14	4	7	0	11	21%	Poor
N3001	2010-11	17	16	5	0	0	5	71%	Fair
N3001	2011-12	13	12	6	0	0	6	54%	Fair
N3001	2012-13	15	15	4	3	0	7	53%	Fair
N3001	**2013-14**	**17**	**16**	**8**	**5**	**0**	**13**	**24%**	**Poor**
N26	2008-09	14	13	5	7	0	12	14%	Poor
N26	2009-10	14	14	3	8	1	12	14%	Poor
N26	2010-11	17	17	8	7	0	15	12%	Poor
N26	2011-12	13	11	7	1	0	8	38%	Poor
N26	2012-13	15	15	8	5	0	13	13%	Poor
N26	**2013-14**	**17**	**16**	**2**	**10**	**1**	**13**	**24%**	**Poor**

Site code	Year	Total number of samples						% sample with no alert*	Ratings
		Samples collected	Samples counted for algae	Green alert	Amber alert	Red alert	Total alert		
N2202	2008-09	12	0	0	0	0	0	100%	Good
N2202	2009-10	14	0	0	0	0	0	100%	Good
N2202	2010-11	16	0	0	0	0	0	100%	Good
N2202	2011-12	12	0	0	0	0	0	100%	Good
N2202	2012-13	17	0	0	0	0	0	100%	Good
N2202	**2013-14**	**17**	**0**	**0**	**0**	**0**	**0**	**100%**	**Good**
N18	2008-09	14	13	6	4	0	10	29%	Poor
N18	2009-10	14	13	7	1	0	8	43%	Fair
N18	2010-11	17	17	9	5	0	14	18%	Poor
N18	2011-12	13	12	6	2	0	8	38%	Poor
N18	2012-13	15	12	6	1	0	7	53%	Fair
N18	**2013-14**	**16**	**15**	**2**	**4**	**0**	**6**	**63%**	**Fair**
NB11	2008-09	16	2	0	0	0	0	100%	Good
NB11	2009-10	17	3	1	0	0	1	94%	Good
NB11	2010-11	16	6	0	0	0	0	100%	Good
NB11	2011-12	12	7	0	0	0	0	100%	Good
NB11	2012-13	15	5	0	0	0	0	100%	Good
NB11	**2013-14**	**17**	**8**	**0**	**0**	**0**	**0**	**100%**	**Good**
NB13	2008-09	16	3	0	0	0	0	100%	Good
NB13	2009-10	17	6	0	0	0	0	100%	Good
NB13	2010-11	16	10	0	0	0	0	100%	Good
NB13	2011-12	12	6	0	0	0	0	100%	Good
NB13	2012-13	15	5	1	0	0	1	93%	Good
NB13	**2013-14**	**17**	**8**	**1**	**0**	**1**	**2**	**88%**	**Good**

* calculation based on total number of samples collected, not based on total number of samples counted for algae.

6.9 Appendix I Summary of wastewater overflows data

Table 6-36 Trend in dry weather wastewater overflow frequency and volumes for ocean plants wastewater system (2008-09 to 2013-14)

Wastewater system	2008-09		2009-10		2010-11		2011-12		2012-13		2013-14	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
North Head / Northern suburbs	332	3,900	375	4,358	456	4,350	318	8,390	283	3,019	441	8,331
Bondi	34	1,772	35	1,578	33	1,855	14	1,189	37	4,691	18	2,154
Malabar/Southern suburbs	118	2,227	125	3,777	150	3,838	56	1,539	111	7,193	91	7,837
Warriewood	34	85	33	55	32	245	30	81	22	88	52	309
Cronulla	30	428	26	612	28	664	7	270	27	459	25	289
Wollongong	32	300	35	306	17	55	5	69	18	18	17	126
Shellharbour	7	15	11	2,538	6	29	2	6	1	16	3	8
Kiama/Bombo	0	0	10	60	3	66	0	0	0	0	2	25
Port Kembla	0	0	1	0	0	0	0	0	0	0	0	0
All ocean systems	**587**	**8,728**	**651**	**13,284**	**725**	**11,102**	**432**	**11,544**	**499**	**15,483**	**649**	**19,080**

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Table 6-37 Trend in dry weather wastewater overflow frequency and volumes for inland wastewater systems (2008-09 to 2013-14)

Wastewater systems	2008-09		2009-10		2010-11		2011-12		2012-13		2013-14	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
Picton	0	0	1	1			2	21	1	0	4	171
West Camden	4	9	10	171	10	43	1		3	1	5	18
Wallacia	0	0	2	1	2	89	1	6	0	0	0	0
Penrith	12	82	17	149	20	103	3	3	7	117	13	896
Blackheath	1	0	Transferred to Winmalee system									
Winmalee	12	26	17	48	29	87	3	173	10	55	11	250
North Richmond	0	0	1	1	1	10	0	0	0	0	0	0
Richmond	0	0	0	0	1	17	0	0	0	0	0	0
St Marys	17	467	25	94	21	96	9	101	6	331	5	1,823
Quakers Hill	29	95	27	132	23	58	17	43	27	83	38	298
Riverstone	2	2	1	1	0	0	0	0	2	4	1	11
Castle Hill	9	98	6	12	8	11	14	87	12	36	12	394
Rouse Hill	3	23	8	35	8	252	6	37	5	75	14	162
Hornsby Heights	9	11	16	55	21	85	12	102	20	60	19	156
West Hornsby	27	158	22	57	47	1,174	23	71	9	23	37	1,186
Brooklyn-Danger Island	0	0	0	0	1	0	0	0	1	3	0	0
All inland systems	**125**	**970**	**153**	**755**	**192**	**2,026**	**91**	**643**	**103**	**788**	**159**	**5,365**

Table 6-38 Trend in wet weather wastewater overflow frequency and volumes for ocean plants wastewater system (2008-09 to 2013-14)

Wastewater system	2008-09		2009-10		2010-11		2011-12		2012-13		2013-14	
	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)
North Head / Northern suburbs	20	1,066.7	22	3,211.4	21	1,536.1	28	8,979.9	8	4,988.9	11	666.7
Bondi	18	35.6	16	153.6	18	64.4	25	311.1	17	113.1	15	10.6
Malabar/Southern suburbs	27	3,694.0	22	2,757.1	36	2,791.4	30	12,306.6	21	7,645.4	14	1303.5
Warriewood	1	0.0	2	26.1	4	64.0	3	2.6	2	6.0	1	0
Cronulla	6	3.8	4	15.0	10	47.4	7	112.4	6	54.0	1	0
Wollongong	5	100.5	8	22.4	10	180.2	9	67.5	10	126.2	6	126.5
Bellambi	7	28.4	8	58.5	10	208.4	4	36.6	9	224.8	14	315.7
Port Kembla	2	24.0	2	14.9	3	170.7	10	36.6	6	85.6	6	143.1
Shellharbour	0	0.0	1	0.8	2	224.1	9	66.7	7	185.2	4	121.4
Kiama/Bombo	0	0.0	1	3.6	10	45.8	10	28.9	7	39.0	6	29.1
All ocean systems	**86**	**4953**	**86**	**6263**	**124**	**5332**	**135**	**21949**	**93**	**13468**	**78**	**2716.6**

Table 6-39 Trend in wet weather wastewater overflow frequency and volumes for inland plants wastewater system (2008-09 to 2013-14)

Wastewater system	2008-09		2009-10		2010-11		2011-12		2012-13		2013-14	
	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)	Maximum overflow frequency	System overflow volume (ML)
Picton	0	0.0	0	0.0	0	0.0	0	0.0	1	4.9	0	0
West Camden	2	0.2	1	1.5	1	0.7	3	23.0	4	35.2	1	0.4
Warragamba/ Wallacia	1	1.2	1	0.2	1	0.0	3	1.2	5	26.8	0	0
Penrith	2	0.0	3	2.6	1	0.3	6	10.1	3	9.5	1	0
Winmalee	0	0.0	1	0.5	0	0.0	0	0.0	2	4.9	0	0
North Richmond	3	0.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0
Richmond	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0
St Marys	2	0.5	4	13.0	1	2.3	9	69.1	3	100.1	3	8.2
Quakers Hill	7	24.8	7	142.0	6	17.7	17	394.4	4	204.2	4	20.4
Riverstone	0	0.0	1	2.9	0	0.0	1	2.3	1	0.9	1	0.0
Castle Hill	0	0.0	2	3.1	0	0.0	1	0.3	1	0.0	1	0.4
Rouse Hill	0	0.0	2	48.5	0	0.0	2	16.5	0	0.0	0	0
Hornsby Heights	0	0.0	2	24.5	0	0.0	1	0.04	0	0.00	1	0
West Hornsby	1	0.4	3	61.9	2	0.5	5	5.5	1	3.7	1	0
Brooklyn-Danger Island	0	0	0	0	0	0	0	0	0	0.0	0	0
All inland systems	**18**	**27.6**	**27**	**300.7**	**12**	**21.5**	**48**	**522.4**	**25**	**390.2**	**13.0**	**29.5**

6.10 Appendix J Summary of dry weather leakage detection program data

Table 6-40 Yearly summary of routine Blue Mountains faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14)

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Blue Mountains	Blackheath	BHBLH1					33	22		
	Mount Victoria	MVMVC1					9	8		
	Emu Plains	PREMP1					2,300	2,100		
	Glenbrook	PRGLB1	5	5						
	Glenmore Park	PRGNP1			600,000	450,000				
	Jamisontown	PRJMT1			770,000	830,000				
	Mount Pleasant	PRMPL1	No flow	No flow						
	Mount Riverview	PRMRV1							No flow	No flow
	Penrith	PRPNR1							260	310
	Warragamba	WGWAR1							12	8
	Wallacia	WLWAL2	6	10						
	Hazelbrook	WMHAZ1					1	1		
	North Katoomba	WMNKT2					1	1		
	South Katoomba	WMSKT1	2,100	2,800						
	Winmalee	WMWIN1					No flow	No flow		
	Wentworth Falls	WMWWF1					10	10		

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-41 Yearly summary of routine Bondi and Brooklyn faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Bondi	Bondi Beach	BNBNB1							8,200	8,300
	Bondi Junction	BNBNJ1					49	44		
	Camperdown	BNCMD1	130,000	130,000	23,000	22,000	550,000	540,000	39,000	34,000
	Edgecliff	BNEDG1			4,300	4,000	20,000	21,000	19,000	15,000
	Rozelle	BNROZ1	No flow	No flow						
	Rose Bay	BNRSB1					64	64		
	Sydney East	BNSYE1							No flow	No flow
	Sydney West	BNSYW2							110,000	160,000
	Vaucluse	BNVAU1					2,800	3,300		

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-42 Yearly summary of routine Brooklyn faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Brooklyn	Brooklyn	BKBKL1							59,000	24,000

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-43 Yearly summary of routine Cronulla faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Cronulla	Bangor	CRBAG1	27	24						
	Cronulla	CRCRN1	22	22						
	Caringbah South	CRCRS1	59	73						
	Engadine	CRENG1					45	64		
	Gymea	CRGYM2			3,400	3,700				
	Jannali	CRJAN1	29	31						
	Loftus	CRLOF1			12	6				
	Menai	CRMEN1	No flow	No flow						
	Miranda	CRMIR1			3,500	2,900				
	Sutherland	CRSUT1					170	170		
	Woolooware	CRWOL1			2,200	2,500				

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-44 Yearly summary of routine Illawarra faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Illawarra	Kiama	BOKIA1			720	620				
	Albion Park	SHALP1					No flow	No flow		
	Lake Illawarra	SHLIL1			390	410				
	Shellharbour	SHSLH1	17	7						
	Brownsville	WOBSV1	No flow	No flow						
	Bulli	WOBUL1			490	440				
	Corrimal	WOCOR1			20	14				
	Dapto	WODAP1			46	48				
	Figtree	WOFGT1			No flow	No flow				
	Fairy Meadow	WOFMW1			380	430				
	Gwynneville	WOGWY1	540	620						
	Port Kembla	WOPKB1			540	560				
	Thirroul	WOTHI1			340	390				
	Unanderra	WOUNA1	6	8						
	Wollongong	WOWOL1	2,700	2,800						

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-45 Yearly summary of routine Malabar faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Malabar	Ashcroft	MAACT1							400	340
	Alexandria	MAALX1					44,000	36,000		
	Arncliffe	MAARN1	1,500	1,900						
	Ashfield	MAASF1	280,000	270,000	2,700	1,400	7,900	7,300	5,400	4,800
	Ambarvale	MAAVL1					720	1,000		
	Bexley	MABEX1	74,000	37,000	4,800	3,800	89,000	100,000	8,500	9,800
	Blakehurst	MABKH1					12,000	15,000		
	Bankstown	MABKN1			4,000	3,400				
	Banksia	MABKS1			530	560				
	Belmore	MABLM1	8,500	7,900	460	420	12,000	17,000	6,500	7,000
	Belmore South	MABLS1					8,300	7,700		
	Botany	MABOT1					42	36		
	Bonnyrigg	MABRG1			300	320				
	Brighton	MABRT1	170	140						
	Bossley Park	MABSP1			No flow	No flow				
	Beverly Hills	MABVH1	4,900	4,000	1,100	900				
	Cabramatta	MACAB1			900,000	1,100,000				
	Casula	MACAS1			60,000	68,000				
	Campbelltown	MACBT1	170	140						
	Condell Park	MACDP1					550	330		
Malabar	Coogee	MACGE1	7,700	7,800						

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	Chifley	MACHF2	15	9						
	Campsie	MACMP1					7,900	8,800		
	Concord East	MACNE1	370	400						
	Concord West	MACNW1					240	250		
	Chipping Norton	MACPN1	260	230						
	Canterbury	MACTB1	310	320						
	Drummoyne	MADRU1	680	180						
	Dulwich Hill	MADUL1					No flow	No flow		
	Earlwood	MAEAR1			28	39				
	Eagle Vale	MAEGV1	220	260						
	Fairfield	MAFAR1			4,500	4,200				
	Five Dock	MAFVD1			5,900	4,800	890	970	450	600
	Glenfield	MAGNF1			20,000	30,000				
	Greenacre	MAGRA1					2,300	1,700		
	Homebush	MAHOM1			6,000	5,300				
	Hoxton Park	MAHOX1			1	1				
	Hurstville	MAHUR1			210	230				
	Ingleburn	MAING1	580	640	890	870				
	Kensington	MAKEN1					1,800	1,000		
	Kogarah Bay	MAKGB1	1,700	2,000						
	Kogarah	MAKOG1	4,200	4,900						
	Kingsgrove	MAKSG1					430	330		
	Lakemba	MALAK1	3,300	2,600						

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Malabar	Leichhardt	MALCH1	47,000	57,000	3,800	3,500	44,000	41,000	6,000	5,800
	Leumeah	MALEU1							150	200
	Liverpool	MALIV1			43,000	34,000				
	Lansvale	MALNV1					No flow	No flow		
	Lugarno	MALUG1	No flow	No flow						
	Maroubra	MAMAR1			710	740				
	Mascot	MAMAS1					No flow	No flow		
	Minto	MAMIN1	960	840						
	Moorebank	MAMOB1	55	64						
	Mount Pritchard	MAMPR1					No flow	No flow		
	Maroubra Beach	MAMRB1	1	1						
	Marrickville	MAMRV2							2,800	2,200
	Padstow	MAPAD1			2,000	1,900				
	Panania	MAPAN1	7,500	8,500						
	Penshurst	MAPHS1	510	450						
	Peakhurst	MAPKH1					No flow	No flow		
	Randwick	MARAN1	3,800	4,300						
	Raby	MARBY1			No flow	No flow				
	Revesby	MAREV1	260	230						
	Ruse	MARUS1							670	570
	Riverwood	MARVW1	680	620	1,400	1,800				
Malabar	Smithfield	MASMF1	270	340						
	South Sydney	MASSY1	3,300	2,300	42,000	30,000	14,000	16,000	17,000	18,000

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	Strathfield	MASTR1	1,700	2,400						
	Summer Hill	MASUM1	2,700,000	2,400,000	4,200	4,200	30,000	29,000	5,900	4,800
	Sydenham	MASYD1	7,300	3,000						
	Villawood	MAVIL1					1,300	1,100		
	Wakeley	MAWAK1					620	570		
	Woodbine	MAWOD1	140	180						
	Wetherill Park	MAWPK1					350	440		
	Yennora	MAYEN1	110	120						

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-46 Yearly summary of routine North Head faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
North Head	Auburn	NHAUB1	90	98						
	Baulkham Hills	NHBAH1							170	200
	Beecroft	NHBCT1	500	560						
	Balgowlah Heights	NHBGH1	470	450	5,100	6,500	31,000	31,000	6,900	6,600
	Belrose	NHBLR1					45	63		
	Bella Vista	NHBLV1	12	7						
	Brookvale	NHBRK1					36,000	36,000		
	Curl Curl	NHCCL1					4,900	4,600		

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	Chatswood	NHCHW1							2,100	1,500
	Collaroy	NHCLR1			550	490				
	Cromer	NHCMR1					9,600	11,000		
	Cremorne	NHCRM1	150	64						
	Castle Hill	NHCSH1			26	16				
	Dundas	NHDUN1			750	920				
	Dundas Valley	NHDVY1					410	170		
	Eastwood	NHEAS1	120	54						
	East Blacktown	NHEBL1							530	500
	Epping	NHEPP1	45,000	62,000						
	Forestville	NHFRV1					140	120		
	Girraween	NHGIW1			6,800	7,400				
	Guildford	NHGLF1	76,000	68,000	4,000	3,200	4,000	3,400	5,400	5,800
	Greenwich	NHGRW1	630	540						
	Holroyd	NHHOL1	150	160						
	Hornsby	NHHOR1					6,900	5,500		
	Hunters Hill	NHHUN1					No flow	No flow		
	Killara	NHKIL1			32	32				
	Killarney Heights	NHKLH1					460	410		
	Lidcombe	NHLID1	1,300	1,400	8,000	7,400	7,300	8,800	35,000	29,000
	Lindfield	NHLIN1			190	220				
	Lane Cove	NHLNC1					No flow	No flow		
	Manly	NHMNY2					110,000	71,000		

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	Mosman	NHMOS1	No flow	No flow						
	Macquarie Park	NHMQP1			No flow	No flow				
	North Epping	NHNEP1	45	27						
	North Parramatta	NHNPR1					2,000	2,800		
	Naremburn	NHNRB1	33,000	34,000						
	North Ryde	NHNRD1			No flow	No flow				
	North Sydney	NHNSY1	1	1						
	Parramatta	NHPAR1	260	190						
	Pendle Hill	NHPNH1			64	56				
	Rosehill	NHRSH1	260	580						
	Roseville	NHRSV1			760	73				
	Ryde	NHRYD1			No flow	No flow				
	Rydalmere	NHRYL1					11	31		
	Seaforth	NHSEA1							480	420
	Silverwater	NHSIL1	190	180						
	Seven Hills	NHSVH1							600	580
	South Wentworthville	NHSWT1			580	540				
	Turramurra	NHTUR1			5	5				
	Wahroonga	NHWAH1			12	10				
	Willoughby	NHWIL1	210	190						
	West Lindfield	NHWLI1			82	150				
	Westmead North	NHWMN1			No flow	No flow				
	Westmead South	NHWMS1	27	27						

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	West Pennant Hills	NHWPH1	2,200	2,900						
	West Ryde	NHWRY1			390	500				
	Winston Hills	NHWTH1					480	530		
	West Turramurra	NHWTU1	2,200	3,000						
	West Wahroonga	NHWWA1			No flow	No flow				
	Wentworthville	NHWWV1					No flow	No flow		
	Yagoona	NHYAG2			5,900	4,200				

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-47 Yearly summary of routine Warriewood faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Warriewood	Avalon	WWAVA1							1,300	1,300
	Elanora Heights	WWELH1					490	410		
	Newport	WWNEW1					2,800	2,700		

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-48 Yearly summary of routine West Camden faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
West Camden	Camden	WCCMD1					No flow	No flow		
	Mount Annan	WCMAN1	3,300	2,400						
	Narellan	WCNRL1			38	27				
	Oakdale	WCOKD1	16	18						

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart

Table 6-49 Yearly summary of routine Western Sydney faecal coliform measurements (cfu/100 mL)* at SCAMP outlets as part of the dry weather leakage detection program (2013-14).

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Western Sydney	Castle Hill STS	CHCHS1			1	1				
	Hornsby Heights	HHHHT1					160	150		
	North Richmond	NRNRC1	110	100						
	Blacktown	QHBLT1			240	300				
	Doonside	QHDON1			150	110				
	Oakhurst	QHOKH1					74	98		
	Quakers Hill	QHQHL1	450	480						
	Rouse Hill	RHRHL1					76	64		
	Richmond	RMRIC1					No flow	No flow		
	Riverstone	RSRVS1	4,700	4,400						
	Blackett	SMBCT1					1,800	1,600		

System	SCAMP	Site Code	Jul 13 – Sep 13		Oct 13 – Dec 13		Jan 14 – Mar 14		Apr 14 – Jul 14	
			Rep 1**	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
	Mount Druitt	SMMDR1	27	27						
	St Marys	SMSMY1			39	34				
	Werrington	SMWER1			7	9				
	Cherrybrook	WHCHB1			82	82				
	Thornleigh	WHTHO1	780	640						

*Routine faecal coliform measurements greater than 5000 cfu/100 mL warranted resampling and investigation of the catchment.

**Rep 1 and Rep 2 are replicate samples taken five minutes apart